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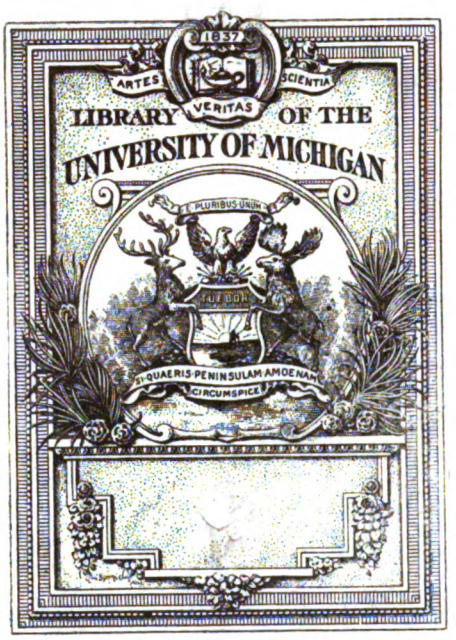

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THE

ELECTRICAL ENGINEER.

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NOTES.

Hawarden.—A 15,000-c.p. arc lamp, to be erected on the Heights, is to astonish the natives.

Central London Railway.—The Royal assent has been given to the Central London (Extension of Time) Bill.

The Cape.—Mr. Cecil Rhodes has announced that the overland telegraph wire will be open to Blantyre in October.

Central Station at Stuttgart.—Messrs. Schuckert and Co. have obtained the contract for this central electric light station.

Telephony in Switzerland.—Telephonic communication has been established between St. Gall and Appenzell. Another line joins Appenzell with Weissbad and Schwendi.

Wiener Privat-Telegraphen-Gesellschaft.—A dividend of 5 per cent. for the past year is declared by the directors. For the previous year the dividend was 3 per cent.

Electricity at Baden-by-Vienna.—In this watering place the streets were lighted electrically for the first time on the 23rd ult. An electric tramway has also been opened.

Hamburg Traction.—Work will shortly be commenced in connection with the construction of an electric railway from Hamburg to Ohlsdorf. Surveys have been completed.

Berlin Electric Traction.—The Charlottenburg Horse Tramway Company have obtained a concession for the use of electric traction from the Brandenburg Gate to the End Station.

Traction on Tramways.—Mr. Denny Lane, in a letter to a Cork paper, pins his faith to the use of gas motors on tramways. No one expected any other expression of opinion from him.

New Book on Telephony.—A work entitled "La Téléphonie," by M. Emile Pierard, has just been published by M. Ch. Desoer, Rue Gerardrie, Liège. It contains 224 illustrations, and is issued at the price of 8f.

That Weekly Paper.—The *Daily News* has just heard of the proposal to construct an electric railway to the top of Snowdon, and to which we referred in our issue of June 22. Better late than never, granny, eh!

Messrs. Lahmeyer and Co.—The balance-sheet for the past working year of the Elektricitäts-Aktiengesellschaft vorm. W. Lahmeyer and Co., of Frankfort-on-the-Maine, shows a deficit of about £2,000, but future prospects are good.

The Commercial Company's Cable.—Messrs. Siemens Bros. telegraph that the steamer "Faraday" completed the laying of the Commercial Cable Company's third Atlantic cable on Monday. The insulation is perfect. During the laying of the cable no hitch of any kind occurred, but operations were much impeded by dense fogs.

Internationale Druckluft und Elektricitats-Gesellschaft.—The gross receipts for the past year of this Berlin company amounted to £40,700, and mainly consisted of interest on advances made to the Paris company.

Electric Traction in St. Petersburg.—The secretary of the Imperial Institute of Engineers of Russia notifies that the tramway lines of St. Petersburg are to be equipped with the best street railway motors that can be obtained. Full particulars and specifications are obtainable from H. N. Mollwo, whose address is 72, English-quay, St. Petersburg.

The Next Cable Move.—The plague in Hong-Kong unfortunately continues, but the *Financial Times* having seen through the dodge, owing to our exposure, has ceased printing items about this epidemic from the *Cable Gazette*, whose next move, it may be expected, will be to spread news about the outbreak of swine fever on the west of Salisbury-court.

Electric Lighting at Essen.—The new building of the Rhenish-Westphalian Coal Syndicate has been lighted electrically. A 50-h.p. Deutz gas-engine supplies motive power to a 600-light dynamo. There are also accumulators for 400 lamps. At present there are installed 600 incandescent lamps and two arc lamps. The installation has been carried out by Herr Ringsdorff, of Essen.

Lighting of the Embankment.—The Works Committee of the London County Council have declined to carry out the electric light installation for Westminster and Waterloo Bridges and the embankment on the ground that the estimates of the Highways Committee were too low. The latter committee have proposed that the work should be put out to tender, and this will be considered next week.

The Brillie Meter.—The Brillié meter for the measurement of electrical energy, according to an article by M. Paul Robert in *Electricité* of June 21, has been considerably improved. Four years have elapsed since the introduction of this type of meter, which in its improved form possesses mechanical features different from those of the old class, and which have rendered the meter more of a practical character.

How Garnesdon Got Electricity.—The *Indian Engineer* of June 9 is kind enough to commence the publication, without the acknowledgment of the source, of the original piece of fiction that appeared under this heading in our issue of May 11. It is to be hoped that the fate of our Indian contemporary for this delinquency will not be the same as that of Mr. Rogers, the chairman of the Garnesdon Local Board.

Equal to Sheet Lightning.—An absurd proposal has just been submitted to the French Academy of Sciences by a too zealous electrician. He suggests, in order to prevent explosions in coal mines, that electricity should be employed for igniting fire-damp before the miners descend the shaft. This ridiculous proposal, which

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if carried into practice would almost be a worse remedy than the evil itself, is about equal to the idiotic remarks made regularly by an electrical sheet.

French Electro-Metallurgical Company.—The following is the production of aluminium at the works of the French Electro-Metallurgical Company during the past four years :

	Neuhausen works.	Froges works.
1890	30 tons	7 tons.
1891	60 tons	20 tons.
1892	300 tons	60 tons.
1893	1,000 tons	260 tons.

Laundries.—A parliamentary paper has been issued giving the reports of her Majesty's inspectors of factories as to the condition of laundries, and among improvements suggested are the keeping down the temperature of the ironing-rooms by proper ventilation or fans where required. Where gas irons are used they should be such as do not emit offensive fumes. The steam should be conveyed from the wash-houses by ventilation or the use of fans. Here is a chance for the introduction of electrically-driven fans and of electric irons.

Electric Light at Dresden.—The central electric light station for lighting the Dresden railway stations comprises two Germania boilers, two Hartmann steam-engines, each of 330 h.p., and two rotary-current Siemens and Halske dynamos. By the end of the year the plant will be doubled, so that 1,320 h.p. will be available. It is intended to drive electric motors at the railway works. At present 100 arc and 400 incandescent lamps are connected. There will ultimately be about 600 or 700 arc lamps and 4,000 incandescent lamps.

Electric Boring Machines for Mines.—In a communication recently made to the Société de l'Industrie Minérale, M. Neu described the electric boring machines made by the Thomson-Houston Company. The author mentioned that the coal basin of the Nord and Pas-de-Calais could claim to be one of the first to introduce the application of electricity in mines, and also the use of electric locomotives, which were set in operation at Marles three years ago, and which were the first of this kind adopted in France for mining purposes.

Personal.—The council of the Society of Arts have awarded the society's silver medal to Mr. W. Worby Beaumont for his paper on "Automatic Balance of Reciprocating Machinery, and the Prevention of Vibration." The thanks of the council have been voted to Mr. W. H. Preece, C.B., F.R.S., for his paper on "Electric Signalling without Wires." Among the Civil List pensions granted by the Government during the year ended June 20 is one of £50 to Mr. Samuel Alfred Varley, in consideration of his services to electrical science.

The Magneto Hand Telephone.—Mr. Norman Hughes has written a booklet entitled "The Magneto Hand Telephone," which is published by Messrs. Spon and Chamberlain, of New York, and Messrs. E. and F. N. Spon, of 125, Strand, W.C. This little work is submitted to the consideration of all interested in telephony, with a view to enable other than licensees to benefit by the expiration of the main patent on the Bell telephone. It deals with the construction, fitting up, and adaptability to everyday use of the magneto hand telephone.

The French Thomson-Houston Company.—The Compagnie Française pour l'Exploitation des Procédés Thomson-Houston have declared a dividend on the past year's working of 5 per cent. The Company have decided to manufacture their electrical plant in France, and for this purpose the works of M. Postel-Vinay are to be acquired by a new company to be formed by the latter and by the Thomson-Houston Company. It has been resolved to increase the capital of the Thomson-Houston Company from £40,000 to £200,000.

A Water-Finder.—We learn from an Austrian electrical paper that Count Wrschowe Sekera von Sedczicz has met with much success as a finder of water, having discovered about 3,000 springs and only had about a dozen failures. He carries with him on his search platinum chains, a magnet, and a watch, and in consequence his system is amusingly referred to as an electrical method. The willow wand used by water wizards in this country has just as much to do with the finding of the water as anything electrical in connection with the count with the jaw-breaking name.

Electricity at Novare.—A central electricity station has been erected at Novare, on the right bank of the Quintino Sella Canal on the road to Milan. Water power to the extent of 300 h.p. is available, of which only 180 h.p. is at present utilised. There are two Jonval turbines driving a three-phase alternating-current dynamo of 19 amperes and 3,000 volts with a separate exciter. The central station is about a mile from the town, in the centre of which is a transformer station, where the pressure is reduced to 110 volts. The current is employed both for lighting and power purposes.

Legalising Electrical Units.—The United States House of Representatives have passed a Bill to define and establish the units of electrical measure. It gives legal recognition to the eight units of electrical measure adopted by the International Electrical Congress, which met in Chicago last autumn. These electrical units are the familiar units of resistance, current, and E.M.F., known as the ohm, the ampere, and the volt respectively. To these are added the unit of quantity, designated as the coulomb ; the unit of capacity, called the farad ; the unit of work, the joule ; the unit of power, the watt ; and the unit of induction, called the henry.

Union Elektricitats-Gesellschaft.— The annual report of this Company has been issued. During 1893 the Company constructed the electric tramways at Bremen and Remscheid, and commenced work on tramways in Hamburg, Erfurt, Gotha, and Brussels, which have since been put into operation. The length of these lines is about 41 miles. The Hamburg Street Tramway Company have also given an order for 42 miles of line and 105 motor cars. As the bulk of the work carried out during the past year was not paid for within the year the balance-sheet shows a loss of £8,457. In the current year this will be wiped off, and the directors expect that a satisfactory dividend will be paid.

The Brown Alternating-Current Motor.—Some interesting figures are given by M. Riccardo Arnò in the *Elettricista* of June 1 embodying the results of tests made with a Brown alternating-current motor of 11 kilowatts capacity at Intra in connection with the installation put down there for M. C. Sutermeister. This motor, which is designed for a frequency of 40 periods per second, a difference of potential of 150 volts, and an angular speed of 800 revolutions a minute, is 48cm. long, 60cm. wide, 61·5cm. high, and weighs 615 kilogrammes, including the pulley. It appears from the tests that the efficiency of the motor fully loaded was 88 per cent., and 50 per cent. at one-tenth of the load.

The Late M. Edmond Carre.—*L'Electricien* of June 30 announces the death of M. Edmond Carré, who was the first manufacturer of carbons for arc lamps, as invented by his brother, M. Ferdinand Carré. He was

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born in 1823 at Moislains, Somme, and in 1868 established works in Paris for the manufacture of refrigerating machinery, but he did not come into prominence until the exhibition of 1878, when he showed various inventions of his brother, comprising refrigerating machinery, carbons, regulators, dielectric machines—receiving three gold medals and one silver medal. At the electrical exhibition of 1881 he obtained fresh successes with carbons and dielectric machines. The carbons brought him a handsome fortune.

Telegraphy with the Far East.—The twenty-fifth anniversary of the establishment of cable telegraphic communication with the Far East will be celebrated by a banquet at the Imperial Institute on Friday, the 20th inst., to be attended by gentlemen representing every section of the British Empire. The buildings and grounds will be specially arranged and illuminated for the occasion. Invitations to the reception state that guests are to have the honour of meeting the Prince of Wales, who, it is expected, will be accompanied by other members of the Royal family. An interesting feature of the celebration will be the display of cable telegraphic instruments in working communication with the four quarters of the world.

Lighting at Hastings.—The ceremony of switching on the electric light to the whole front esplanade, the three miles from the Fish Market to the end of the Marina, was performed on Saturday by the Mayor of Hastings (Alderman Tree). The light has been used for the illumination of a portion of the front for several years. In place of 15 lamps previously used, 52 2,000-c.p. lamps have been substituted, and these were turned on simultaneously in the presence of thousands of people. Previous to the ceremony there was a banquet at the Eversfield Hotel, presided over by Mr. H. M. Baker, chairman of the electric light company, and the guests included the mayors of Hastings and Winchester, and representatives of other municipalities.

The Electric Light in Warfare.—Some interesting experiments are to be carried out in connection with the use of search-lights for night attacks, and in the practice of besieging operations at Thorn by the German army during their forthcoming manœuvres. The plant consists of an 18-h.p. portable engine, with dynamo and search-light. The projector is not used directly, but through the medium of a mirror about 600ft. distant, so that the enemy is unable to fix the position of the plant. The mirror has an electric motor attached to it, which is connected to the dynamo by means of two cables. This allows of the mirror being moved to any desired angle by those in charge. A similar arrangement will be used in the naval manœuvres for the defence of ports.

Laying of New Mains.—The House-to-House Electric Light Supply Company intend to lay high-tension mains and to construct street boxes in Redcliffe-gardens and a short part of Fulham-road; the London Electric Supply Corporation are about to lay trunk mains in St. Thomas's-street, Maze Pond, Great Maze Pond, Snow's Fields, and Newcomen-street; the City of London Electric Lighting Company propose to lay mains across the Victoria-embankment at four points—namely, Temple-avenue, Carmelite-street, and each side of John Carpenter-street, and to connect the new mains with those in the subway of the embankment; and the Kensington and Knightsbridge Electric Lighting Company intend to lay mains and to construct street boxes in Stamford-road, Kensington.

Telegraphy in Africa.—The African Transcontinental Telegraph Company and the Portuguese Government have arrived at an agreement by which the latter undertakes to construct the telegraph line through the Portuguese sphere on the Zambesi, and will charge the company an annual rental for maintenance. There will be no telegraph station within the Portuguese sphere, and it is understood that the Government will make use of the Transcontinental Telegraph Company's material now on the spot in order to prevent delay in proceeding with the construction. A German daily paper prints an apparently inspired article contradicting the reports that the German Government had granted to an English company, or even to the English Government, a concession to construct a telegraph line in the German East African Protectorate.

Excursion to Antwerp.—As mentioned in our last issue, the Northern Society of Electrical Engineers have made arrangements for an excursion to the Antwerp Exhibition. A special saloon carriage will be attached to the train leaving the London-road Station, M.S. and L., Manchester, at 3 p.m. on Friday, July 20, arriving at Harwich at 9.20 p.m. The party will embark on the steamer which leaves Harwich (Parkeston Quay) at 10.15 p.m. and arrives in Antwerp at 10 a.m. Saturday. The party will return from Antwerp at 6.45 p.m. on Monday, July 23, arriving in Manchester at 3 p.m. the following day. Those members who do not find it convenient to travel from Manchester can join the party at Harwich. Mr. John Darney, the honorary secretary of the society, will be glad to hear from those who may be desirous of accompanying the party.

Electric Shot Firing.—Before the recent meeting of the North of England Institute of Mining and Mechanical Engineers, Mr. J. D. Kendall contributed a paper on misfires. In the course of the discussion, Mr. J. L. Hedley, H.M. inspector of mines, in regard to inferior detonators, suggested the desirability of using a galvanometer to test each detonator before it was sent into the mine; and as Mr. Kendall said defective fuse was the most abundant source of mis-fires, why not do away with the fuse altogether and use the electric battery. No doubt this suggestion would sound revolutionary to many miners, but if once adopted the change would never be regretted, and the evils and dangers arising from the present system of shot firing would to a great extent disappear. He was glad to learn that several gentlemen connected with mining in the district had taken the matter up in a way which would not only conduce to extra safety at their own mines, but would, he trusted, be the means of inducing others to take similar steps for the protection of their workmen.

Electric Lighting at Chemnitz.—About a year ago the Chemnitz Municipality instructed Messrs. Siemens and Halske to erect a central electric light station in that town. This is now completed and at work. Owing to the large area which had to be supplied, a system of high-tension rotary current has been employed, and the installation is the largest of this description in Germany. The station lies at the periphery of the town. There are three triple-expansion condensing engines, made by the Saxon Machinery Works, and these are of 220 effective horse-power. Each engine is coupled direct to a Siemens and Halske rotary-current dynamo, and also drives the continuous-current exciting dynamo. The capacity of each of the generating dynamos at 150 revolutions and full excitation is 180,000 watts, at a pressure of 2,000 to 2,200 volts. Concentric triple conductors carry the current to transformers in the neighbourhood where the current is to be used, the pressure being transformed to 120 volts. The low-pressure current is then further transmitted by concentric triple conductors.

"Vanity Fair" Unfair.—If the following quotation from *Vanity Fair* is a criterion of the accuracy—inaccuracy, we should say—of the personal paragraphs published in that paper under the title of the "Man of the Day," we

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pity the recipients of these personals! Our contemporary, in writing of Mr. C. Grey Mott, says: "When 10 years ago an Act of Parliament was obtained for the construction of a subway between the Monument and The Elephant and Castle (which was to be worked by the endless cable system of America), he was persuaded to preside over the destinies of the company whose enterprise it was. Then, quickly recognising the difficulties that were ahead of the company, he began to study electricity as a means of locomotion, and studied it to such purpose that he presently and successfully worked out a system of electric traction which was in advance of the times; the result being that the company adopted his ideas." As a matter of fact the tunnel was carried out on the Greathead system; the three-rail electric system is that of Dr. Hopkinson; and the design of the first locomotives that of Messrs. Mather and Platt.

Plant for the Transmission of Power.—The recent terrible colliery disasters in South Wales and in Silesia point once more to the urgent necessity for a wider adoption of electricity for lighting and power purposes in mines, so as to minimise, if not practically prevent, the loss of life through explosions. In this connection the new catalogue issued by Messrs. John Davis and Son, of Derby, dealing with plant and apparatus for the transmission of power in mining and other operations, and for electrical illumination, comes out at an opportune moment. The Davis and Stokes's safety motor for use in fiery and dusty mines may be mentioned first. The safety commutator overcomes the difficulty of rendering sparking at the brushes harmless in an explosive atmosphere, and unless the commutator is securely closed, the motor fitted with it cannot be operated. The estimates given for electric lighting plant for mills, collieries, and private houses, for combined pumping and lighting plant, and for electric haulage plant, are interesting. A list of some of the various installations carried out on these lines is contained in the catalogue, where special protective fittings for incandescent lamps are priced and illustrated. The remaining portions of the list deals with steam dynamos, boilers, gas-engines, general fittings, switchboards, arc lamps, electric blasting apparatus, measuring instruments, telephones, etc.

The Proposed Pacific Cable.—The Inter-Colonial Conference, to which reference has been made in previous issues, was opened at Ottawa last week. The conference was engaged on Monday in the discussion of the Pacific cable question, which was brought forward by the Hon. F. B. Suttor (New South Wales). A paper was read by Mr. Sandford Fleming, in which he submitted proposals for the construction of the cable under an Imperial and colonial guarantee. The consideration of the subject was resumed on Tuesday and Wednesday. When the conference rose on Wednesday afternoon it was officially announced that a resolution had been passed endorsing the project of a Pacific cable free from foreign control, and asking the Imperial Government to cause an accurate survey to be made of the proposed routes at the joint expense of Great Britain, Canada, and Australasia. None of the colonies will commit themselves definitely to the scheme until the prospective cost has been ascertained. It is estimated that the cost of the preliminary survey would not exceed £25,000. A recent issue of the *Sydney Daily Telegraph* contains the following: "In view of a possibility that the Solomon Group will be included in the Pacific cable route, H.M. surveying ship 'Penguin,' which returned to port on May 5, will shortly commence some important work between Queensland and these islands. The ship is at present under orders to make a survey of Jervis Bay, and as soon as this work has been completed—probably in a month hence—she will proceed northward and take a line of soundings from a point north of Brisbane to the Solomon Islands in connection with the proposed Pacific cable. The ship will subsequently make a stay of several months in the islands, the officers meanwhile completing the survey of the group."

Gift to the Royal Institution.—The Royal Institution on Monday confirmed the acceptance by the managers of the offer by Mr. Ludwig Mond of a munificent endowment of scientific research. Last year Mr. Mond acquired the large freehold house, No. 20, Albemarle street, contiguous to the buildings of the Royal Institution. This house he has resolved to convey in fee simple to the Royal Institution, and to defray the expense of converting it from its present uses into a laboratory of chemical and physical research, to be called the Davy-Faraday Research Laboratory, and of equipping it with everything necessary for the conducting of scientific research upon a large scale. By this generous offer, Mr. Mond realises an idea which engaged the attention of Faraday and Brande and the managers of the Royal Institution half a century ago. The Davy-Faraday laboratory is to be placed under the management of a committee nominated by the managers of the Royal Institution from among themselves, while the laboratory will have a competent chief of its own, devoting all his time to its work. Mr. Mond desires that the resident professor at the Royal Institution should accept the position of director, thus further strengthening the ties between the Royal Institution and the laboratory as well as ensuring for the latter all the aid it is in the power of the Royal Institution to afford. The laboratory is to be free to all persons, without distinction of sex or nationality, who in the opinion of the managers of the Royal Institution are fully qualified to undertake scientific investigation, preference being naturally given to those who have actually done original work. After providing for all the needs of the Davy-Faraday research laboratory, the house given to the Royal Institution will afford space sufficient to provide a considerable addition to the accommodation of the Royal Institution itself.

High-Pressure Continuous-Current Transmission.—A concession was granted some time ago for the erection and working for 40 years of an electric light station in the town of Sigmaringen. This installation, which has been carried out by the Schuckert Company, comprises two main features: (1) the electrical transmission of power by means of high-tension direct current, and (2) electric light plant in conjunction with accumulators. With regard to the latter, the installation is arranged on the three-wire system, the conductors being partly carried overhead and partly underground. The batteries are of the Pollak type. At Lauchterthal, just over three miles distant from Sigmaringen, is a fall of water which has been profitably used in this undertaking. The turbines in which the water, which has a fall of 30ft., is utilised are two in number, having been furnished by Mr. J. M. Voith, of Heidenheim. They are each of 182 h.p. One drives a dynamo and the other supplies power for the working of the Lauchterthal rolling-mill. The generating station contains three four-pole dynamos, one of which is kept as reserve, and each of which at 460 revolutions a minute gives a continuous current of 61 amperes at 1,100 volts. The transmission is effected on the three-wire system, two of the dynamos being connected in series, and thus yielding 2,200 volts. At the secondary station in Sigmaringen are installed three similar four-pole motors coupled direct to dynamos of the same type. The motors each give off about 70 h.p., which is directly trans-

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mitted to the dynamos, which at a mean pressure of 260 volts yield 170 amperes; the two motors at work are, of course, united in series, the third forming a stand-by. A portion of the current is utilised for charging accumulators and partly for direct supply. The number of lamps connected is 3,000 incandescents and 20 arc lamps, whilst several electric motors are also energised.

The Transmission of Rectified Currents.—In the *Electrical Engineer* of May 4 was given an illustrated description of the Hutin and Leblanc system and apparatus for the conversion of alternating into direct currents. An interesting application of this method in the transmission of electrical energy between La Chapelle and the Epinay railway station has now been carried out for the Northern of France Railway Company. The problem which MM. Hutin and Leblanc had to solve was as follows: given a continuous current at from 110 to 170 volts, furnished by an Edison dynamo at La Chapelle electricity works, and working only a few hours a day, to transmit the current to the Epinay railway station and to utilise it in the charging of accumulators for the lighting of the station. The distance separating the electricity works and the railway station is about five miles. The solution of the problem was found in the use of rectifiers. For this purpose a frequency and pressure transformer has been put down, this converting the direct current at the electricity works into an alternating triphase current of from 4,500 to 6,000 volts. A similar apparatus at the receiving end of the line—that is, at the railway station—is employed for retransforming this triphase alternating current into direct current. The electricity works contain an Edison dynamo capable of giving 100 amperes at from 110 to 200 volts. The transformer located here is of 15 kilowatts capacity. An identical transformer, as already mentioned, is arranged at the railway station, and supplies the current to a battery of accumulators, the object of which is to energise 64 incandescent lamps, which constitute the illumination of the station. Our French contemporary *Electricité*, from which this information is abstracted, states that as a result of the Epinay experiments it may be concluded that the efficiency of a fairly important transmission scheme on the Hutin and Leblanc system may reach 90 per cent., including the loss in the line.

Phosphorescence.—The production of liquid oxygen in considerable quantities at the Royal Institution has afforded a convenient means of investigating the behaviour of substances exposed to light at a temperature of 180deg. below zero, and at a meeting of the Chemical Society held on Thursday last week at the Royal Institution, Prof. Dewar gave an account of the researches which he has lately been carrying out in this direction. Finding that at low temperatures chemical action is almost, if not quite, in abeyance, Prof. Dewar was led to try whether photographic action also ceases. He found that it does not, though it is diminished by 80 per cent. or more. While investigating this, he noticed that the apparatus with which he was working was phosphorescing brightly, and he was thus induced to study phosphorescence itself at low temperatures. Beginning with gelatine and celluloid—substances which he was using in his photographic experiments—he found them to be very luminous when cooled to 180deg. and exposed for a second to the beam of a strong electric light. In the same way phosphorescence was produced in numerous other organic substances, such as ivory, bone, indiarubber, egg-shell, feathers, cotton-wool, linen, leather, blossoms of flowers, etc. Naturally the question presented itself of the relation of phosphorescence to structure. Prof. Dewar therefore experimented with various definite organic compounds. From these and other experiments he is led to the provisional generalisation that the more complex a body is in structure, the more likely it is to phosphoresce, perhaps because in some way its structure enables it to take up the light-vibrations with the more facility. The capability of oxygen for phosphorescing is another curious fact. In the gaseous state it can be made to glow if exposed to an electric spark while rushing into a large vacuum tube. This property is shared by its compounds, but is not possessed by hydrogen or any other gas. Here, strange to say, the presence of a trace of organic matter destroys the effect. Prof. Dewar stated that a drop or two of ether or of scent in the room would make the experiment impossible for hours. That the phosphorescence is due to some kind of molecular change in the oxygen is indicated by the fact that ozone, among other products, is formed during the process.

An Electric Steering Compass.—A new electric steering compass has been devised by Lieutenant Bersier, of the French navy. In this appliance the needle of the compass actuates the rudder by means of an electric current, and thus precludes the possibility of any error on the part of a living steersman from fatigue or confusion. The difficulty of constructing such a compass hitherto has been owing partly to the heaving of the ship, and partly to the difficulty of causing the delicate needle or card to act on the steering gear without impeding its motion. In Lord Kelvin's compass, for example, the card is merely a skeleton disc of paper, silk thread, and aluminium with eight parallel wires of magnetised steel underneath, and it rests freely on a point or pivot of iridium or other hard metal by means of a cup of ruby or sapphire. The slightest contact with another body would disturb its motions in the magnetic field of the earth. M. Bersier, according to the *Times*, gets rid of all contact by making the current form a Ruhmkorff coil spark from a metal point on the edge of the card to semi-circular plates of metal insulated from each other and from the sides of the compass bowl in which they are fixed. The coil is excited by a battery if there is no electric lighting installation on the vessel; and a current of two to three amperes is sufficient. A wire from the coil leads to the pivot of the card and the cup over it, from which a light wire along the radius of the card corresponding to "north," conveys the current; and according as the ship is to right or left of the course a spark three centimetres long passes to the right or left plate in the bowl and excites one or other of two electromagnets forming the circuit of a small electromotor. This motor works the steering motor like the hands of a man. The mechanism can be applied to any existing steering gear. The new compass has been tried in the French squadron for several months past, and is said to have succeeded perfectly well. The compass card seems quite indifferent to the spark, probably because the current of the coil is alternating and of low strength. Moreover, certain precautions are taken in producing the spark, and the coil and electromagnets are at some distance, about five metres from the compass. The new compass also registers all variations, of course, if desired, the spark piercing a band of paper which is moved by clockwork up the bowl. Moreover, by a simple arrangement of Geissler tubes, steering orders can be automatically transmitted, and the course changed from any part of the ship. In practice the compass enables a course to be steered to a fraction of a degree—that is to say, with much greater precision than by hand, and it is claimed that it is specially suitable for passenger steamers such as the Atlantic liners, as it would enable them to travel in a straighter line, thus saving both time and money. It also permits the vessel to be steered from the masthead compass.

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PHYSICAL UNITS.

BY MAGNUS MACLEAN, M.A., F.R.S.E.

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(Continued from page 719, Vol. XIII.)

§ 25. *Moment of a couple* is the product of either force into the arm. Its dimensional expression is therefore

$$[G]=[F\,.\,L]=[M\,L^2\,T^{-2}].$$

Moment of inertia of a set of bodies round any axis is the sum of the products of each mass into the square of its distance from the axis. If the masses be $m_1\ m_2\ m_3\ \ldots$ and the distances be $r_1\ r_2\ r_3\ \ldots$ then $I = m_1 r_1^2 + m_2 r_2^2 + m_3 r_3^2\ \ldots$

$$= \Sigma m r^2 = k^2 \Sigma m = M k^2$$

where k is called the radius of gyration, and may be defined as the radius of an infinitely thin rim in which all the masses may be supposed to be concentrated, so as to leave the moment of inertia of the system unaltered. Its dimensional formula is therefore $[I]=[M\,L^2]$.

Moment of momentum of a moving body round any point is the product of its momentum into the perpendicular distance from the point on its line of motion. Its dimensional formula is therefore $=[M\,.\,v\,.\,L]=[M\,L^2\,T^{-1}]$. If we make use of the analogues, that moment of a couple in rotational motion is analogous to force in translational motion, and moment of inertia to mass, we get the following convenient and useful relations:

Translational motion.	Rotational motion.
$a=\frac{F}{M}$	$\dot{\omega}=\frac{\text{moment of couple}}{\text{moment of inertia}}=\frac{G}{I}$
$v=a\,t=\frac{F}{M}\,.\,t$	$\omega=\dot{\omega}\,t=\frac{G}{I}\,.\,t$
$M\,v=F\,t$	$I\,\omega=G\,t$
$s=\frac{1}{2}\,a\,t^2$	$\theta=\frac{1}{2}\dot{\omega}\,t^2$
$=\frac{1}{2}\cdot\frac{F}{M}\cdot\frac{M^2\,v^2}{F^2}$	$=\frac{1}{2}\,\frac{G}{I}\cdot\frac{I^2\,\omega^2}{G^2}$
$F\,s=\frac{1}{2}\,M\,v^2$	$G\,\theta=\frac{1}{2}\,I\,\omega^2$

If the linear velocity be V, and the angular velocity be Ω, at the zero of reckoning, then the resulting equations would be $M\,(v-V)=\pm F\,t$; $\frac{1}{2}\,M\,(v^2-V^2)=\pm F\,s$; $I\,(\omega-\Omega)=\pm G\,t$; $\frac{1}{2}\,I\,(\omega^2-\Omega^2)=\pm G\,\theta$. (See § 24.)

§ 26. *Activity* is a word introduced by Lord Kelvin to signify "time-rate of doing work." Its dimensional formula is therefore $[A]=[W\,T^{-1}]=[M\,L^2\,T^{-3}]$. The unit rate of working used by engineers in this country is *one horse-power*—that is, 550 foot-pounds per second. In the metric system this is equivalent to 76 metre kilogrammes per second. Unit rate of working, or unit activity, on this system is one *erg* per second. In practical electricity a *watt* is generally employed as the unit of activity, and is equivalent to 10^7 ergs per second. One *watt* is a joule per second. 1 h.p. = 746 watts.

Density of a body is the quantity of matter in unit volume of it. Specific gravity of a body is the ratio of the weight of any volume of it to the weight of an equal volume of water. In the metric system unit volume of water is unit mass, but this is not so on the British system. Hence in the metric system the same number expresses the density and the specific gravity of the body, whereas on the British system the density of a body is equal to its specific gravity multiplied by 62·5, since one cubic foot of water weighs approximately 62·5lb. Specific gravity being a ratio, its value must be the same whatever system of units we use, and its dimensional formula must necessarily be unity. The dimensional formula for density is

$$[s]=[M/V]=[M\,L^{-3}]$$

§ 27. In the theory of elastic bodies any modulus is stress divided by strain, and the different moduluses are obtained by defining the stress and the strain in particular ways. A strain is any change in the shape or in the bulk of a body, and stress is the name given to the forces which produce this strain. Thus bodies can have two distinct kinds of elasticity—namely, elasticity of shape, or rigidity modulus, and elasticity of bulk, or bulk modulus. Fluids have a bulk modulus in perfection, but have no rigidity modulus. Solids have both a bulk modulus and a rigidity modulus, but neither of them in perfection. *Strain* is a mere ratio of length to length, or volume to volume, and hence its dimension is unity. *Stress* is invariably given in units of force per unit of area, and its dimensional formula is therefore

$$[M\,L^{-1}\,T^{-2}].$$

Rigidity modulus, n, is the tangential forces (shearing forces) per unit area, divided by the shear produced. Here shear is defined as an angle. If a cube be taken, then the deformation from a right angle expressed as a fraction of a radian is the shear.

Bulk modulus, k, is the hydrostatic forces per unit area divided by the change in volume per unit volume.

Young's modulus, M, is the stretching forces per unit area divided by the elongation produced per unit length.

$$M = \frac{1}{\frac{1}{3n}+\frac{1}{9k}} = \frac{9nk}{3k+n}.$$

(See Thomson and Tait, "Natural Philosophy," § 683, p. 221.)

Hence the dimensional formula for rigidity modulus, n, bulk modulus, k, and Young's modulus, M, is, in each case, $[M\,L^{-1}\,T^{-2}]$.

§ 28. Torsional rigidity and flexural rigidity depend not only on the material but on the shape and on the axis round which torsion or flexure is taken. Torsional rigidity of a bar may be defined as the couple that produces unit twist in it per unit length, and its flexural rigidity in any given plane as the couple that would produce in it unit curvature in this plane. Let N denote torsional rigidity and N^1 flexural rigidity, then

$$[N] \text{ or } [N^1]=[M\,L^3\,T^{-2}].$$

For a symmetrical rod the torsional rigidity is equal to the rigidity modulus of the material of which it is made multiplied by the moment of inertia of the cross-section round the proper diameter. Hence its torsional rigidity is proportional to the product of the rigidity modulus and the square of its cross-section, and therefore the dimensional formula is

$$[N]=[M\,L^{-1}\,T^{-2}]\times[L^4]=[M\,L^3\,T^{-2}].$$

The flexural rigidity is proportional to the product of the Young's modulus and the square of the cross-section. Hence its dimensional formula is

$$[N^1]=[M\,L^{-1}\,T^{-2}]\times[L^4]=[M\,L^3\,T^{-2}],$$

the same as otherwise found above.

§ 29. *Surface tension* of liquids is given in units of force per unit of length. Its dimensional formula is therefore

$$[\tau]=[M\,L\,T^{-2}]\div[L]=[M\,T^{-2}].$$

This is equivalent to energy per unit area.

§ 30. *Viscosity* is a property possessed not only by liquids and gases, but by the most elastic of solids. To define the viscosity of a fluid, suppose you have a layer of unit thickness of it between two planes of indefinite extent to each of which the fluid adheres. Let one plane be fixed: then the tangential force per unit area necessary to move the other plane with unit velocity is the measure of the viscosity of the fluid.* It is, therefore, tangential force per unit area divided by shear per unit time.

The dimensions of viscosity will therefore differ from the dimensions of stress simply by the time unit, just as the dimensions of velocity differ from those of acceleration. Hence the dimensional formula for viscosity is

$$[\mu]=[M\,L^{-1}\,T^{-1}].$$

The viscosity of water diminishes with rise of temperature,

* "The *viscosity* of a liquid (or the numerical reckoning or measure of the viscous quality) is defined as the tangential force per unit area, in either of the mutually perpendicular planes of zero elongation, of a simple distortion, required to produce change of shape at unit speed."—Kelvin, "Mathematical and Physical Papers," vol. viii., p. 437.

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and Poiseuille, who investigated the flow of water through capillary tubes, gives

$$Q = 1836{\cdot}724\ (1 + 0{\cdot}0336793\,t + 0{\cdot}0002209936t^2)\ \frac{H\,D^4}{L}\ *,$$

where Q is the quantity of water in cubic millimetres that, at temperature t, flows in one second through a capillary tube of length L, and diameter D, under a pressure of a mercury column of height H. Reducing to C.G.S. units, and neglecting figures after the fifth decimal place, this gives

$$Q = 1350\ (1 + 0{\cdot}03368\,t + 0{\cdot}00022\,t^2)\ \frac{p\,D^4}{L}.$$

where Q = quantity in cubic centimetres that flows through in one second;
p = the pressure at the mouth of the capillary tube in grammes weight per square centimetre (approximately equal to the head of the water);
D = diameter of the capillary tube in centimetres;
and L = length " " " "

But it can be shown that for laminar motion

$$Q = \frac{\pi}{128\,\mu} \times \frac{p\,D^4}{L},$$

where μ is the viscosity of the water.

$$\therefore \mu = \frac{1{\cdot}818 \times 10^{-5}}{1 + 0{\cdot}03368\,t + 0{\cdot}00022\,t^2} \text{ gms. wt. per sq. cm.}$$

Thus $\mu_0 = 1{\cdot}818 \times 10^{-5}$ grammes weight per sq. cm.
$\mu_{100} = {\cdot}277 \times 10^{-5}$ " " "

The viscosity of water at 100deg. C. is less than a sixth of the viscosity of water at 0deg. C.

§ 31. "The diffusivity of one substance in another is the number of units of the substance which pass in unit of time through unit of surface, across which the gradient of concentration is unit of substance per unit of volume per unit of length."†

"*Diffusivity* is essentially to be reckoned in units of area per unit of time,"‡ and its dimensional formula is therefore $[\kappa] = [L^2\,T^{-1}]$.

In art. xcviii., of Kelvin, "Mathematical and Physical Papers," vol. iii., p. 428, it is shown that the same law governs the following five cases of diffusion:

I. Motion of a viscous fluid.
II. Closed electric currents within a homogeneous conductor.
III. Heat.
IV. Substances in solution.
V. Electric potential in the conductor of a submarine cable when electromagnetic inertia can be neglected.

See also, in this connection, Tables A, B, and C, pages 207 and 208 of the same volume.

It may be remarked that the diffusivity of fluid for viscous motion is its viscosity divided by its density, and therefore $[\kappa] = [M\,L^{-1}\,T^{-1}] \div [M\,L^{-3}] = [L^2\,T^{-1}]$.

INTERRUPTIONS AND REPAIRS OF CABLES AND LAND LINES.

The following table, which has been forwarded to us for publication, is self-explanatory, but scarcely agrees with Sir J. Pender's views given in another column.

	Date of interruption.	Date of repair.
Brest—St. Pierre cable, P. Q. Co..	March 28, 1894	June 13, 1894.
Accra—Kotonou cable	April 1, 1894..	June 14, 1894.
Accra—Lagos cable	May 21, 1894..	June 6, 1894.
Bagdad—Fao land line	June 5, 1894...	June 6, 1894.
Bagdad—Fao land line	June 11, 1894.	June 12, 1894.
Saigon—Bangkok land line.....	June 27, 1894.	June 28, 1894.
Brest—St. Pierre cable, Anglo ...	April 6, 1893..	Still interrupted.
Bissao—Bolama cable	Nov. 24, 1893.	
Assab—Massowah cable	May 30, 1894..	
Tarifa—Tangiers cable	June 9, 1894...	
Sierra-Leone—Accra cable.....	July 2, 1894 ...	

* *Annalen der Physik*, Poggendorff, band lviii., p. 436; or *Repertorium der Physik*, Dove, band vii., p. 131.
† Tait, "Properties of Matter," p. 257.
‡ Kelvin, "Mathematical and Physical Papers," vol. iii., p. 205.

PRACTICAL NOTES ON DYNAMO CALCULATION.—IV.*

BY ALFRED E. WIENER.†

10. *Armature Insulations.*—According to the size and the voltage of a dynamo the thicknesses of the insulations in its armature vary in very wide limits.

The coating of the armature conductor, if single wire is employed, usually is effected by a double cotton covering, ranging in diametrical thickness from ·012in. to ·020in., according to the size of the wire and the voltage. If stranded cable is used for winding the armature, either bare or single cotton-covered wire is used to make up the cable, and the whole is covered with two or three layers of cotton. The thickness of the single cotton insulation in this case varies from ·005in. to ·010in. in diameter. For very thin wires, from No. 20 B.W.G. (·035in.) down, a double silk covering from ·004in. to 005in. diametrical thickness is applied.

In case of rectangular or wedge-shaped conductors, according to their size and to the voltage of the machine, either a double cotton covering, as with wires, is used, or oiled paper, cardboard, asbestos, or mica is employed for their enwrapping or separation. The thickness of the insulation in the latter case varies between ·010in. and ·020in. each side.

Besides this coating of the single conductors, sometimes—particularly in high-voltage machines—a sheet of insulating material is employed to separate the layers from one another. The thickness of this insulation, for which either oiled paper, rubber tape, or silk is used, ranges from ·007in. to ·030in.

The insulation of the conductors from the iron body in smooth armatures is effected by serving the core with one or two coatings of enamel or japan, and then covering it by either oiled paper, cardboard, canvas, silk, tape, sheet rubber, cotton cloth, asbestos, or mica, varying in radial thickness between ·012in. and $\frac{3}{16}$in.

For toothed and perforated armatures this core insulation is carried out in form of paper, or cardboard, or vulcanised fibre tubes or channels, fitted into the grooves, or—especially in large toothed core machines—by means of mica troughs lining the bottom and the sides of the slots. The thickness of this lining ranges from ·010in. to ·125in., proportional to the size of the slots, and according to the voltage of the dynamo.

11. *Arrangement of Armature Winding.*—By "arrangement" of the armature winding is understood the grouping of the conductors into a number of armature coils, each containing a certain number of turns, or convolutions, of the armature wire, and each one corresponding to a division of the collector or commutator.

The E.M.F. generated by the combination of a series of convolutions, or by a coil, while under the commutator brushes is not constant, but fluctuates with the rate of its cutting lines of force in the different positions during that period. This fluctuation of the E.M.F. of a dynamo consequently increases with the angle which is embraced by each coil of the armature, and can be mathematically determined from the measure of this angle. In a 10-coil armature, for instance, the angle embraced by each coil is 36deg., and the fluctuations of the E.M.F. are calculated to amount to ± 2·4 per cent. of the total E.M.F. generated. With a 12-division commutator, the angle enclosed by each armature coil is 30deg., and the fluctuations figure to ±1·7 per cent. For an 18-bar commutator, the coil angle is 20deg., and the fluctuations are found to be reduced to ± 1 per cent. For 24 divisions in the commutator, the angle is 15deg., to which correspond fluctuations in the amount of about ± ½ of 1 per cent. With 36 bars the angle is 10deg., and the fluctuations ± ⅓ of 1 per cent.

* From the *Electrical World* (New York).
† The following typographical errors occurred in the section of this article published in these columns June 22: Page 722, first column, thirty-eighth line from top, "In the average values . . . " should read, "In Table III. the average values . . . " In Fig. 1, page 722, the expression for the pitch of the slots should be $\frac{da' \times \pi}{n'}$, instead of $\frac{da \times h}{n'}$; for the width of the slot, in Figs. 1 and 3, pages 722 and 723, the letter s should be used instead of S; in Fig. 2, page 723, the diameter of the whole should be designated by $\delta a'$ instead of δa.

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For 48 divisions the angle is 7½deg, and the fluctuations $\pm \frac{1}{10}$ of 1 per cent. For 90 divisions the angle is 4deg., and the fluctuations $\mp \frac{3}{1000}$ of 1 per cent. With a 360-division commutator, finally, the angle enclosed by each coil is 1deg., and the fluctuations of the E.M.F. reduced to but $\frac{3}{1000}$ of 1 per cent.

From these figures it is apparent that the fluctuations become practically insignificant, or the potential of the machine practically steady, if, for bipolar dynamos, armature coils of an angular breadth of less than 10deg., or, what amounts to the same thing, if commutators with from 36 divisions upward, are used. For low-potential machines, up to 300 volts, it has been found good practice to provide, per pair of poles, between 40 and 60 divisions in the commutator.

For high-potential dynamos the voltage itself determines the number of commutator bars. For in these the self-induction set up in the separate coils and the sparking at the commutator caused by the potential of this self-induction between two adjacent commutator divisions, are more important considerations than the fluctuation of the E.M.M.

No potential below 20 volts is able to maintain an arc across even the slightest distance between two copper points. The potentials above this figure necessary to carry an arc over a certain distance depend upon the intensity of the current. In order to maintain, between two copper conductors, an arc of ·040in. length—the usual thickness of the commutator insulation for high-voltage machines—according to actual experiments made by the author, imitating as nearly as possible the conditions of a commutator, a current of

100	amperes	takes 20	volts
50	,,	,, 21	,,
20	,,	,, 23	,,
10	,,	,, 25	,,
5	,,	,, 30	,,
2	,,	,, 40	,,
1	,,	,, 50	,,

From this it can be concluded that, in order to prevent the commutator of a high-voltage machine from becoming unnecessarily expensive, allowances have to be made as follows:

TABLE XVI.—Differences of Potential Between Commutator Divisions.

Current intensity per pole.	Difference of potential between commutator divisions.
Over 100 amperes	10 to 20 volts
100 to 50 ,,	12 ,, 21 ,,
15 ,, 20 ,,	15 ,, 23 ,,
20 ,, 10 ,,	20 ,, 25 ,,
10 ,, 5 ,,	25 ,, 30 ,,
5 ,, 2 ,,	30 ,, 40 ,,
2 ,, 1 ,,	35 ,, 50 ,,

The respective minimum numbers of commutator divisions, consequently, are:

$$\left.\begin{array}{lll}
\text{For over 100 A. p. pole } n_{min} & = \frac{E \times 2P}{20} & = \frac{E \times P}{10} \\
\text{For 100 to 50 A. p. pole } \ldots & = \frac{E \times 2P}{21} & = \frac{E \times P}{10{\cdot}5} \\
\text{For 50 to 20 A. p. pole } \ldots & = \frac{E \times 2P}{23} & = \frac{E \times P}{11{\cdot}5} \\
\text{For 20 to 10 A. p. pole } \ldots & = \frac{E \times 2P}{25} & = \frac{E \times P}{12{\cdot}5} \\
\text{For 10 to 5 A. p. pole } \ldots & = \frac{E \times 2P}{30} & = \frac{E \times P}{15} \\
\text{For 5 to 2 A. p. pole } \ldots & = \frac{E \times 2P}{40} & = \frac{E \times P}{20} \\
\text{For 2 to 1 A. p. pole } \ldots & = \frac{E \times 2P}{50} & = \frac{E \times P}{25}
\end{array}\right\} \quad (15)$$

Having thus determined the minimum number of divisions that can be used in the commutator without excessive sparking, the actual number, n, to be employed has to be chosen by comparing this value of n_{min} with the total number of conductors on the armature, found by multiplying the rounded result of equation (8), (9), or (10) respectively, with that of formula (11), and dividing the product by the number, p, of armature wires stranded in parallel.

The number of turns, m, of armature conductors per commutator division, or the number of convolutions in each armature coil, is then readily obtained by dividing the total number of armature convolutions by the number of coils, n. The number of armature convolutions in ring armatures is identical with the number of armature conductors, while in drum armatures it takes two conductors to make one turn, and, therefore, the number of turns is but one-half the number of conductors. Hence we have:

For ring armatures:

$$m = \frac{o \times u}{n \times p} \quad \ldots\ldots \quad (16)$$

and for drum armatures, or drum-wound ring armatures:

$$m = \frac{o \times u}{2 \times n \times p} \quad \ldots\ldots \quad (17)$$

If the armature is to have spacing strips, or driving horns, the number of the armature divisions for this purpose depends upon the number of armature coils, n, the number of turns per coil, m, and the number of conductors in parallel, p.

In ordinary machines the number of armature divisions is usually made equal to the number of coils, n, and sometimes—especially in drum armatures—double the number of coils, $2n$, is taken. For high-current output machines often a greater number of armature divisions than that given by the number of coils is chosen. In such a case the total number of single wires, or cables, $m \times n \times p$, is to be suitably arranged in groups. The number of these groups is to be a multiple of the number of coils, n, and since the number of turns per coil, m, in high-current dynamos, is usually $= 1$, the problem of grouping, in this case, amounts to subdividing the number of parallel wires, p.

12. *Radial Depth of Armature Core—Density of Magnetic Lines in Armature Body.*—Diameter and length of the armature core being determined, its proper radial depth can be readily found by the cross-section to be provided for the passage of the magnetic lines of force.

The density of lines permitted per unit area of armature cross-section is limited by the heating of the armature due to hysteresis and eddy-current losses. The heat generated by either of these causes increases with the density of the lines, and with the number of magnetic reversals per second. The latter number is the product of the number of revolutions per second and the number of magnet poles, and therefore it is obvious that in order to keep the temperature increase of the armature in its practical limits, in dynamos where this product is great, larger specific sectional areas of the armature core are to be allowed than in machines having a small number of magnetic reversals, or a low "frequency," as half the number of reversals, or the number of complete magnetic "cycles," is called. The former—high frequency—is the case for high speed and multipolar dynamos, the latter—low frequency—for slow-speed and bipolar ones. On the other hand, large multipolar machines generally have well-ventilated ring armatures, and in these an even considerably larger amount of heat generated will produce a smaller temperature increase than in drum armatures of equal output.

According to these considerations, the following values of the densities of lines of force in the armature core are recommended:

TABLE XVII.—Core Densities for Various Kinds of Armatures.

Kind of armature.	Density of lines of force. Per square inch.	(Gausses.)
Slow-speed bipolar drum.....	50,000 to 80,000	8,000 to 12,500
,, ,, ring	80,000 ,, 120,000	12,500 ,, 18,500
High-speed ,, drum.....	40,000 ,, 70,000	6,000 ,, 11,000
,, ,, ring	60,000 ,, 90,000	9,000 ,, 14,000
Slow-speed multipolar drum..	30,000 ,, 60,000	4,500 ,, 9,000
,, ,, ring ...	50,000 ,, 80,000	8,000 ,, 12,500
High-speed ,, drum..	25,000 ,, 50,000	4,000 ,, 8,000
,, ,, ring...	40,000 ,, 70,000	6,000 ,, 11,000

The cross-section of the magnetic circuit in the armature core is the product of the net length, and the net the radial depth of the core, and of the number of poles; and this product, divided into the total magnetic flux through the armatures, gives the density of lines per unit area. In

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order to obtain the net radial depth or breadth of the cross-section of any armature core, therefore, the total armature flux is to be divided by the product of the armature density, of the net length of the body, and of the number of poles:

$$b_a = \frac{\phi}{2\,P \times \mathfrak{B}_a \times l_a \times k_1} \quad . \quad . \quad . \quad (18)$$

The symbols used in this formula denote:

b_a = radial depth, or breadth of cross-section of armature core, in inches;

ϕ = useful flux, in webers, or number of useful lines of force cutting armature conductors, the calculation of which will be the subject of a subsequent chapter (Part II., Chapter 1); for determining the radial depth of toothed and of perforated armatures, this is to be multiplied by the factor of core leakage (see Table XI., Chapter 8);

$\mathfrak{B}_a$ = density of magnetic lines in armature body, in lines of force per square inch, given in Table XVII.;

P = number of pairs of magnet poles;

l_a = length of armature core in inches, from formula (12);

k_1 = ratio of net iron section to total cross-section of armature core (see Table XVIII.).

The constant k_1 depends upon the material and the manner of building up of the armature core. In order to prevent excessive losses and resulting heating of the armature due to eddy currents in the iron, it is necessary to laminate the body perpendicular to the direction of the active armature conductors. In case the active pole faces embrace either the outer, or the inner, or both circumferences of the armature, the active conductors are those parallel to the shaft, and the lamination of the core is to be effected perpendicularly to the shaft; while in case of the poles being at the sides of the armature (flat-ring type), the active conductors run perpendicular to the shaft, and the lamination is to take place parallel to the shaft. In case of the pole-pieces embracing three sides of the armature section, finally, the active conductors are partly parallel and partly perpendicular to the shaft, and the lamination in consequence is also to be carried out in both directions. The materials for effecting these various laminations are iron discs, iron ribbon, and iron wire respectively. The insulation of these laminæ in the majority of machines has been, and is yet, effected by inserting sheets of thin paper, asbestos, etc., between them, although it has been repeatedly shown by practical experiments* that such an insulation is not only entirely unnecessary, but, on the contrary, even disadvantageous, For, in order not to lose too much of the available sectional area of the body, the lamination in such armatures is usually made rather coarse, but it is just the fineness of the lamination, and not the thickness of its insulation, that avoids in a higher degree the generation of eddy currents. The oxide coating created by heating the iron is a very effective and suitable insulation of the armature core laminæ.

In the following table, values of the ratio, k_1, of the net to the total core section are given for various thicknesses of the iron, and for the different modes of insulation now in use:

TABLE XVIII.—Ratio of Net Iron Section to Total Cross-section of Armature Core.

Material.	Thickness, in inches.	Insulation.	Value of k_1.
Sheet iron (discs or ribbon)...	·080	Paper or asbestos	·95 to ·90
,, ...	·040	,, ,,	·92 ,, ·88
,, ...	·020	Paper or enamel	·90 ,, ·85
,, ...	·010	,, ,,	·85 ,, ·80
,, ...	·010	Oxide coating	·95 ,, ·90
Square wire.....	·080	Cotton covering	·90 ,, ·80
,, ,, ...	·040	,, ,,	·85 ,, ·75
,, ,, ...	·020	Enamel or varnish	·80 ,, ·70
,, ,, ...	·020	Oxide coating	·90 ,, ·85
Round wire	·080	Cotton covering	·80 ,, ·70
,, ,, ...	·040	,, ,,	·75 ,, ·65
,, ,, ...	·020	Enamel or varnish	·70 ,, ·60
,, ,, ...	·020	Oxide coating	·85 ,, ·80

In large ring armatures, for the sake of ventilation, air-spaces are provided in modern machines by means of light brass frames inserted in certain intervals between the core discs. In calculating the radial depth, b_a, of the body the sum of these distance-pieces is to be deducted from the total length, l_a, of the core, the reduced length so found being used instead of l_a in formula (18).

(To be continued.)

* Ernst Schulz, *Elek. Zeit.*, December 29, 1893. See the *Electrical World's* digest, "Iron in Armatures," vol. xxiii., p. 91, January 20, 1894, and p. 248, February 24, 1894.

GAS v. STEAM FOR CENTRAL STATIONS.

In his paper read towards the end of 1892 before the Manchester Association of Engineers, Mr. B. H. Thwaite directed attention to the possibilities of the use of gas for various purposes when generated in the coalfields as a heat-giver rather than as a light-giver. This paper of Mr. Thwaite's will be found in our issues of December, 1892, and it gave rise to much thoughtful consideration amongst electrical engineers, so much so that more than one prominent engineer examined carefully into the subject. We do not, however, find that many English engineers have been bold enough to specify gas-engines for central-station work. We have, however, before us a report to one of our large towns which deals with the question, and it may interest our readers to know somewhat of the matter. In the first place, the authority was particularly desirous of obtaining an investigation into the comparative merits of steam and gas, and with this view instructed their consulting engineer to report, firstly, upon an installation of a temporary character for 1,000 16-c.p. lamps, to be afterwards extended into a complete installation for 10,000 16-c.p. lamps burning simultaneously. The question was between Dowson gas and steam, it being accepted that unless ordinary gas could be supplied at 1s. per thousand its use was out of the question. This price for ordinary gas not being likely, its use was not considered. The comparison was made between a typical set of steam plant and a typical set of gas plant. The steam plant would consist of a Lancashire double-flued steel boiler, a Willans central-valve compound non-condensing engine, and a suitable dynamo driven direct from the engine as a unit. The gas plant, of a Dowson generating set, a Crossley gas-engine, and a suitable dynamo driven by means of a belt. One of the most important considerations in such a comparison is the ground area required by the different systems, and in this respect steam is easily first. The importance of this where land is dear and not easily obtainable is clear. In the particular case before us the available land is insufficient for the extensions, and the requisite area would have to be made up by taking from a baths site—a serious inconvenience. But by far the most important consideration is that of the noise from the exhausts of these gas-engines—a matter which is troublesome everywhere, but especially so in crowded localities. In the complete scheme, as contemplated in this instance, there would be no less than 17 different and distinct exhausts, all from the largest type of engine, 35 h.p. nominal, each exhaust giving, say, from 50 to 100 explosions per minute according to the load on that particular engine. These troubles might be modified, but could hardly be entirely abolished, by passing through silencing pits, or by carrying the outlets to a distance. Another important consideration is the rise of temperature in the engine-house. This might, however, be obviated at least to a great extent by special contrivances. But to get rid of the troubles from exhaust, and from radiation of heat, simply means increasing the initial outlay. With regard to this initial outlay, the engineer's estimate is that the generating plant for the preliminary installation will cost, with steam £2,700, and with gas, £3,092. This shows a balance of £392 in favour of steam. In the complete installation the cost for generating plant is, with steam, £13,325, and with gas, £17,432, or £4,107 in favour of steam. But the initial expense is hardly ever, or never, so important as the working expense; and again, the estimate is in favour of steam—being for the preliminary installation £1,108 for steam and £1,116 per annum for gas. In the complete installation the estimate £4,201 for steam and £4,440 for gas.

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Our endeavour is to give and to obtain information, and in order that our readers may examine these totals we are fain to venture to give the details, and trust that by so doing we are not passing the bounds of prudential discussion. It may be taken that as a rule authors of reports do not expect details to become public property, but this question is so important to electrical engineers generally that we venture to break through the rule and be the exception.

THE PATTON SYSTEM OF STREET CAR PROPULSION.

Among the many attempts that are being made from time to time to introduce a system of street car propulsion intended to supersede the overhead trolley construction, the Patton system is one of the latest claimants for recognition. The New York *Electrical Engineer* states that it

CAPITAL EXPENDITURE.

Preliminary Installation of 160 h.p., to actuate 1,000 16-c.p. lamps simultaneously.

Steam Plant.

One steel Lancashire boiler, 28ft. by 7ft. diameter, fixed, including brickwork	£500	
Two Willans "F F S" steam-engines, driving two Siemens dynamos direct, including feeders	1,500	£2,700
Steam, exhaust, and water connections, feed-pumps and water-tanks	500	
Six-ton overhead traveller	200	
Electric instruments and connections and double set of storage batteries	1,700	2,900
Distribution service and other mains, etc., in town (compulsory district)	1,200	
Central-station buildings		2,000
		£7,600
Contingencies, etc., 10 per cent.		760
		£8,360
Add for land (electric light works site), 918 square yards		1,000
		£9,360

Dowson Gas Plant.

One Dowson gas set, including one gas-tank, two generators, scrubbers, etc., fixed	£732	
Two Crossley gas-engines, 35 h.p. nominal each	1,200	
Two Siemens dynamos, belt driven, all fixed	710	£3,092
Water tanks, piping, and connections	100	
Six-ton overhead traveller	300	
Electrical instruments and connections and double set of storage batteries	1,700	£2,900
Distribution, service, and other mains, etc., in town (compulsory district)	1,200	
Central-station buildings and generator sheds		2,000
		£7,992
Contingencies, etc., 10 per cent.		799
		£8,791
Add for land (electric light works site), 918 square yards		1,000
		£9,761

CAPITAL COST.

Complete Installation, 1,400 h.p., to actuate 10,000 16-c.p. lamps simultaneously.

Steam-Driven Plant.

Four steel Lancashire boilers, 28ft. by 7ft. diameter	£2,200	
Three Willans "F F S" steam-engines driving three Siemens 45-kilowatt dynamos direct		
Three Willans "II S" engines, three Siemens 150-kilowatt dynamos	10,825	£13,325
Two Willans "III S" engines, two Siemens 200-kilowatt dynamos		
Foundations, etc., to above	300	
Steam, exhaust, and other connections	1,000	
Water-tanks, feed-pumps, etc.	550	3,130
Overhead traveller, feed-water heaters	1,080	
Fuel economiser	500	
Electrical instruments and connections, and two double sets of storage batteries		5,300
Distribution service, etc., in town		9,800
Central-station buildings and chimney		3,700
		£35,255
Contingencies, etc., 10 per cent.		3,525
		£38,780
Land (electric light works site), 918 square yards		1,000
		£39,780

Dowson Gas-Driven Plant.

Three Dowson gas sets, including four gas-tanks	£3,674	
Nine generators, scrubbers, fixed with piping		
Three Crossley single-cylinder 35 h.p. nominal engines	7,450	£17,432
Seven Crossley double-cylinder 70 h.p. nominal engines		
Three Siemens 50-kilowatt dynamos, belt-driven	5,370	
Seven ,, 100 ,, ,, ,,		
Leather belting, etc., to above	590	
Concrete foundations	348	
Water-service pumps, tanks	700	1,050
Overhead traveller	350	
Electrical instruments and connections, and two double sets of storage batteries		5,300
Distribution service in town		9,800
Central-station buildings		3,300
		£36,882
Contingencies, 10 per cent.		3,688
		£40,570
Land, 1,300 square yards		£1,430
		£42,000

WORKING EXPENSES.

Preliminary Installation, producing 50,000 units sold (75,000 indicated horse-power hours net).

Steam Plant.

Coal (8lb. per indicated horse-power hour)—280 tons at 6s. per ton	£84	
Water, oil, waste, etc.	50	£134
Management and wages		600
Repairs, maintenance, and miscellaneous		150
Rent, rates, taxes		120
Office expenses, collection, etc.		104
		£1,108

Dowson Gas Plant.

Coal (anthracite, 1½lb. per indicated horse-power hour), including generators, waste, boilers, etc., 45 tons at £1. 4s. per ton	£54	
Water, 525,000 gallons at 7d., and meter rent	18	£92
Oil, waste, etc.	20	
Management and wages		600
Repairs, maintenance, and miscellaneous		200
Rent, rates, and taxes		120
Office expenses, collection, etc.		104
		£1,116

WORKING EXPENSES.

Complete Installation, producing 500,000 units sold (750,000 indicated horse-power hours net).

Steam-Driven Plant.

Coal (6lb. per indicated horse-power hour), including waste, 2,100 tons at 6s. per ton	£630	
Water, 4,000,000 gallons at 7d. per 1,000	£117	£831
Oil, waste, etc.	84	201
Management and wages		2,200
Repairs, maintenance, and miscellaneous		750
Rent, rates, taxes, etc.		160
Office expenses, collection, etc.		260
		£4,201

Dowson Gas-Driven Plant.

Coal, anthracite (at 1½lb. per indicated horse-power hour, including boiler, etc.), 500 tons at 24s.	£600	
Water, 500,000 gallons, waste and boilers	150	£870
Oil, waste, etc.	120	
Management and wages		2,200
Repairs, maintenance, and miscellaneous		950
Rent, rates, taxes, etc.		160
Office expenses, collection, etc.		260
		£4,440

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consists essentially of a combination of gas-engine, electric generator, storage battery, and motor, all carried on one car. The arrangement is shown diagrammatically in the accompanying figure.

The chief point of merit claimed consists in the employment of a storage battery so arranged as to be capable of being charged continually by the generator, which from the intermittent character of the load can be of considerably less capacity than would be required were the power of the

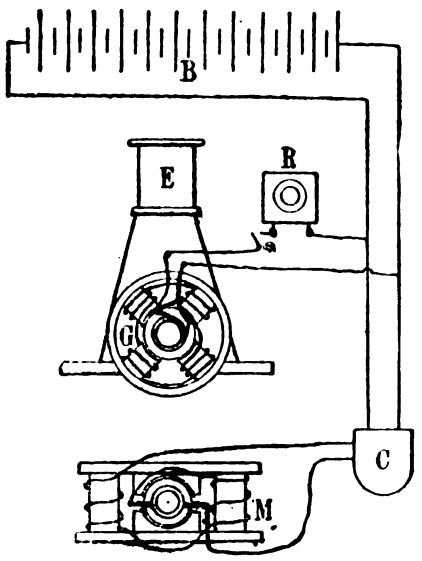


Diagram of Circuit in Patton System.

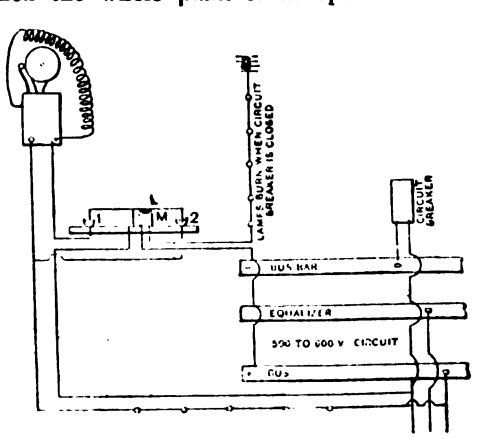
engine to be applied to the car axle direct. In the diagram, E represents a vertical gas-engine, coupled direct to the shunt-wound dynamo, G; a battery of accumulators is shown at B, and the motor is represented at M. The controller is shown at C, and R is the starting rheostat.

A car equipped with a combination of this kind has been in operation on the Calumet Electric Railway line in Sixty-seventh-street in Chicago for several weeks, and is reported as giving general satisfaction. The operating expense is said to be about one-half that of running a trolley car of the same capacity.

A TELL-TALE FOR CIRCUIT BREAKERS.*

BY E. M. HIGHLANDS.

I have on two different occasions found in central stations operating both railway and lighting circuits, with only one man who attends both to engines and dynamos, that when the whole plant is in operation the circuit



Tell Tale for Circuit Breakers.

breaker often blows out without the engineer hearing it, and, consequently, often remains open quite a while. The superintendents of these plants generally try to cut expenses, and object to installing any apparatus that is not absolutely necessary, and on these occasions, for an outlay of 8dol. to 10dol., I have been able to place the following alarm on the circuit, which rings a 7in. gong while the circuit breaker is open and the instant it is closed immediately ceases to ring, and it does this without the use of batteries or any attention whatever. I think the diagram herewith will be almost self-explanatory.

Two circuits are required, one on each side of the circuit breaker—one to ring the bell, and the other to operate the switch. The operation is as follows: The magnet, M, attracts a pivoted lever, L, which completes a circuit through a cup of mercury, 2, which cuts the bell out. When the circuit breaker opens, the magnet releases the lever, L, which makes contact through cup 1, and consequently rings the bell, which has a 7in. gong. A shunt of 100ft. of No. 30 wire from the negative binding post to the vibrator post prevents sparking at the bell contacts. I think this scheme is in use in several Iowa stations, having been seen and approved of by visiting electricians.

AN OPTICAL PHASE INDICATOR AND SYNCHRONISER.*

BY GEORGE S. MOLER AND FREDERICK BEDELL.

The following instrument has been devised by the writers to give definite information in regard to the relative speeds and phase positions of the motor and generator in laboratory investigation. It shows:

1. When the machines are synchronous.
2. Which machine is running the faster when they are not synchronous.
3. The angle by which the motor lags behind the generator.

We will first describe the simplest form of the phase indicator. The motor and generator are placed together with shafts in line and abutting, but not quite touching. The two machines must have the same number of poles, so that a revolution of the armature of each represents the same number of alternations. The abutting ends of the shafts carry two discs, one connected rigidly with the motor armature, the other similarly connected with the armature of the generator, as shown in Fig. 1. In these discs are curved slits, one slit for each pair of poles of the machines. These slits are shown in Fig. 2 for an eight-pole machine. The two discs are in every way similar, the one being the reverse of the other. The two discs are practically superimposed, and together form one disc with four holes, where the slits of one disc cross over the slits of the other. Evidently the distances of these four holes from the centre depend upon the relative positions of the two armatures; they move in and out as the armatures shift their relative positions. From the symmetrical arrangement of the slits, if one armature is stationary and the other is moved past two pole-pieces or through 90deg. of arc (corresponding

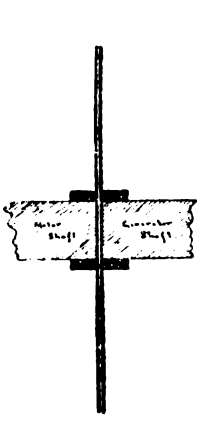


Fig. 1.

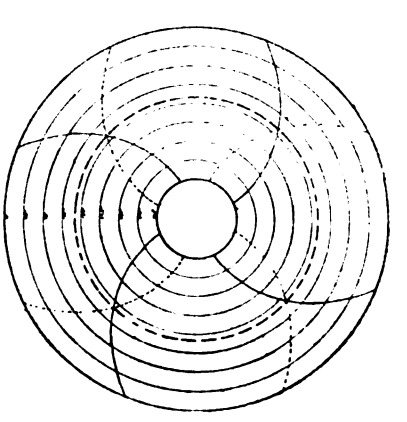


Fig. 3.

to a complete period of alternation, or 360deg. of phase), the intersection of the slits will be the same distance from the centre as before. The curvature of the slits is such that the distance to or from the centre that the intersections of the two sets of slits move is proportional to the change in relative position of the two armatures.

* The *Electrical Engineer* (New York).

* Abstract of paper presented at the Philadelphia meeting of the American Institute of Electrical Engineers.

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When the two armatures are running at the same speed in the same direction and there is a source of light on one side of the discs, the intersection of the slits, as seen from the other side, appears as a continuous ring of light. A slight difference of speed causes this ring of light to move outward or inward, according to which disc is revolving the faster. The more rapidly the ring moves in or out, the greater the difference in speed of the two discs. If the ring is moving out, a new ring starts at the centre when one ring reaches the edges, and these rings keep following one another outward. If the difference in speed is the other way, the successive rings move inward.

In Fig. 3 the heavy dotted line represents the ring of light for a particular position of the two discs.

The position of the ring of light indicates the relative position of the two armatures. The discs may be secured to the shafts, so that when the armatures are in the same positions with reference to the pole-pieces (*i e.*, the machines are in the same phase) the ring of light will be at the inner or outer ends of the slits. The concentric rings in Fig. 3 represent the phase differences corresponding to positions of the ring of light in this case.

For convenience in operation, the arrangement of the apparatus, which has thus far proved satisfactory, has been as follows: On one side of the pair of discs is placed an incandescent lamp enclosed in a box. One side of the box is close to the discs and has a slit in it about ½in. wide, extending from the shaft to the circumference of the disc.

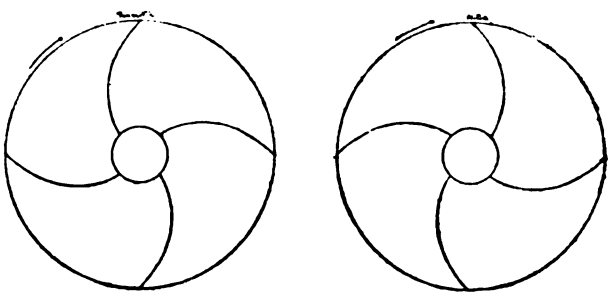


Fig. 2.

This slit is covered with a piece of oiled paper, so as to give a diffused light upon the discs. A complete ring of light is no longer seen from the other side, but only a small portion, corresponding to the width of the ½in. slit. A stationary scale is fixed so as to extend from the shaft to the edge of the discs on the opposite side from the lamps, so that the distance of the changing line of light from the centre may be read so as to give the phase difference of the two machines by direct reading. To enable one to see the scale and line of light most conveniently a mirror is arranged at 45deg. with the discs, so that the line of sight is at right angles to the shaft.

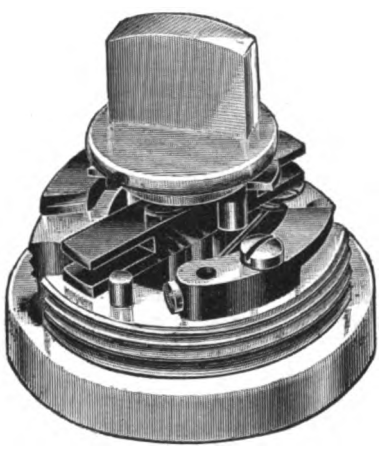
The discs may be arranged in the manner just described upon the abutting ends of the motor and generator shafts only in case the two machines have the same number of poles. Where such is not the case one or both of the discs can be driven by gears, which will give the proper relative speeds of the two discs.

In operation the instrument has proved quite satisfactory, giving exact and definite information concerning the changes in the armature lag of the motor. The fluctuations in this lag are usually quite marked, and the conditions which cause them can be readily investigated by this apparatus. For instance, this fluctuation is small with proper field excitation. As the field current of the motor is diminished, this fluctuation increases, the line of light moving rapidly back and forth through a greater and greater distance, which finally becomes so great as the excitation is weakened that it goes a distance beyond which it cannot recover—*i.e.*, the motor gets out of step and stops. It would be possible to make a more detailed investigation of these fluctuations by means of a revolving mirror, and they may be photographed and made of permanent record by means of a moving plate.

The apparatus can be applied to other lines of work involving an investigation of phase differences and synchronism, and may be modified to meet the requirements of the problem in hand; but it is peculiarly suited for use in synchronous motor work, for which it was designed. The scope of the present paper admits only of a general description of the apparatus here given.

WARD'S DOUBLE-BREAK QUICK-ACTION SWITCH.

In the annexed illustration is shown the double-break quick-action switch manufactured by Messrs. J. H. Ward and Co., of the Gorton Brook Electric Works, Manchester. This switch has few working parts, and is said to be permanently reliable and cheap. The advantages claimed for this switch, which is mounted on porcelain, with cover and handle of the same material, are in the construction of the terminals and in the cross-bar, which, instead of entering between two contact-plates, grips from the outside a solid tongue of metal cast on to the terminals. By this means sparking is reduced, and the faulty contact caused after a little usage by the softening of the spark-plate, in the ordinary type of switch, is said to be entirely done away with. The metal conducting parts are massive, and are fixed to the front of the base. The spring, instead of working on the brass current-carrying parts, works on two steel pins, thus reducing friction and the wearing away of parts where the spring usually rubs. The switch is rendered dustproof by the method of fixing the handle to the cover. This type of switch



is made in sizes of from one to six amperes, and from six to twelve amperes.

THE HISTORY OF WOODHOUSE AND RAWSON UNITED, LIMITED,

As Detailed in the Bankruptcy Court.

THURSDAY.

The resumption of this enquiry took place yesterday, when **Mr. Lambert**, liquidator of Woodhouse and Rawson, Limited, was examined by the Official Receiver. The witness stated that he supposed that the prospectus of the United Company came before him as a director of Woodhouse and Rawson, Limited. The managing directors did most of the work in connection with the valuations. He always understood that the patents were valuable, but no value had, so far as he knew, been placed upon the patents. He was not an expert as to electrical patents. The Woodhouse and Rawson Company had only been in existence two years when it was absorbed by the United Company, and it had, in fact, only been able in that time to begin to get to work.

By **Mr. Pilling**: The witness had nothing much to do with the estimate of £75,000. He knew the estimate was made, but not exactly how or by whom. As a vendor he, of course, accepted the estimate. He could not recollect what went to founders' shares at the distribution. Out of the £75,000 received, £51,000 was in debentures and £12,000 in cash, and four-fifths, or, roughly, £40,000, in debentures went to the founders' shares, or should have gone had it been possible to realise them, but he thought that the founders' shares did not, in fact, realise anything.

By the **Official Receiver**: A sum of £17,000 guaranteed book debts was wiped out. Mr. Rawson was given £10,000 for special services in connection with the Elmore business, out of which they had done very well. He did not think that Mr. Rawson was paid anything for the promotion of the United Company.

By **Mr. F. Rawson**: As to valuations he knew little. As to his own knowledge, the managing directors prepared the prospectus. He did not instruct valuers, nor did he know of any minute of the Board as to value. He thought there was a good future for the Cadby Hall Works. He agreed that many differences arose between Mr. Rawson and Mr. Hoster over the negotiations at the formation of the United Company, Mr. Rawson doing his best for the United, and Mr. Hoster for the Limited. Great care was taken by the directors of the United Company to get all information

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possible. Mr. Rawson tried all he could to get a settlement with the holders of founders' shares.

Mr. Philip Rawson, who was examined by the Official Receiver, said he was no relation to Mr. F. Rawson. He first lent money to Mr. F. Rawson, and afterwards became a director of the manufacturing company. He was not interested in the formation of Woodhouse and Rawson, Limited, from the partnership. He was not paid the money lent to the partners, but it was probably settled by getting shares in the company. The witness said that he did not press for his money, or enquire into the affairs of the partnership, and he had no recollection of getting Mr. Pixley's report. He was not aware of a final deficiency of £44,000 of the manufacturing company. He was an original director of the United, but did not attend the preliminary meetings, as he did not intend to become a director. He did not recollect about the valuer's original report of Mr. Edmunds not forthcoming (dated April 12, 1889). The witness did not form any independent idea of the patents, but was satisfied as to the amount to be given after discussing the matter with Sir A. Cappel. He considered the business to be taken to be both industrial and financial, so far as financial meant testing and selling electrical concerns. He remembered the minute referring to the secession of three directors and the circular to be sent to proposing shareholders. He believed he saw it in print before being issued, but thought it was brought before the solicitor. The circular did not mention anything about the return of subscriptions. He understood, however, that the circular was in accord with the minute. He would generally understand from the circular that it carried out the views of the retiring directors, but now admitted that the wording of the circular was not so in accord. He did not know the connection between Mr. F. L. Rawson, Baron Grant, and the Phœnix Trust. He did not think Baron Grant was consulted in the formation of Woodhouse and Rawson, Limited. The report on the sale of Elmore shares to the Phœnix Trust was not recognised by witness. He did not recollect the sale of Elmore shares to the Phœnix Trust, and did not think he knew anything about the Phœnix Trust at that time, or the confirmation of minutes wherein this was mentioned. The witness did not make any enquiry as to the composition of the Phœnix Trust, and did not recollect the minute promising the report of the managing director above mentioned. He did not recognise the circular dated September 1, 1890, puffing up Elmore shares, but supposed that he must have seen it. He was appointed a committee with Mr. F. L. Rawson as to the financial arrangements of the Okonite Company, but had no recollection of doing anything as such a committeeman. He did not recollect any consultation for application for Okonite shares from nominees of Woodhouse and Rawson United. The balance-sheet 1891 and financial account was for over 13 months and industrial over 11 months. He did not remember that the 13 months was to include the Epstein Company's formation. Certainly not as far as memory of the witness went. Such extensions did, however, admit of the paper profit being shown. He did not recollect any enquiry as to shares taken up by the public, and did not know that even to the present time only five Epstein shares had been taken by the public. The Epstein interest was acquired for £4,000 and experiments made with it cost £12,000—being a total of £16,000. The witness was told that the value of the Phœnix shares held by the company was £15,000, and at that time he thought this was correct. He did not remember Messrs. Pilling's report on the Manchester accounts showing a loss, or another report on the Kidsgrove accounts. He was aware that the industrial businesses in 1891 were not very prosperous, but could throw no light upon the advance of money for transactions in preference shares. It was suggested that this advance was to get a Stock Exchange transaction so as to get a quotation for shares, and the witness thought that the transaction entered into in accord with the minute of the Board was right, but he did not recollect the whole circumstances, and therefore could not say what guided them at the time. On December 3, 1893, witness wrote a letter to Sir Rawson Rawson. His resignation had been held over, and Sir R. Rawson wrote to know how the resignation was to be treated. The letter of resignation was sent in at the beginning of September, 1892, and a further letter on the subject later in the month. The circular relating to the creation of debenture stock spoke of it as a first charge, but as a matter of fact they were not secured as a first charge. Witness understood that they were a first charge on the whole property of the Company. He was not aware that some of the old debenture-holders converted this stock, and had lost their first charge by the proceeding.

Cross-examined: He was of opinion that Mr. F. L. Rawson's application for preference shares was *bonâ fide*, and he saw no objection to the shares being delivered to nominees of the managing director. Sir Rawson Rawson's statement as to the financial position of the Company might have been in 1890 and not in 1891. The witness had a total interest of £4,000 in Woodhouse and Rawson United; he had not sold a single share, and held them now.

Sir Leopold McClintock, examined by the Official Receiver, said that he held 250 shares in Woodhouse and Rawson, Limited, as security for a loan, and 40 shares in manufacturing company. He had no recollection of the large debt to Woodhouse and Rawson, Limited, or to the valuation put upon the manufacturing company. The company was wound up in 1889. The witness had received no dividends from the manufacturing company. He joined the Board in place of one of the gentlemen who had resigned, and thought that the business was to be a combination of financial and industrial—mainly industrial. His own inclination was in favour of the industrial work.

[A reprinted prospectus was here put in that gave the name of Sir L. McClintock as an original director, whereas he did not join the Board till after the date on the prospectus—viz., July 15—the list opening on July 22, Sir Leopold McClintock not joining till August.]

The witness did not know the relations of the managing director with the Phœnix Trust. He resigned on August 18, 1890, but remained a little longer on pressure being brought to bear upon him. The financial business was getting beyond him, and the work too much.

Mr. Foley, examined by the Official Receiver, stated that he was at first in the secretary's office, and that many documents of a confidential nature passed through his hands. He had no knowledge of the transactions *re* the Phœnix Trust, but became aware of some of them afterwards. He did not join the Company until October, 1890, and the circular referring to Elmore shares and the Phœnix Trust was dated September 1. There was a contract between the Phœnix Trust and Woodhouse and Rawson United to take certain shares. Witness bought founders' shares of the Elmore Company, and held them now. He became secretary in February, 1892. Letters passed between the National Finance Corporation and Woodhouse and Rawson United.

Mr. Stutchbury, examined by the Official Receiver, deposed that he was secretary of Woodhouse and Rawson United in January, 1891, and manager in the beginning of 1892. After becoming secretary he looked into the business affairs of the company and formed the impression that the industrial part was neglected, and gathered from the general manager, Mr. North, that it was conducted at a loss. In discussion with the chairman he mentioned that he thought that the industrial part had been neglected, and suggested that more attention should be paid to it. The chairman thought it better to continue the financial business, but the managing director mainly agreed with him. Then he converted Sir J. Stokes, and afterwards Mr. Pope, to these views. From extracts from the books in 1890, it was shown that the industrial businesses, except works department, each and all showed a loss; the Cadby Hall department showed a profit. So far as Manchester, Bradford, and the Jensen bell departments were concerned, the books showed the loss. He had the balance-sheet of 1891 prepared, and thought that the original draft might be at the offices of the Company. The draft showed a loss of about £15,000 on trading. The draft was taken to Mr. Rawson, but to his knowledge it was not brought to the auditor. From extracts of books for 1891 similar to those of 1890, the losses were shown.

The proceedings were then adjourned.

INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS COMPANY.

The thirty-first half-yearly ordinary general meeting of the shareholders in this Company was held yesterday afternoon at the Cannon-street Hotel.

Mr. S. William Silver, who occupied the chair, stated that the principal object for which the meeting was called was to declare a dividend for the half-year. The books were made up, as he thought they were aware, once a year, and he had no hesitation in recommending for their adoption that a dividend of 10s. per share, or at the rate of 5 per cent. for the half-year, be declared. When he met them last February he referred to the considerable difficulty they had experienced in securing contracts and work generally owing to the depression in trade which then existed. This state of things had, unfortunately, increased. Notwithstanding this condition of affairs, they had managed to get their fair share of business. This was to be accounted for by the efforts used to make known, both at home and abroad, the excellence of the work turned out at Silvertown, and the excellent condition of the machinery, which was quite up to the requirements of the hour. So much was this the case that he thought he might say they received the first offer of most of the improvements introduced into this country. With regard to submarine cable work, they had done practically very little, with the exception of laying a short line for the Spanish Government. The works at Silvertown and Persan were in a very efficient state. He did not think there was anything else of importance to which he need direct their attention, and concluded by formally declaring the dividend.

The proposition was seconded by **Mr. Abraham Scott**, a director.

At the request of the **Chairman**, **Mr. W. Grey**, one of the directors, gave a short account of his recent visit to Persan, in the course of which he stated that he found the factory there, and everything connected with it, in an efficient and satisfactory condition. He was quite satisfied with the way in which their affairs were being managed there, although of course business was nothing near so brisk as in former years.

The payment of the dividend was then sanctioned.

Wolfenbuttel-Brunswick Tramway.—An arrangement has been made between Messrs. Schuckert and Co., of Nuremberg, and Messrs. Brandes and Co., of Wolfenbüttel, for the construction of an electric tramway between Wolfenbüttel and Brunswick. The former will finance the undertaking and carry out the electrical part of the work, while the latter will lay the rails, supply the iron masts, etc.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

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THE DANGER OF FAMILIARITY WITH DANGER.

Incidents, the fatalist would say, hardly require "improving upon": it is almost useless to moralise upon them, because no change of antecedents can be thereby effected. Until such time, however, as we deem these doctrines more worthy of credence, we intend to punctuate occurrences with comment of the kind that blends plain speaking with sympathy and regret.

The occasion that calls for such remarks as the above is that to which reference is elsewhere made—viz., the terrible accident which happened on Saturday last at the Blackfriars sub-station of the London Electric Supply Corporation's system, wherein one of their employés received the full force of the high-tension current, and was, of course, instantly killed. Since the unfortunate man was a servant of the electric lighting company, and not one of the general public who would be presumably ignorant of all danger, there is in this accident no scope for the daily Press to make much of it by headline or editorial. The gas journals, we should say, will hardly venture to criticise this mote in the eye of electricity, seeing that the countless endeavours of authorised gas-fitters to find leakages of gas with a lighted candle prove the presence of a big beam in their own. It falls, therefore, upon the electrical Press more especially to analyse the causes of such a terrible incident as this, and apportion the blame or responsibility where it is best deserved.

Summarising the evidence, and gauging the probabilities of the case, it seems quite clear that *if* (such virtue is there in an "if") the deceased man had replaced a guard rail he might yet have been alive. Yet one can hardly say that he was to blame; this particular combination of circumstances had never arisen before, and could hardly have been specially contemplated or provided for in any way. The accident shows most of all the immense and absolute importance of taking every possible precaution at all times in such work, and yet the tendency of human nature is continually towards fatal forgetfulness—the one little slip which makes life the forfeit. There is no cultivating a habit of carefulness by personal experience in this case: once trespass too far and all is over. The same thing happens time and again in other directions: a collier strikes a match to light his pipe, and forthwith the whole pit is fired; he may neglect the roof-timbers in the place where he works, but pays the penalty when the heavy stones fall down and crush out his life. The abstract danger of a familiarity that breeds contempt is less carefully avoided by the average worker than is the actual object itself which contains the hidden terror.

It would be illogical to declaim against high tensions as a result of this accident; we live in an age of high pressure, and must fall in with the spirit of the times. For that matter, a pressure of ten thousand volts on an alternating-current circuit offers no more danger to the unfortunate being who enters into the circuit than does one or two thousand. Either of them is more than sufficient to destroy life in the merest fraction of a second. The question may, how-

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ever, well be asked, how it is that the fatal accidents occurring in electricity supply station work have so far taken place on the higher pressure systems? We believe that hitherto at the Bankside, West Brompton, and other stations worked on the two thousand-volt standard, there have been no accidents whatever of a similar nature to that now dealt with. The reason for this does not lie, as above stated, in any quantitative difference in pressures: it is, we think, to be sought rather in the extraordinary care taken on every hand in these stations to enclose and protect the high-pressure circuits. The chamber in which operations like those carried on by the deceased man must be conducted, ought to be arranged on the presumption that dangerous elements will tend to come together. Ample space should be allowed for any operations required, and the points of contact or terminals of high-pressure mains so covered up and protected that ordinary methods will not permit any employé to touch them. This can quite well be done, whilst at the same time preserving full efficiency and convenience in the station plant.

And yet it is difficult to say that the electric supply company absolutely deserves blame. Most elaborate precautions are taken, as will be seen from the account on another page, to secure the safety of the employés from contact with "earth," and the engineers would naturally find it hard to believe that part of a man's body should actually take the place of a switch bar—some eighteen inches long—fenced off on all sides. This is just what happened, however, and, of course, it might under the same conditions occur again. We prefer to think, however, that no more such terrible incidents will be recorded in the annals of this station, and that it will in the future be impossible—as nearly as may be, that is—for any of the workmen to receive a fatal shock unless they are on suicide bent. Even then it should require an act of wilful damage to the plant in order to obtain suitable conditions.

Some of our readers will doubtless know the Blackfriars station. If so, they will share our admiration of the switching equipment and general station appliances in the transformer-room. Arrangements equally good for the switch-room, in which this accident happened, ought to secure safety as far as it is possible to obtain it; but when all is said and done, the element of human fallibility yet remains. Not all the Board of Trade rules in the world can prevent a sleepy signalman from sending a crowded express train to its doom in the rear of a shunting goods train; in the present case, however, the unfortunate man himself was the only victim.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

"OUR REVIEW OF REVIEWS."

SIR,—I was unable to give you "Our Review of Reviews" last week, my free copy *not* having reached me. Sam says this is not surprising, considering the number It prints for gratuitous circulation. I believe there is some truth in this. For instance, one day when I went to Its office to buy a copy—the day after publication—the lady editress informed me that they had had a run on that issue—the usual publisher's excuse for not speaking the truth. The lady, however, ultimately managed to supply me with a copy that had been returned through the post. Sam says he thinks It is revising Its free-list; but as he still receives three copies he made me a present of one, and here I am. Turning up It of June 21, I find it stated that this is the last number which will be published. Well, nobody will weep. But reading on further, I find that it was merely the last number that would be issued from 11, Queen Victoria-street. Atcheu! The next issue was, It stated, to blossom forth at 117, Bishopsgate-street. This address, Sam remarked, on looking up the directory, is the home of the House-to-House Electric Light Supply Company, and also the late business address of Mr. R. Hammond. Of course, there is no connection between the two. "Gas Meter," I am pleased to say, admits candidly that "'E dunno where 'e are," and trots out a bit of schoolboy's Greek. Then follows a reference to the competition for self-contained vehicles, which you mentioned in March. Better late than never. Something next appears from an American source about electric head lights. Surely a "meteor" is sufficient for the purpose. Following this comes a lot of twaddle concerning the City of London Company's recent banquet, and an article by Mr. C. P. Sparks on transformers is given. Passing on from "Our Review of Reviews," which this week is scarcely worth mention, It gives a supplement describing the central station at Burton-on-Trent, which was detailed in the *Electrical Engineer* on June 8. Mr. Chestnut, jun., manages to fill three columns from the financial dailies, and "Lamplighter" pads out with some five columns of Press cuttings, interpolated with "I this and I that and I the other." Pheugh!

I shall soon begin to think that "Gas Meter" is a Frenchman. He writes quites nicely in It of the 28th June about the French Anarchists and the late President Carnot; and this, too, in a *soi-disant* electrical sheet! "Gas Meter," it appears, was present at the recent assembly of the Asso ciation of Municipal and County Engineers. So was Mr. Hammond. Do you see? American gas commissioners, the *Century* on municipal spirit in Germany and coal tar conclude this interesting hash up. An article follows by Mr. J. S. Raworth descriptive of his patent switch and safety gear. The Doulton casing for underground cables, which you illustrated and described several months ago, is now discovered by It. Then comes that would-be-if-you-could-know-all padding called "Our Review of Reviews." It is not so silly as it used to be. It has got frightened; It does not like being treated in the same manner as It deals with others; but It is rot. It will find it warm if It goes to see H. L., whose identity It has failed to discover; being sheet lightning It ought to be already pretty near. Passing on from Mr. Chestnut, jun., a note is given on electric tanning; that's what It is going to receive. But stop. The information contained in this note was published in the *Electrical Engineer* months ago, and now It states that "we have been favoured with a report," etc. "Lamplighter" then holds forth with the usual supply of paste and scissors set forth in the first person, the information contained in the whole of which has already been published in your journal. Sam says that next week I must make it very hot for It. I will.—Yours, etc.,

Timbuctoo, July 3, 1894. JOHNNY.

REVIEWS.

Electric Light Installations—Vol. II.: Apparatus. By Sir DAVID SALOMONS, Bart., M.A. London: Whittaker and Co.

The first volume, of which the present work forms a continuation, has passed through several editions, and this fact alone will tend to draw attention to the book under review. It gives essentially a description of the plant and accessories used in electric light installations—the foremost types of dynamos, motors, and apparatus being dealt with.

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Of course, to have referred to each individual one would have rendered the book merely an illustrated catalogue, which was not the author's intention. The author has not confined himself to mere descriptions, but has given much information of practical value in the working of electric lighting plant. Whilst some instances are given of the applications of electrical energy, the author has decided to treat the special applications of the machines and appliances in a third volume, which, when completed, might readily be amalgamated with Vols. I. and II. so as to form one book.

L'Eclairage a Paris. Par HENRI MARECHAL, Ingénieur des Ponts et Chaussées et du Service Municipal de la Ville de Paris. Paris: Baudry et Cie., 15, Rue des Saints Pères.

The present work comprises a volume of 500 pages with 211 illustrations in the text. It gives a full description of the different methods adopted in the lighting of Paris, and detailed particulars of this important service. Most of the chapters are, of course, devoted to the subjects of the production, distribution, and utilisation of gas and electricity. The gas industry is represented by the Compagnie Parisienne des Gaz, which employs over 9,000 persons, and distils per annum more than a million tons of coal. The gas is distributed not only in Paris but also in the suburbs through mains extending over a total of 1,500 miles. The electric lighting industry has made striking progress, various companies having been authorised to supply electrical energy. The town of Paris itself, as will be remembered, has set an example in erecting municipal plant at the Halles Centrales. M. Maréchal's work shows that if all the gasworks are more or less alike, there is great variety in the different systems employed in the large electric lighting stations. The production of electricity is described under its different forms—namely, continuous and alternating currents, and distribution direct and by means of accumulators. The great diversity in the distribution of electricity is very instructive, and permits of useful comparisons being established. A chapter is devoted to the distribution and sale of electricity, cost and sale prices being given. The relations of the Municipality with the gas company and the electrical companies are clearly and carefully explained. An interesting chapter deals with the calculation of the lighting of the public roads, showing the influence of the height of the lamp-posts, and giving diagrams of the photometric curves of the different lamps and burners in use. M. Maréchal's work will prove interesting to those concerned in the electrical illumination of large towns.

ANOTHER FATAL ACCIDENT AT BLACKFRIARS.

We much regret having to record another lamentable occurrence at the Blackfriars sub-station of the London Electric Supply Corporation. Last year, it will be remembered, one of the company's employés at this important station received a fatal shock, owing to an act of carelessness in his not having switched off one of the high-tension mains—a duty which he well understood and which he had carried out scores of times previously.

On the present occasion the exact circumstances have been somewhat different, though in the end it is much to be feared that the same want of constant watchfulness and care on the part of the workman may have been the proximate cause of the sad accident. On Saturday afternoon last, about half-past four, the unfortunate man was engaged in the underground chamber where the high-tension mains enter the station from Deptford, and thence are connected by means of switches to the Blackfriars transformers, or to those at the other sub-stations belonging to the company—in all of which, it will be remembered, the 10,000-volt current is transformed down into one of a pressure equal to 2,400 volts.

The chamber itself, where the connections between the machines at Deptford and the London mains are thus made, is quite a small room—perhaps too small for such important work to be carried on; but it is safe to say that the circumstances giving rise to this accident will hardly arise in the future. On each side of the room are placed the inner conductors or positive wires of the Ferranti concentric mains coming from Deptford, and terminals or contact-pieces on these wires are connected with similar terminals or contact-pieces on the outgoing leads—placed on the wall underneath—by means of switch bars pushed in from the centre platform. Each set of terminals is separated from its neighbours alongside by means of heavy slate partitions, and guarded in front by a substantial wooden handrail, which slides up and out when testing goes on.

This appears to have been the case on Saturday, as the deceased man had removed the handrail in front of the third London main, in order to test for a fault. Without replacing the handrail, he then turned to the other side of the chamber to connect with a dead main, but while doing this his head must have touched the live main placed on the wall just above. The shock from this contact (though of course no current passed through his body then) appears to have knocked him backwards across the platform—in the absence of the handrail—right on to the terminals, where he had just been testing. The circuit was then practically completed from head to back where he was in contact with the terminals, and the full force of the high-tension current followed.

The fuse on this main at Deptford was at once blown out by the rush of current, and by the time that help arrived (the unfortunate man's assistant was only a few yards away), the body was released from contact, but, of course, death had been instantaneous.

It seems quite certain that no "earthing" occurred in the case at all: the centre platform on which the man stood is covered with thick sheets of indiarubber; it is formed of well-varnished wood, and supported on a number of oil insulators. Moreover, the man was wearing the usual thick indiarubber-soled shoes, which are not punctured in any way. The explanation we have given, however, seems quite clearly to be the most accurate possible: the "charging" shock threw the unfortunate man into such a position—owing to his having forgotten to replace the handrail—that his body short-circuited the mains, with, of course, fatal results.

SOME STORAGE BATTERY PHENOMENA.*

BY W. W. GRISCOM.

The study of a complete curve of discharge of a storage battery discloses three rather sharply defined changes in potential difference, and after allowing for the effect of internal resistance, we find that the changes are those of the E.M.F. What is the reason for these changes? Which plate is responsible for them?

A microscopic examination of the negative (spongy lead) plate disclosed metallic lead and what appeared to be one or possibly two sulphates. The positive (peroxide) plate, however, showed spongyform crystals of very dark colour, known as electrolytic peroxide; other comparatively large crystals of brilliant red, probably Frankland's red sulphate; others of yellow, probably yellow sulphate; and, finally, the better known white sulphate of lead.

The production of these diverse chemical forms must be attended by production of diverse potentials, and the E.M.F. of the battery is possibly a resultant with one or more chemical reactions predominating at various parts of the charge and discharge.

That there should be any change of E.M.F. during the charge or discharge of the battery shows the complexity of the chemical actions, and as the changes are at times sudden and at times gradual, uniform and invariable, it would seem to point to the conception that the E.M.F. is the resultant of three or more sets of chemical actions.

The material on the charged positive plate of the battery is commonly called peroxide of lead, but it certainly differs from it both in its ability to generate E.M.F. and in its appearance, and Fitzgerald has pointed out that its composition corresponds to the hydrated peroxide of lead

* Paper read before the American Institute of Electrical Engineers.

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($H_2Pb_2O_5$). He further intimates that a higher oxide of lead may be present, such as perplumbic acid ($H_2Pb_2O_7$). McLeod has told us how peroxide of hydrogen, ozone, and persulphuric acid are produced. Then there are the two new sulphates of lead. With this array of chemical products to assist our imagination, the wonderful curves of E.M.F. of a storage battery on charge and discharge become comprehensible. And the fact observed by Gladstone and Tribe that 34 per cent. more of oxygen was absorbed by the positive plate than could be accounted for by the production of PbO_2 becomes explicable. It has probably been used in converting $H_2Pb_2O_5$ into $H_2Pb_2O_7$. Their suggestion that it was absorbed by local action between the grid and the peroxide during charge is utterly untenable. There is no such action. And if there were, the grid would not last through a dozen charges.

The conversion of $H_2Pb_2O_5$ into $H_2Pb_2O_7$ would account for the abnormal rise of E.M.F. at the end of charge, and if it be assumed that the $H_2Pb_2O_7$ is not stable but yields ozone gradually, thus accounting for the odour of a freshly-charged positive plate, it would account for the steady fall of E.M.F. on interrupting the charging current. The chemist will easily see relation between these reactions and the presence of peroxide of hydrogen and the continual evolution of oxygen from the positive plate, and the fact that a charged cell gradually loses its charge, maintaining for days a higher temperature than the air.

I am sorry that the time allotted me for the preparation of this paper did not admit of the preparation of curves showing the differences in temperature between certain plates of a cell and even between different parts of the same plate. Of course, these changes, many of them, are very minute, and they are due to at least two causes—viz., the liberation or combination of sulphuric acid on the one hand, and C_2R on the other.

In order to study the progressive changes on either plates and to plot them out in a curve, it is merely necessary to choose a substance which produces a measurable E.M.F. with the plates independently of the E.M.F. which is being produced by the two plates appertaining to the battery; but this substance must be one which is neither modified by the electrolyte nor by the minute current which it is required to produce for the voltmeter. The last is of more consequence than is generally understood, as a storage battery which has been over-discharged and which has been allowed to recuperate will, even if it be of large size—say, of 350 ampere-hours' capacity—produce a deflection on a Weston voltmeter (of about 300 ohms), which at first may be $1\frac{75}{100}$ volts, and which will immediately begin to fall with a velocity quite appreciable to the eye. Many substances have been tried for such a test plate, as, for example, zinc, carbon, platinum, and copper, but nothing seems to be better than a well-charged Faure or Planté couple of considerable dimensions. The use of such plates was first published by Mr. Crompton, although they have been used for years in my laboratories, and give concordant results.

It might be desirable, but it is not necessary, to ascertain accurately the exact fraction of the total E.M.F. which is due to the plate under test. It is important, however, to know the rate of its change of E.M.F. while the cell of which it forms an individual part is discharging or charging.

The negative plate maintains a nearly horizontal line until the potential difference of the couple on discharge has fallen to 1·9 volts, while the positive plate maintains a curve almost parallel to that of the cell, showing that the characteristic curve on discharge of a storage battery with plates of nearly equal capacity is due mainly to the reaction in the positive plate.

At the end of the charge, however, the characteristic curve of E.M.F. is due to the negative, the rapid rise of its curve being nearly parallel to that of the battery, while the rise of potential of the positive is nearly a straight line, which, however, is gradually rising.

It should be noted that this curve is the true E.M.F., and is not dependent on the internal resistance of the cell, which reaches the maximum shortly after the fourteenth hour in this case, and remains quite constant during the remaining seven hours of the charge. But while the E.M.F. is not dependent on the internal resistance, the sudden changes in each curve are usually simultaneous, indicating a common cause.

It may be considered proven, therefore, that in a storage battery with plates of nearly equal capacity, the changes in the positive plate determine the characteristic curves of potential on discharge, and that the changes in the negative plate determine the characteristic curves of potential at the end of the charge.

(To be continued.)

THE PACIFIC CABLE QUESTION.

The following letters, taken from the appendix to a Canadian Blue-book recently published, tell their own tale. Sir John Pender in this controversy has followed the devious paths of the weather-cock. At one time he blows hot, at another time he blows cold—probably because the situation is of a duplicate character; and sometimes he feels master in one direction, and sometimes in another. It is evident, however, whether the Pacific cable be laid—as assuredly it will be laid—or strangled for a time—as just now Sir John would like it strangled—he is playing his cards so as to try and remain Vicar of Bray. We like a man who knows his own mind and sticks to it, but the man whose whole policy is shilly-shally is a repugnant character to those who like to go straight at the goal when it is in sight:

Letter from SIR JOHN PENDER *to* MR. SANDFORD FLEMING.

The Eastern Extension, Australasia, and China Telegraph Company, Limited,
Winchester House, 50, Old Broad-street, London, E.C.,
July 22, 1890.

Dear Mr. Sandford Fleming,—I have read your circular letter of the 18th inst., together with the annexed correspondence with the Colonial Office, on the subject of the recent unfortunate interruption of telegraphic communication with the Australian colonies, and the establishment of an alternative route *vid* the Pacific, and if the various Governments interested are determined to have a line across the Pacific, and are prepared to incur the requisite expenditure for the purpose, I am quite ready, as I have always told you, to co operate in carrying out the work on fair and reasonable terms, and in this way the object might be attained more easily and economically than if third parties were employed. But if it should be decided to establish a Pacific communication as a separate and distinct undertaking from the existing lines, it must not be forgotten that two cables across the Pacific will be required, which, according to your own figures would cost £3,600,000, or £108,000 per annum, as one line could no more be relied upon in the Pacific than in the Java Seas, where all our three cables between Java and Australia were suddenly and simultaneously interrupted by earthquake a few days ago.

Fortunately, however, this is a very rare occurrence, only one previous interruption of the kind having occurred on our system during a period of over 20 years. Moreover, the Java Seas are mostly shallow, so that repairs can be easily and promptly made, as in the present instance, while the Pacific Ocean is not only subject, perhaps, in a greater degree than the Java waters to volcanic disturbances, but the depths are so great that repairs would be most difficult and costly when an interruption occurred. The cost of maintaining the present system amounts to over £100,000 per annum.

I am looking forward, if spared, to visiting Hong-Kong next year, travelling through Canada by the Canadian Pacific line, when I hope to inspect that wonderful undertaking in which you have played such a prominent part, and at the same time discuss with you the best means of establishing closer telegraphic communication between Canada and the Australian colonies when the time is ripe for carrying out the work.—Faithfully yours,

JOHN PENDER.

P.S.—Your letter to Lord Knutsford ignores the fact that there is at present an alternative line to India *vid* the west and east coasts of Africa, quite independent of the Red Sea route.

Letter from MR. SANDFORD FLEMING *to* SIR JOHN PENDER.

17, Victoria-street, London, S.W., July 24, 1890.

Sir John Pender, 50, Old Broad-street, London.

Dear Sir John,—I received late last evening your favour of the 22nd, and desire to thank you for it. I am very glad to find you are coming to realise that it is absolutely necessary to have an alternative cable to Australia by way of Canada and the Pacific. I have always held, and I now hold, that the means taken to establish the new telegraph connection is entirely secondary, provided that the new line be secured. Its establishment, by whatever means, is the primary consideration, and it is for the Governments concerned to decide how it is to be done. In my humble judgment, if they consult economy and decide to secure cheap telegraphy, they will act wisely in making the work a public undertaking, and in retaining it in their own hands under an efficient management.

I notice what you say about having two cables across the Pacific

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on account of possible interruptions, but it seems to me this conclusion on your part is scarcely logical if as you say interruptions are so exceedingly rare. A breakdown once in 20 years would not of itself justify the laying of a second cable at an additional cost of £1,800,000.

Are you, however, quite accurate? Is it the case that interruptions on your cable are so infrequent? I have a list before me by which it would appear that the Eastern Extension cables between India and Australia have broken down 36 times within the last 18 years, and of these 14 breaks were between Port Darwin and Banjoewangie, the nearest sections to Australia. I notice also that one of the 14 breakdowns referred to caused an interruption of four months, and another of three months and a half. The other interruptions were generally for much shorter periods. It is quite true that you have now more than one cable on that section, but I do not see that duplicating, even triplicating the cable on the same route is an absolute security from interruptions as shown by the simultaneous breaking down of all three cables for a period of 10 days during the present month.

Be all that as it may, my contention is simply that a line from Australia to England by way of Canada would be a great advantage all round. That to Australia and New Zealand, it would be better than relying wholly on the one existing route. To these colonies it would give two strings to their bow, and that is commonly held to be an advantage. You say that under certain circumstances two cables across the Pacific will be required. In this I am not disposed to disagree with you, as I believe more than two will eventually be required, but let us have one at a time, and the sooner we get that one the better. In after years other cables can be laid as they are required to meet the demands of a wonderful development of commerce, which I am satisfied will come in the not distant future.

You suggest that repairs in the deep water of the Pacific would be most difficult and costly. Let me remind you of the fact, established by experience on the line between Lisbon and Pernambuco, passing through waters about the same depth as the Pacific, that no repairs of any consequence have been found necessary in the deep-water section of that line since it was laid some 13 years ago.

Referring to the postscript of your letter, there is indeed a cable laid round the west and east coasts of Africa connecting England with Aden in that way, but that line of cables passes through no less than 10 foreign ports, beginning with Lisbon and ending with Mozambique. You are aware, too, the existence of that line did not obviate the necessity, so recently as the month of May lost, of sending Australian messages through Russia Siberia, China, and French Cochin-China, when two of your cables east of Aden broke down. I still think I was strictly correct in my statement to Lord Knutsford respecting the proposed Pacific cable: "It will indirectly give a new means of communication with India should the lines through Europe and the Red Sea become through war or other cause unusable."

Receive my thanks for your friendly letter and for the evidence it conveys to my mind that you are prepared to accept the conviction that Canada and Australia must be connected telegraphically. In this you merely evince your usual wide discernment, and few men have it in their power in a larger degree than you to hasten the advancement of a public undertaking fraught with so many advantages to the colonies and the Empire.—Yours faithfully,

SANDFORD FLEMING.

ELECTRIC LIGHTING PROVISIONAL ORDERS.

The proposals contained in the provisional orders included in the Electric Lighting Provisional Orders (No. 4) Bill have been published in an official paper, of which the following is an abstract.

Aberdare Electric Lighting Order, 1894.—The undertakers are J. C. Howell, Limited. The area of supply is a portion of the district of the Aberdare Local Board. The order contains provisions that the undertakers shall lay down mains in certain specified streets within a period of two years, and it provides for the supply of electrical energy in the remainder of the area on certain specified conditions; also for the appointment, remuneration, and duties of electric inspectors, and the testing of electric lines, and other works.

Birmingham Electric Light and Power Order, 1894.—The undertakers are the Birmingham Electric Supply Company, Limited. The area of supply is a portion of the city of Birmingham. The order contains provisions similar to those referred to in the case of the previous order. The order also provides for the revocation of the Birmingham Electric Light and Power Orders, 1889 and 1891.

Chelmsford Electric Lighting Order, 1894.—The undertakers are Crompton and Co., Limited. The area of supply is the borough of Chelmsford. The order provides for the supply of electrical energy by the undertakers in the whole of the area of supply on certain specified conditions. The order also contains provisions similar to those referred to in the case of the Aberdare Electric Lighting Order, 1894, above mentioned. The order also provides for the purchase of the undertaking by the local authority after the expiration of 21 or 31 years from the commencement of the order on certain terms specified in the order; the transfer of the undertaking with the consent of the Board of Trade and the local authority to the Chelmsford Electric Lighting Company, Limited; and the revocation of the Chelmsford Electric Lighting License, 1890.

Guildford Electric Lighting Order, 1894.—The undertakers are the Holloway Electricity Supply Company, Limited. The area of supply is the borough of Guildford. The order contains similar provisions to those referred to in the case of the Aberdare Electric Lighting Order, 1894. The order also provides that the local authority may purchase the undertaking after the expiration of 35 years from the commencement of the order.

ELECTRIC LIGHT AND TRACTION BEFORE THE ASSOCIATION OF MUNICIPAL ENGINEERS.

In our last issue we published the paper read by Mr. Shoolbred before this association on the "Bradford Corporation Electricity Supply." The illustrations showing the ampere output curves were printed not quite in proper order, but, nevertheless, our readers have no doubt been able to understand the correct arrangement. We now give, as promised, an abstract of the paper on

Electric Street Tramways.

BY ROBERT HAMMOND, M.I.E.E.

On the occasion of last year's annual meeting of this association, at West Bromwich, an inspection was made of the South Staffordshire Electric Tramways, serving about eight miles of the immediate vicinity. The writer had the pleasure of accompanying the members on that visit, and is now glad to have the opportunity of complying with the request then made that he should read at this meeting a paper on "Electric Street Tramways," in order to create discussion upon a subject rapidly growing in importance. At the outset the writer would like to make it clear that he approaches the problem absolutely without personal bias. He has no particular system to push and no special form of apparatus to advocate. His main desire is to lay before the association the arguments in favour of the adoption of electric tramways in this country, especially in connection with municipal electricity supply works. By the courtesy of Messrs. Siemens and Halske, of Vienna, he last year was enabled to make a complete inspection of the electric tramways at Budapest. Over street crossings a speed of only 3·7 miles is allowed, but on straight runs a speed of nine miles is often reached, and on the branch to Steinbruch a speed of 15 miles. On this portion the wires are, however, carried overhead. In the heart of the city passengers frequently ride for ridiculously short distances, the minimum fare being six kreuzers, less than 1¼d. (1·2d.). The track is so solidly laid that the cars glide smoothly along without jolting or rattling. Sharp stopping and starting is admirably effected, there being an entire absence of jibbing. No electrical skill is required to drive the cars, the drivers being very low-waged men. There are 56 cars running on ordinary days and 72 on Sundays. As many as 60,000 people have been carried in one day, and last year the total number of passengers was upwards of 13,000,000. The gross revenue last year amounted to £81,330, the working expenses £48,878, and the net earnings £32,452. It must be acknowledged, however, that conditions at Budapest are extremely favourable. The bulk of the streets are flat, while a very gentle slope to the river assists the drainage of the conduits. There is only one steep gradient in the whole run. Though Budapest is important as affording an almost unique example of the conduit system, there are many other cities in Europe where electric tramways or railways are in operation. I give in Table I. the complete list.

It will be noticed that there are 47 lines in operation, the total length being 194½ miles, and the horse-power employed 14,579 i.h.p.

It is in the United States, however, that electric traction has reached the greatest development, as will be seen by the latest published data to the end of 1893, to which, however, considerable additions would doubtless have to be made in order to bring it completely up to date:

	Mileage of line.	Cars.
Horse tramways	3,486	15,680
Electric ,,	7,671	17,974
Cable ,,	676	4,867
Steam ,,	536	657
Total	12,369	39,178

It is interesting to consider the reasons which have led to the great extension of electric traction, and to the almost universal opinion that horse traction must eventually disappear from all main routes of tramways. One of the past-presidents of your association, Mr. G. Laws, the city engineer of Newcastle-on-Tyne, has, within the past few weeks, presented a most able report to his Tramways Committee on the best system of tramways suitable for Newcastle (*vide* the *Electrical Engineer* of June 8, 1894).

One of the most pressing problems encountered by members of corporations, and especially by borough engineers, is that

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TABLE I.

Country and town.	System.	Date of completion.	Length of line (miles).	Total driving power (h.p.)	Method of transmission.
UNITED KINGDOM.					
Portrush-Bushmills (Ireland)	Siemens	1883	6	100	Third rail
Blackpool	Holroyd-Smith	1883	2	140	Conduit
Ryde Pier (I.W.)	Siemens	1883	¾	12	Third rail
Brighton	Magnus Volk	1884	1	20	Third rail
Bessbrook-Newry (Ireland)	Hopkinson	1885	3½	62	Third rail
Birmingham	Elwell-Parker	1890	3	80	Accumulators
Southend Pier	Crompton	1890	¾	50	Third rail
London (City and South London Railway)	Hopkinson	1890	3½	1,200	Third rail
Carstairs	Anderson-Munro	1891	1½	50	Overhead
Leeds	Thomson-Houston	1891	5½	200	Overhead
Peter Port (Guernsey)	Siemens Bros.	1892	1¾	200	Overhead
Walsall, Wednesbury, Darlaston (S. Staff.)	Electric Construction Corporation	1892	7½	380	Overhead
Liverpool	Hopkinson	1893	6¼	1,600	Third rail
Douglas-Grondle Glen (Isle of Man)	Hopkinson	1893	2½	100	Overhead
GERMANY.					
Lichterfeld (near Berlin)	Siemens and Halske	1881	2¼	60	Overhead
Frankfort-Offenbach	Siemens and Halske	1884	4¼	160	Overhead
Halle	Sprague	1891 1892	4¾ 3	350	Overhead
Gera	Sprague	1892	5	525	Overhead
Bremen	Thomson-Houston	1892	7¼	450	Overhead
Hanover	Siemens and Halske	1893	7½	400	Overhead
Breslau	Sprague	1893	11	600	Overhead
Dresden	Siemens and Halske	1893	3¾	270	Overhead
Remscheid	Thomson-Houston	1893	5¼	330	Overhead
Barmen	Siemens and Halske	1893	1	400	Overhead
Essen	Sprague	1893	7¾	400	Overhead
AUSTRIA-HUNGARY.					
Moëdling-Vienna	Siemens and Halske	1883	2¾	195	Overhead
Budapest	Siemens and Halske	1889	12½	900	Conduit
Budapest	Siemens and Halske	1893	3¼		
Lemberg	Siemens and Halske	1893	3¾	400	Overhead
Baden-Veslau	Schuckert	—	3	60	Overhead
BELGIUM.					
Liège-Herstal	Compagnie Internationale d'Electricité	1893	2	120	Overhead
SPAIN.					
Bilbao	Thomson-Houston	1891	8¾	280	Overhead
FRANCE.					
Clermont-Ferrand	Thury	1890	4½	500	Overhead
Marseilles	Oerlikon	1892	3¾	750	Overhead
Paris—					
Madeleine-Saint-Denis	—	1892	5¼	375	Accumulators
Opéra-Saint-Denis	—	1893	5¾		
Salève	Compagnie de l'Industrie Electrique de Gèneve	1892	3½	500	Overhead
Bordeaux-Bouscat	Thomson-Houston	1893	3	300	Overhead
ITALY.					
Florence-Fiesole	Sprague and Thomson-Houston	1890	4½	250	Overhead
Genoa	Siemens and Halske	1892	1¼	300	Overhead
Rome	Cattori	1893	½	130	Overhead
Milan	Thomson-Houston	1893	2	300	Overhead
RUSSIA.					
Kiew	Sprague	1892	2	120	Overhead
SWITZERLAND.					
Vevey-Montreuse	—	1887	6½	600	Overhead
Sirrach-Gelterkinden	Oerlikon	1891	2	40	Overhead
Grütch-Mürren	Oerlikon	1891	2¾	150	Overhead
Orbe-Chavornay	Compagnie de l'Industrie Electrique de Gèneve	1893	2½	130	Overhead
Stausstad-Staus	Ditto	1893	1	40	Overhead
	Totals		194½	14,579	

connected with the overcrowding of ever-increasing urban populations; and one of the easiest, and at the same time soundest, solutions of the problem is the provision of cheap and expeditious transit, by which the spreading out of the population is facilitated, and pure air and more wholesome surroundings are placed within the reach of the great bulk of the ratepayers.

We have, then, to consider how this cheap, quick transit can be best obtained. To quote from Mr. Laws's report: "It seems unnecessary to further consider horse traction at all. It has done fairly well in the past, and has served its purpose and become obsolete as not meeting the public wants. The town, in fact, has outgrown it, and wants something more modern and offering greater facilities in speed, accommodation, and cheapness." The choice, indeed, lies between electric cable, steam, gas, and oil traction. Each one of these methods is of sufficient importance to form the subject of a separate discussion, and for the purpose of keeping the present paper within the prescribed limits, attention is limited to electric traction.

The first requisite in electric traction is a "central station," as it was first named, though more recent practice dictates the term "electricity supply work," or even "electricity works," like gasworks—or, more ambiguously, "power-house." Granted, then, the existence of electricity works—owned, it is to be presumed, by the local authority—the next point to be considered is how the electrical energy produced there can be made to do traction work—one, three, or, if need be, five miles or more away.

Considering that a tramcar must by its very nature run on a pair of rails, it would appear to be a very simple thing to connect one rail to the positive pole of the stationary dynamo and the other to the negative pole, so that the one rail should form the outward path for the electrical energy and the other the homeward path. Such was the plan adopted by Mr. Magnus Volk in his little pioneer electric railway at Brighton. The children playing on the beach soon learnt by sundry practical demonstrations *in corpore vili* to avoid those rails, though the more mischievous took their revenge by surreptitiously placing conductors across them, often thereby affording the electrical energy an easier path back to the stationary dynamo than that provided by Mr. Volk through the motor on the car, so bringing the same to a standstill. The E.M.F., or difference of pressure between the rails, was not enough to do bodily harm, it being possible to keep it low on account of the shortness of the length of line. The first electric railway constructed by Messrs. Siemens and Halske, at Lichterfeld, was on this system, but the track is raised about 6in. above the level of the public road in order to prevent other vehicles using it. It is evident, however, that open rails capable of administering shocks, however far removed from dangerous, could not be tolerated in the public streets, and attention was early given to other means of conveying the

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electrical energy to the moving car. The main systems may be divided into (I.) accumulator ; (II.) overhead ; (III.) conduit.

I. The Accumulator System.

In this system the stationary dynamo is used to "charge" secondary batteries or accumulators. These are packed in batches under the seats of the car, and when it speeds on its course all difficulties with regard to the method of conveying the electrical energy to the motors vanishes, the moving power being, of course, carried on the car itself. Here would appear to be a model system of electric traction, but, unfortunately, the drawbacks to the present methods of "storing" have hitherto proved a complete bar to its extension. The constant chemical changes taking place—some essential, others unavoidable—eventually rot away the plates of the best batteries. It will be seen that "storage" is altogether a very complicated process. Again, the plates secure the longest life by a slow and regular rate of discharge, but the conditions of tramway working involve exactly the opposite, in consequence of the constant stoppages and the varying gradients. Before dealing specially with the question of weight it will be well to dispose of the question of deterioration. Not only is this accelerated by the rapid variation of the output, but it is also increased by irregularities in the track causing jolting. When the storage system was abandoned in Brussels, it was stated that 200 days was the length of life of the positive plates. Reports from other places give the life of batteries at less than a year. It is true that a longer life is claimed by some makers, but it may be stated with certainty that the cost of maintenance of accumulators, running up sometimes to 100 per cent. per annum, is, with the cells at present in use, except under exceptional treatment in the hands of experts, never below 50 per cent. per annum. Returning to the question of weight, taking 72 cells as a usual number, the total weight works out 3,600lb., or rather more than 1½ tons. The cars must, of course, be built on stronger lines to carry the extra weight. In America a standard 16ft. car, with its two 15-h.p. motors, weighs about five tons, and in addition of the accumulators brings it up to about seven tons. In some recent statistics on the subject published by Mr. Epstein*, 10 tons is given as the weight of the accumulator car, as against eight tons, the weight of an ordinary car, including, in both cases, 40 passengers. The heavier cars pound the track in a way to cause serious deterioration. The heavier weight has always to be conveyed, "hail, rain, or shine." Mr. Epstein, a strong advocate of accumulator traction, gives in the article above mentioned the following table :

Table II.—Estimated Cost of Working—Accumulators.
Cars for 40 passengers.

	Pence per car mile. L.	H.	A.
1. Running expenses—			
(*a*) Fuel	·20	·60	·40
(*b*) Oil, waste, and sundries	·03	·08	·05
(*c*) Brushes on motors and lubrication	·10	·30	·20
(*d*) Wages at charging station	·50	1·00	·75
(*e*) Drivers' wages	·50	1·00	·75
	1·33	2·98	2·15
2. Maintenance of roads	·50	1·00	·75
3. Repairs of cars	·25	·75	·50
4. Traffic expenses—			
Wages of inspectors, cashiers, timekeepers, conductors, tickets, and miscellaneous	1·00	2·00	1·50
5. General charges—			
Directors' fees, salaries, office expenses, advertisements, insurance, and miscellaneous, rents, rates, taxes, etc.	·50	1·00	·75
6. Maintenance of accumulators	·50	1·50	1·00
7. Depreciation and repairs	·50	1·00	·75
Total working and general expenses	4·58	10·23	7·40
Interest on capital invested	1·77	2·64	2·20
Grand total	6·35	12·87	9·60

L. Lowest. H. Highest. A. Average.

The only two accumulator lines in Europe are the Saint-Denis line in Paris, and that belonging to the Birmingham Central. The cars on the Saint-Denis line weigh 12 tons, including passengers. A recent return gives the cost of working per kilometre run at 53 centimes, as against 56 centimes for horse traction. This is equivalent to slightly over 8d. per car mile. With regard to the Birmingham Central line, Mr. Broekman, the engineer, as the result of daily tests, gives 3·928d. as the cost of traction per car mile run. The total costs, as gathered from the last report, were 16·55d., being an increase of 1·16d. upon that of the previous year. There would appear to be a large margin for economies in management. The net loss on the year's running was £98, as compared with £1,600 in the previous year. On a recent inspection of the line the writer found a most satisfactory, smooth, trustworthy, and apparently very popular 10 minutes' service. With regard to capital outlay, the advantage would be on the side of the accumulator system in the case of a long run with a few cars, though on a line with a large number of cars this advantage would be lost. Capital outlay is, of course, largely affected by local conditions, but £7,000 per mile for 10 minutes' service may be taken as a guide of the cost of the accumulator system. Finally, with regard to cost of running, the results of actual work in the United States tend to show that the accumulator system requires an expenditure of 1·5 horse-power hour per car mile, as against 1 h.p. of of the overhead system. This is, of course, due to the extra dead-weight carried. If this dead-weight could be reduced without impairing the all-round efficiency of the accumulators, their use for traction would be greatly facilitated. Before the paper is closed, attention will be drawn to means by which possibly they could be advantageously used, in spite of all their drawbacks.

* "More Light on Electric Traction," by L. Epstein. *Electrical Review*, vol. xxxiv., p. 28.

II. Overhead System.

By a glance at Table I., containing the list of electric tramways and railways at present in operation in Europe, it will be seen that they are divided as to systems as follows :

	Overhead wires.	Conduit.	Accumulators.	3rd rail.
England	5	1	1	7*
Germany	11	—	—	—
Austria-Hungary	4	1	—	—
Belgium	1	—	—	—
Spain	1	—	—	—
France	4	—	1	—
Italy	4	—	—	—
Russia	1	—	—	—
Switzerland	5	—	—	—
Total	36	2	2	7*

* Including City and South London Underground and Liverpool Overhead.

Summary.

Overhead wires	36
Conduit	2
Accumulators	2
Third rail	7
Total number of electric tramways and railways in Europe	47

It will be seen that by far the largest number of street tramways in Europe are worked by means of overhead wires, and in the States the whole of the 8,000 miles in operation are so worked. The South Staffordshire Electric Tramways, inspected by the members of the association last year, as well as those at Roundhay Park, Leeds, are on this system. The latter line is erected exactly on the American plan. On the South Staffordshire line the use of the span-wire system is avoided. Mr. Alfred Dickinson, A.M.I.C.E., the engineer of the line, designed a system by which the "trolley wire" and feeders are carried on one side of the road, contact being made with a "fishing-rod" arrangement.

Mr. Dickinson, the engineer of the South Staffordshire line, states last year's working costs to be 4·6d. per car mile run. Mr. Graff Baker, who superintended the laying down of the Leeds line, has entered into a contract to equip a similar line in Coventry. It is evident that an overhead system affords the cheapest method of conveying the electrical energy to the car. Before the Electric Powers (Protective Clauses) Committee evidence was given that in Leeds the cost of running the electric line was 5½d. per car mile as compared with 7·77d., the cost of steam and horse traction in the same city, and before the Electric and Cable Railways Committee Mr. Preece stated that 6d. per car mile was the average cost of running in the States. There the success of the overhead system has indeed been very great. Messrs. Crosby and Bell,* in reference to the American electric trams, says : "Experience thus far shows that the substitution of electricity for horses is followed by an increase in gross receipts ranging from 25 to 300 per cent. over the original receipts. Even when the service with horses has been good, considerable increase (rarely less than 30 per cent.) is marked. No better evidence could be had of the desirability of the electric railway. The expense per car mile will generally prove to be less than by horses. We say generally because in a city where horses and forage are exceedingly cheap, while coal and mechanical skill are unusually high, it might be impossible to secure the economy usually counted upon. As an illustration of the difference, exemplified on a large scale, we subjoin a statement (Table III.) made by the West End Railway Company of Boston, showing the greater economy per car mile of electric traction. It is to be noted in this case that the figures for horses represent the result of years of effort toward the best attainable practice, while for electric traction the figures cover contract prices for repairs made very early in the history of the business, and consequently at a higher price than would now be made. Moreover, the practice generally being new, it remains for time to develop those small economies which show a system at its best. For both horses and electricity these

* "The Electric Railway." New York : The W. J. Johnston Company.

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TABLE III.—Operations of the West End Street Railway Company, Boston, Mass., 1891.

	April		August	
	Electric.	Horse.	Electric.	Horse.
Gross receipts	$134,321	$344,396	$136,246	$392,474
General expenses	8.193	22,514	6,027	18,160
Maintenance expenses	9,795	22,692	12,498	18,669
Transportation expenses	37,653	114,001	31,123	105,953
Motive power	30,194	117,740	25,630	113,351
Total operating expenses	85,835	276,947	75,278	256,133
Net earnings	48,487	67,449	60,968	136,341
Miles run	394,459	1,083,887	363,836	1,096,376
Ratio of mileage	36·68	73·32	24·92	75·08
Per cent. operating expenses	63·36	80·62	57·13	64·52
Expenses per mile run—	Cents.	Cents.	Cents.	Cents.
Motive power per mile	7·65	10·86	7·04	10·33
Car repairs per mile	1·39	0·93	1·57	0·03
Damages per mile	0·75	0·78	0·23	0·10
Conductors and drivers per mile	7·33	8·28	6·85	8·10
Other expenses per mile	4·63	4·70	5·C0	4·81
Total expenses per mile	21·75	25·56	20·69	23·37
Earnings per mile run	34·05	31·77	37·45	35·80
Net earned per mile	12·30	6·22	16·76	12·43

figures of cost are high as compared with the rates attainable elsewhere. Coal, forage, and labour are in Boston well above the average for the entire country." It is a question whether the prejudice which exists in England against overhead wires will be overcome by the facilities which the system offers to cheap and rapid transit. Even if it be deemed that the system is not suitable for a crowded town or city, it may be acknowledged as quite permissible in the suburbs. The opinion of the members of the association would be of great value on this point.

Before closing the remarks under this head, attention must be drawn to the extremely good results given by lines employing a "third rail" as the conductor. The earliest example of this method is the line which was opened for traffic over 10 years ago, and which is still doing excellent work between Portrush and Bushmills, in the North of Ireland, a distance of six miles. The "third rail," which brings the electrical energy to the motor, consists of T-iron weighing 19lb. per yard. It is carried on creosoted wooden posts, 10ft. apart and 22in. from the inside rail, and 17in. above ground. Limit of speed 10 miles an hour. Following close upon this line in point of time was another "third-rail" line—namely, that constructed by Messrs. Mather and Platt between Bessbrook and Newry. In this line the conductor consists of inverted channel steel, laid midway between the rails. It is worked by water power, and the costs per tram mile were, according to the last data published, as low as 3·94d. The City and South London costs (third rail) work out at 7d. per 30-ton train mile: but this is deemed high, and 10d. is taken as the estimate of cost of the 180-ton trains on the proposed Finsbury Park electric line.

III. CONDUIT SYSTEM.

By means of this system the objectionable overhead wires are dispensed with, and the drawbacks to the use of accumulators avoided. It is, however, significant that there are, beyond the two experimental lines mentioned by Mr. Preece, no conduit systems now in operation in the United States, while there are only two in Europe. At the opening of the paper a description was given of the working of the Budapest tramways, and attention drawn to the excellent results obtained there. The car mile cost of running in 1893 amounted to 5·14d., taking the florin at equal to 20 pence. As already pointed out, large profits are being made annually, and it has recently been decided to extend the system throughout the whole city, and to entirely abolish horse traction. The Metropolitan Traction Company have just contracted with Messrs. Siemens and Halske to construct a similar line in New York. The only example of the conduit system in this country is that at Blackpool, which was laid down in 1883 by Mr. Holroyd Smith. The conduit here is only 12in. deep, as against 27½in. at Budapest, and the slot ½in. wide at the top, as against 1 1/8in. As the line runs the whole length of the esplanade, the conduit is frequently flooded by the tide twice a day, the water depositing therein shingle, stones, and sand. The line has, however, during the past few months been thoroughly overhauled, and the electric cars have been restarted most successfully this week. So satisfied is the Blackpool Corporation with the conduit system that large extensions are projected. In defence of that system they have, within the past few days, successfully sustained their case before the Board of Trade against the opposition of a tramway company fringing their borders. The cost of running is returned for 1893 at 5d. per car mile, though older statistics placed it much higher. Indeed, it is claimed that if the bad condition of the road had not prevented continuous running, the 1893 cost would probably have been as low as 3·5d. per car mile. In addition to the lines in work at Budapest and Blackpool, there are other "conduit systems" which have been designed, but as they are not yet in actual work, and only differ in technical details, they need not be here described. The writer wishes to state his conviction that there are many towns in this country where a properly-designed and solidly-constructed conduit system would prove a great success.

BEST METHODS OF "GENERATING" THE ELECTRICAL ENERGY.

Having now described the various systems of electric traction, consideration may profitably be given to the most economical method of "generating" the electrical energy for running them. The writer is convinced that low costs can best be attained by a combination of electric traction with electric lighting. In connection with the running of electricity supply works for electric lighting, he has had during the past 10 years to carefully consider the costs of production of electrical energy. The popular idea is that by far the greatest cost is that of coal, and that preference should be given to plant providing for low coal consumption, with regard first to steadiness of running, easy manipulation, cheap maintenance, etc. The actual position held by coal may be seen by the following statement:

TABLE IV.—Average Cost of Producing Electrical Energy in 24 Electricity Works in the United Kingdom in 1893, excluding depreciation.

		Pence per 1,000 (watt-hours).	Percentage.
Coal	£48,503	1·02	28·97
Oil, waste, water, stores	11,388	·24	6·80
Salaries of engineers and works wages	41,450	·87	24·77
Repairs and maintenance	23,441	·49	14·00
Rents, rates, and taxes	8,762	·18	5·21
Management	33,915	·71	20·25
11,411,176 units	£167,459	3·51	100%

An examination of the above percentages show that the value of the raw materials used in an electricity supply works, practically devoted exclusively to lighting, only amounts to 35·77 per cent. of the total annual costs, and it is confidently believed that this percentage will be considerably decreased. It is manifest, therefore, that an increase of the duration of the daily load, not necessitating additional plant or additional labour, would only affect the coal, etc., bill. On these lines it will be seen that, supposing the load were doubled, the resulting cost would be:

TABLE V.	Cost of production of electrical energy. 1 unit.	2 units.
Coal, oil, waste, stores, water, and sundries	1·26d.	2·52d.
Other charges	2·25d.	2·25d.
	3·51d.	4·77d.
Or per unit		2·38d.

If the load were similarly multiplied, say, four times, with, perhaps, an increase of 20 per cent. on the other charges, the result would be:

TABLE VI.	Cost of production of electrical energy. 1 unit.	4 units.
Coal, oil, waste, stores, water, and sundries	1·26d.	5·04d.
Other charges	2·25d.	2·70d.
	3·51d.	7·74d.
Or per unit		1·94d.

As a matter of fact the coal bill would not be augmented in exact proportion to the load, because in electric lighting works the time of "small load" presses very unremuneratively on the coal consumption; indeed, it might be fairer to assume that the quadrupling of the load would be effected at the expense of only trebling the coal bill, etc. On the other hand, it may be urged that four times the load, though spread over the usual working hours of the "central station," could not be coped with at an increase of only 20 per cent. upon the "other charges." The writer is, however, content to leave the estimate as it stands,

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in order to illustrate the fact that a lengthening of the hours of active use of the electricity works plant would lead to considerably lower costs all round. The combination, indeed, of electric traction and electric lighting would appear to be a most beneficial one. At the opening of the day, when the trams start operation, there is no load upon the electricity works, and this absence of load practically continues till sunset. Here, then, is a most convenient use for plant otherwise lying idle. In the case of electricity works specially confined to traction, the whole of the standing charges are, of course, debited to the cost of the car mile run, whereas, if worked in connection with electric lighting, only a portion of those charges would be debited. It must, however, be borne in mind that at one period of each evening the electric lighting load and the tram load would clash, and this has hitherto been considered a bar to the combination of the two works. It is fully admitted by the writer that the overlapping of the loads is a matter of great moment, and the means by which it can be coped with will have to be carefully thought out. He is, however, convinced that an economical arrangement can be arrived at. It will be seen at once that the accumulator system is that which lends itself most readily to the combined plan. The duration of the top load in electric lighting works varies according to different localities, but it frequently lasts for less than one hour. Up till the moment of reaching it there is a margin of capacity in the plant for doing the work of charging the batteries, and from the moment the load begins to fall off the margin of capacity is released, so that in the case of the accumulator system it would be only necessary to cease storing for about one hour; and, on the other hand, extra storing would be effected during the hours of the night when the electric lighting load was practically nil, and the trams were not in operation. In the case of systems of direct supply, it might still be possible to tide over the period of maximum electric lighting load by secondary batteries fixed in the station, which, charged during the day, could be used at the critical period to give out the electrical energy necessary to feed the motors on the cars. As soon as the electric lighting load began to fall off, the dynamos thereby released could be put on to the traction work. It would, of course, never be desirable for the lighting and the traction work to be coupled together from the same dynamo, as the heavy variations of the traction load would cause unpleasant fluctuations in the light. There is a third plan which the writer has lately been considering, and which might, indeed, prove the most economical method of dealing with the overlapping difficulty—viz., the horsing of the tramcars during the time of the top lighting load. In conversation with a leading provincial jobmaster, the writer finds that in many cities horses are jobbed out to do purely light day work, and that it would be a boon to the jobmaster to be offered employment to which they could be put during the evening. As doubtless the members of the association have the control of the horses belonging to their respective local authorities, it will be useful to gather their opinion upon this point. By whatever means, however, the overlapping load may be coped with, the writer urges that it by no means presents an insuperable difficulty, and even though, comparatively speaking, it may not be dealt with economically, the advantages of the combination of traction and lighting in one works completely outweigh the disadvantages connected with the less economical running of the trams, for a short time daily.

As mentioned last week, the discussion on the papers presented by Mr. Shoolbred and Mr. Hammond was taken together. It was very brief, and was as follows:

Mr. Crompton said there was a mistake of 50 per cent. in the working cost of the last mentioned in the list of companies working on the low-pressure system. This was of great importance in view of the great battle which had raged as to the best system of electric lighting. One body of electricians held one system to be correct, and the other held very different views. The result had been very puzzling to the various committees who had investigated the electric lighting of towns. On that very important point Mr. Shoolbred's paper was highly instructive. He showed results which redounded greatly to the credit of those in charge of the Bradford installation, and he must say that Mr. Shoolbred and his engineer, Mr. Baynes, were to be congratulated on the results of their four years' extremely hard work. There was no doubt Mr. Shoolbred was to be congratulated on having been firm enough to get his committee to adopt the system which had been adopted. The committee had been strongly attacked for not having adopted the high-pressure alternating system. The right-hand column showed if they had done so their working costs would have been considerably higher, and instead of being a financial success the works would not have been a success. He knew what he was saying was of a highly controversial nature, and might be contradicted by those who followed him, but when he told them that Lord Kelvin, the late Dr. Werner von Siemens, Prof. Hefner von Alteneck, of Berlin, and Prof. Kennedy, who probably advised more towns than anyone else in England, were of the same opinion on the matter, they would see he was one of a very strong army. The whole point was this: towns that they were proposing to supply electrical energy to varied very much in their requirements. Most provincial towns consisted of a condensed business quarter and a suburb of villa residences in which the business men engaged in the town during the day lived in the evening; and the difficult problem was how to put down works to supply these two classes of buildings in the most satisfactory manner, and at the cheapest possible cost. It was extremely difficult for corporation committees to choose between those who held these divergent views. Those who advocated the high-pressure system were able to show that their plant would cost less money; those who thought with himself that the comparative safety and moderate pressure adopted at Bradford were the best, were able to show that though the capital to be raised in the first instance was higher, the working costs were so much less that even with the added cost of capital it did not reach the high figure it reached where the high-pressure system had been adopted. Personally, he was in a peculiar position. He advised three of the largest companies in London, and those works were on the low-pressure system, and he held three-fourths of the capital of a high-pressure alternating system providing the electric light to a provincial town, and his pocket had suffered thereby. He had had every opportunity of making it as economical as possible—he was alluding to Chelmsford—and he was just making it turn the corner; whereas with other towns this turning of the corner had taken place some years ago. Of the municipal corporations who had taken up electric lighting, Bradford was the oldest, and was a success. Hull was also very well satisfied with the results of its undertaking. The four low-pressure companies in London were paying an average of 5 per cent. on their capital. If they turned to the other side, there were only two companies—those at Newcastle—which were paying any interest on their capital when invested in high-pressure plant. The reason was not far to seek. At Newcastle coal was purchased at 3s. 2d. to 5s. 6d., and they had consequently been able to show exceptionally low working costs in their exceptional position. The advocates of the high-pressure system invariably pointed to those two companies to prove the success of the system, and it was high time this matter should be shown up. In that room he had already read a long paper, which was subjected for two nights to the discussion of engineering experts, and he was then able to show that at Newcastle the absolute working costs as regards fuel and labour and all the items which went to make up the real costs of electricity as apart from management and sinking fund, were 2½ to three times as great at Newcastle as when they were compared with equal prices of coal to the cost of working the low-pressure system in London. His remarks on Mr. Shoolbred's paper would not altogether suit Mr. Hammond; but as regard Mr. Hammond's own paper it was one of very great interest, and its only fault was that he had not made his case strong enough. He had put before them a very moderate case as to municipalities taking up the driving of trams by electricity.

Mr. R. Hammond said he was very much obliged for the opportunity of a six minutes' speech, as a set off against his paper being crowded out. He was hardly able in that six minutes to follow Mr. Crompton in his discussion of Mr. Shoolbred's paper. He would only say it was, perhaps, to be regretted that from the point of view of the association that Mr. Crompton did not deal with the subject of municipal electricity works generally rather than laying before them a plea for any particular system. With regard to electric trams, he was very pleased to hear from so close an observer as Mr. Crompton that he thought he (Mr. Hammond) had put his case too weakly, or at all events he had not put it as strong as he might have put it. The great argument he wanted to drive home in his paper was this—that in electricity supply works there were perforce a great many idle hours. From six o'clock in the morning to sunset there was, roughly speaking, no load whatever upon an electricity works. Of course, he knew that in some works a certain amount of accumulating was done during the day, and for the details and explanation of his short remarks he must refer them to his paper. Let them take it on the broad principle that lighting was not required during the day, and from half-past five to six o'clock in the morning there was a capacity in the electricity works which might very well be utilised for tramways. He need hardly, before gentlemen so well acquainted with the principles of cost and standing charges, draw their attention to the fact of how markedly costs were decreased by an increase of output. But he would like to say this, that this was especially so in the case of those works that obtained an increase of output, not by doubling the work at one particular end of the day, but by doubling the hours' duration of work. If in any electricity works—Bradford, for instance—they were in the course of the next 12 months to double the number of lights that were now attached to the station, and fed from it, then necessarily there would be a double plant and a double cost; but if they glanced at the diagrams which Mr. Shoolbred had so ably prepared, and which set forth the position so exactly, they would see it was only in a certain portion of the evening that the top load was reached and that it rapidly fell away. Therefore any broadening out of the groove would simply lead to an increase in the use of raw material. All the standing charges would be the same, roughly, though in his paper he had provided for a further 20 per cent. beyond the coal bill. This appeared to offer a solution to the difficulty which electrical engineers were suffering under of reducing the cost of electrical energy. He had taken the 24 companies which made returns. He had not taken particular works, but those whose Board of Trade returns were available. He admitted there was a difficulty which was manifest to all, and that was the overlapping of the load. The reply was, it was all very well to begin at six o'clock in the morning, but what were they going to do when the double load came on at night. He quite believed the difficulty of the overlapping of the load could be coped with electrically, but

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rather than run the two he would bring out horses for a couple of hours and horse the trams. He was told by a jobmaster that those horses which went in at three or four o'clock in the afternoon could be used for the critical period. What he wished to establish was that there was idle plant which could be used in the direction of traction, with the result of greatly reducing the costs all round.

LEGAL INTELLIGENCE.

DICKINSON v. SCOTT.

This action, in which Mr. Ronald A. Scott, M.I.E.E., etc., was sued in the County Court of Durham, at Stockton-on-Tees, for hire of a building, warehousing, and work in connection with the exhibition of his electric advertising apparatus, came recently before two judges of the High Court sitting at a Divisional Court of Appeal, on a motion by Mr. Scott to set aside the judgment of the Court below.

Mr. C. Arnold White appeared for the appellant, and Mr. Jarburgh Anderson represented the respondent.

This action had turned on the question whether a claim by a certain Mr. Folkard, who was a general agent for sale of electrical apparatus for Mr. Scott in the North of England, was in consequence and impliedly an agent for the purpose of pledging his credit in connection with the exhibition in question, which was held at Middlesbrough, preliminary to negotiations for the acquisition by Mr. Folkard and his friends of a sole license for use in the northern counties for a certain sum. His Honour Judge Turner held that Mr. Folkard had this authority, and in consequence Mr. Scott must pay for rent of the building and the work done by the plaintiff, Mr. Dickinson, and his workmen, but not for warehousing the apparatus after the exhibition. Mr. Scott had counterclaimed for damage sustained by the detention of the apparatus. The counterclaim was disallowed, and the defendant was to pay the whole claim (except the portion for warehousing) and costs. He thereupon appealed to set aside this judgment, and for a new trial upon the counterclaim on the ground that the judgment was wrong in law.

The motion was heard before Mr. Justice Cave and Mr. Justice Collins in June last, and, after considerable argument by the learned counsel, the hearing was adjourned for a week on their lordships' suggestion with a view to settlement.

We understand that this has now been arranged to the satisfaction of Mr. Ronald Scott upon the terms that he should be repaid all the costs and the whole of the money paid over upon judgment in Mr. Dickinson's favour on the claim, and, in addition, a substantial sum to cover costs and damages upon the appeal.

COMPANIES' MEETINGS.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY, LIMITED.

An extraordinary general meeting was held on Tuesday to approve of a provisional agreement for the sale of the Swan Company's undertaking to the Company.

Mr. James Staats Forbes, who presided, said: We have called this meeting, not because there was any legal necessity to do so, for this is a matter which was in the competence of the Board to commit you to without confirmation. That, however, is not the way in which we do business in this Company; we like the shareholders to come in and confirm what we do. We made it a condition of this bargain, and of the vote we took on behalf of the Swan people, that the agreement was still open to objection if the Edison and Swan Company, as a separate company, did not confirm it at this meeting; therefore, we have called you together. The discussion which took place at the previous meeting had, among other advantages, that of giving me an opportunity of stating what the position is. The Edison and Swan, in which we ourselves are considerable partners, has such a common interest with the Swan Company that we thought it prudent to acquire that portion of its business which was not absorbed in the original amalgamation of the British patents. We are now the subjects of active competition, and this being so, we came to the conclusion that it was very desirable to join our forces, so as to present a united front to the enemy, not only in Great Britain, but also on the Continent, and for that residuum the Swan Company has agreed to accept £100,000 of debentures. The question we have to determine to-day is whether the Edison and Swan Company is willing to give that for it. I do not know whether anybody will be prepared to express disapprobation of it, or to use arguments which will induce us to reconsider our decision. If they are so prepared, we are at their service. I now beg to move the following resolution: "That the provisional agreement, dated June 5, 1894, submitted to this meeting, and expressed to be made between the Swan United Electric Light Company, Limited, and this Company, for a sale of the Swan Company's undertaking to this Company for debenture stock of this Company, be, and the same is hereby, approved."

Major Flood-Page, in seconding the resolution, said that every single director and every official connected with the management of this organisation was in accord in thinking that if they were to make a success of that undertaking they must have this fusion.

The resolution was then put and carried without discussion.

SWAN UNITED ELECTRIC LIGHT COMPANY, LIMITED.

An extraordinary general meeting was held on Tuesday at Cannon-street Hotel, E.C., under the presidency of Mr. James Staats Forbes (the chairman).

The **Chairman**, in the course of his remarks, said: I assume that everybody is conversant with the resolution now to be submitted, and therefore my business is very simple. The whole matter was fully discussed at the former meeting, and it was thought desirable, in the interests of all concerned, that the agreement should be approved. I will therefore content myself by proposing the confirmation of the following resolution: "That the Swan United Electric Light Company, Limited, be wound up voluntarily, and that Henry Charles Gover, of 100, Victoria-street, in the city of Westminster, be, and he is hereby, appointed liquidator for the purpose of such winding up, and that the liquidator be, and he is hereby, authorised to carry into effect, upon the terms of a provisional agreement between the two companies dated June 5 (subject to any modification), a sale of the Company's undertaking to the Edison and Swan United Electric Light Company, Limited, for debenture stock of that company, to be distributed among the members of this Company."

Major Flood-Page seconded the resolution, which, after some discussion, was unanimously adopted.

ORIENTAL TELEPHONE AND ELECTRIC COMPANY.

The first ordinary or statutory meeting of the shareholders of this Company was held on Wednesday at Winchester House, Old Broad-street, in compliance with the Companies' Act, 1867, Mr. William Addison occupying the chair.

The **Chairman** said that the reconstruction arrangements had proceeded satisfactorily. The new Company was registered in the afternoon of the day on which the resolution was passed by the old company, and the business had since been conducted without any drawback. There was every reason to believe that the shares were well and firmly held, as there had been but few transfers. The Company's business was showing fair progress, the reports from the various agencies and the affiliated companies being satisfactory. With regard to India, the volume of business showed a satisfactory increase, but the depreciation of silver necessarily affected them. The new company having only been formed on March 12, they could not at that meeting bring forward any report or balance-sheet, but they would do so at the earliest opportunity next year, which would probably be in April. As there was no special resolution to put before the meeting, he would be happy to answer any question.

No questions being asked, the Chairman declared the meeting at an end.

BUSINESS NOTES.

Glasgow.—Electrical plant for the illumination of the tramway depôt is being laid down at the depôt.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 1st inst. amounted to £894.

Direct Spanish Telegraph Company.—For the month of June the receipts were £1,617, as against £1,730 for the corresponding period of last year.

Cuba Submarine Telegraph Company.—For the month of June the receipts were £117 more than for the corresponding period of last year.

Eastern Extension Telegraph Company.—For the month of June the receipts show a decrease of £1,199 as compared with the corresponding period of last year.

West India and Panama Telegraph Company.—The receipts for the two weeks ended June 30 were £16 less than for the corresponding period of last year.

Tenders for Buildings.—The London County Council invite tenders for the construction of the buildings in connection with the electric lighting of the embankment.

Lecturer Required.—An assistant lecturer in mathematics and physics is required for the Battersea Polytechnic Institute. Particulars may be obtained of the secretary.

Brasyer v. Harness.—Colonel Brasyer is endeavouring to secure the return of money from Mr. Harness and the "Medical Battery Company," and he also claims damages for negligence.

Bolton.—The electric lighting works, which have cost something like £40,000, along with plant, are approaching completion, and in a few weeks the Corporation expect to be in a position to supply this illuminant.

Newcastle.—The Finance Committee of the Town Council have reported on the proposed alterations in the Town Hall. The estimated cost of installing the electric light is £470. The report stands over for consideration.

Windermere and District Electricity Supply Company, Limited.—This Company has been registered with a capital of £50,000, in £5 shares, to carry on business as electrical engineers, electricians, engineers and contractors, etc.

Wolverhampton.—The directors of Messrs. Thos. Parker, Limited, have accepted the contract of Mr. H. Lovatt, builder, etc., Wolverhampton, for the erection of their new electrical engineering works in the Wednesfield-road.

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Eastern Telegraph Company.—The directors recommend, after placing £110,000 to the reserve fund, a further dividend of 2s. 6d. per share and a bonus of 3s. per share, making a total distribution of 6½ per cent. for the year ended March 31 last.

Newport (Mon.).—The first lengths of a new line of tramway, owned by the Corporation, have been laid. According to a Welsh paper, it is hoped that in no long period electric traction will be adopted, and that the cars will be lighted electrically.

Mason's Stair Treads.—The Safety Tread Syndicate, Limited, of 15, Barbican, E.C., inform us that Mason's unwearable non-slipping stair treads have been introduced as the covering for the stairs in the towers of the new Tower Bridge opened on Saturday.

Electric Novelty Syndicate, Limited.—This Company has been registered with a capital of £4,500 in £1 shares to carry into effect an agreement between R. Myers and this Company for the acquisition of certain patents relating to improvements in electrical toys.

Business Notice.—We are requested to state that Messrs. Habgood and Smith, of Queen Victoria-street, and Great Missenden, are in no way connected with the British Volta Electric Glow Lamp Company, of 49, Queen Victoria-street and Great Missenden, Bucks.

St. James's and Pall Mall Electric Light Company.—The directors have declared an interim dividend on the first preference shares at the rate of 7 per cent. per annum, and on the ordinary shares at the rate of 4 per cent. per annum for the half-year ended June 30.

St. Pancras.—The Vestry have sanctioned the outlay required for wiring the buildings under the control of the Board of Guardians and the Committee of the Baths and Washhouses. It is stated that it will be at least 12 months before the scheme can be carried out.

Edinburgh.—The Cleaning and Lighting Committee of Edinburgh Town Council on Monday agreed to recommend that George-street, St Andrew-square, Charlotte-square, and streets leading from these thoroughfares into Princes-street, should be lighted by electricity.

Coventry.—The Electric Light Committee of the City Council report that 106 applications have been received for the post of clerk of works at the new buildings, and that Messrs. A. Davies (Coventry) and J. B. Crawford (London) are to meet them with a view to final selection.

Fraser and Fraser, Limited. — This Company has been registered with a capital of £30,000 in £1 shares to acquire the business of engineers and boilermakers now carried on by Fraser and Fraser at the Railway Works, Bromley-by-Bow, and Monument-chambers, King William-street, E.C.

Dover.—At a meeting of the Town Council, Councillor Clark said that observations had been made because the town men were employed in laying down the mains. He wished it to go to the public that this was done by agreement, and the company were paying the Council for the work done by them.

Lancashire Boiler Required.—The Hereford Gas Committee invite tenders by the 21st inst. for the construction and fixing of a Lancashire steam-boiler. Specification may be seen and the drawings and site inspected on application to Mr. William Parlby, gas engineer and manager. Gasworks, Hereford.

Tenders for West Ham.—As mentioned in our last issue, tenders are invited for the electric lighting at the Public Hall and Free Library, Barking-road, Canning Town, E., for the West Ham Town Council. Tenders are to be sent to Mr. Fred. E. Hilleary, town clerk, Town Hall, West Ham, by 10th inst.

Mill-Lighting.—Messrs. Bennett and Druce, of 30, Winckley-square, Preston, have secured an order for a complete plant consisting of engine, dynamo, and fittings for a mill situated in the North-West Provinces of India. The engine is by Messrs. Marshall, Sons, and Co., Limited, of Gainsborough.

Extension of Patents.—The Electric Construction Company, Limited, and the Electric Power Storage Company, Limited, who are exclusive licensees under Camille Faure's patent for improvements in batteries, intend to present a petition praying that the said letters patent may be extended for a further term.

Elmore's German and Austro-Hungarian Metal Company, Limited.—It is announced that, owing to continued ill-health, the chairman (Mr. Rock) has been compelled to resign his seat on the Board of this Company, and that Mr. John Heal, of the firm of Bloor and Heal, of Snow-hill, E.C., has been appointed a director of the Company.

City and South London Railway.—The receipts of the Company for the week ended July 1 were £1,020, against £811 for the corresponding week of 1893, or an increase of £209. The total receipts for the half-year ended July 1 were £23,636, as compared with £22,610 in the corresponding period of 1893, or an increase of £1,026.

Removal.—Messrs. Winfields, Limited, of Birmingham, are removing their London sample-room to 30, Snow-hill, E.C. The London business is under the management of Mr. Seymour Croneen, and arrangements are being made for the display in the new showroom of a fresh selection of samples, including the latest designs in gas and electric light fittings.

Birmingham Trams.—In moving the adoption of the report of the Public Works Committee of the Town Council on Tuesday, Mr. Smith said he thought the committee would have the approval of the Council in refusing the tramway company permission to adopt the overhead wires on the Bristol-road route. They were very unsightly, and would disfigure the road.

Engineer Wanted.—The Corporation of Wolverhampton invite applications for the appointment of working foreman engineer for the electric works, at a salary commencing at £2 per week. Applications must be made on forms to be obtained from Mr. F. Harman Lewis, borough electrical engineer, Town Hall, Wolverhampton. The forms must be returned by 14th inst.

Tenders for Wolverhampton.—As stated in our last issue, the Lighting Committee of the Corporation of Wolverhampton invites tenders for the supply of electric fittings suitable for the Town Hall, Art Gallery, School of Art, Free Library, and Market Hall, and for the electric wiring and erection of selected fittings. Further information is given in our advertisement columns.

Darwen.—The architect of the new technical school has been instructed to prepare plans and estimates for erecting a building behind the news-room for the reception of the electrical machinery. The committee have taken this course on the suggestion of Mr. Barton, the electrical engineer, who advised them to have the electrical machinery in a structure outside the main building.

Warning.—We hear of several cases of a person who passes as a representative of well-known firms and obtains goods in their name without any authority. Messrs. Edmundsons, Limited, 19, Great George-street, Westminster, inform us that they have had several such instances brought to their notice quite recently, and wish to warn all firms not to supply goods to anyone without their official order.

City of London Company's Dividend.—The directors of the City of London Electric Lighting Company, Limited, have declared an interim dividend on the preference shares of the Company at the rate of 6 per cent. per annum, for the six months ending June 30. The dividend will be payable on and after the 19th inst. The warrants for the interest due June 30 on the debenture stock have been posted.

Wimshurst, Hollick, and Co., Limited.—This Company has been registered with a capital of £40,000 in £5 shares, to carry into effect an agreement between T. D. Hollick, Sidney Hollick, and F. W. Drake, and this Company, for the acquisition of the business of electrical and general engineers and boilermakers now carried on by Wimshurst, Hollick, and Co. at 602-604, Commercial-road, London.

Rochdale.—A bazaar has been held at Mount Falinge, a large residence in this town, on behalf of the building fund of Providence Chapel. There was a temporary installation of the electric light, which was carried out by Mr. J. K. Grindrod. Each room of the house was lighted with incandescent lamps, and outside there were two arc lights. A dynamo driven by a portable engine was employed.

Derbyshire.—It is mentioned in the forty-second annual report of the Derbyshire County Lunatic Asylum that, in connection with the matter of lighting, the question of electric installation has been under consideration, a special report dated December 6 last having been obtained from Mr. A. H. Preece, 39, Victoria-street, Westminster, London, who inspected the asylum and went fully into the subject.

Wolverhampton.—A start was made not long ago with the new municipal electric lighting works, which are situated in Commercial road, and within a few months the new illuminant will be in use in the principal thoroughfares and public buildings. The mains have been laid down as far as Dudley-street and Queen-square, so that in a short time the centre of the town at any rate will have been provided for.

Dissolution of Partnership.—The partnership subsisting between William Thomas Burbey, Albert Edward Williamson, and Edward Lionel Joseph, as electrical engineers and manufacturers, at 92, Queen Victoria-street, and at Church-street, Horsley-down, has been dissolved by mutual consent so far as regards William Thomas Burbey. The business will be continued by Albert Edward Williamson and Edward Lionel Joseph.

Cheltenham.—On Monday, Mr. H. Kilgour was appointed electrician to the Town Council, at a salary of £200, rising to £250. Messrs. Malvern's tender at £1,799 was accepted for the erection of the central electric lighting station. The tender of Callender's Bitumen Telegraph and Waterproof Company at £1,031. 8s. 4d. was accepted for the supply of cables, subject to the high-pressure cables being guaranteed for 10 years.

Ilfracombe.—At a meeting of the Local Board on Monday the Great Western Light and Power Company, Limited, intimated their intention to apply for a provisional order to enable them to supply electricity to the district. Mr. Prouse (surveyor) said the Board ought itself to obtain the order, and if they did not care about supplying the electricity they could lease their rights to a company. It was decided to oppose the provisional order.

The Phonograph Action.—In the case of the Edison-Bell Phonograph Corporation, Limited, *v.* the London Phonograph Company, Mr. Justice North has granted an injunction restraining the defendants from infringing the plaintiffs' patent for phonographs. His Lordship said that Mr. Justice Wright had already held that the plaintiff's patent was valid, and, admittedly, there had been infringement of two of the claims in the specification.

Kingston-on-Thames.—The Lighting and Market Committee reported to the Town Council last week that the town clerk had submitted a letter from the Local Government Board in regard to the application for the further loan of £6,000 for electric lighting purposes, stating the particulars that would be required for the Board's consideration, the same to include the plans and estimates. The consulting engineer submitted the estimates, and was instructed to prepare the necessary plans.

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Harrow.—A petition, signed by 109 ratepayers, has been presented to the Local Board by Mr. O. A. Saunders on the subject of electric lighting, asking that before any proceedings were taken the Board would call a public meeting. It appears that the Board has no power to spend money in calling a public meeting. It was therefore suggested that a deputation from the signatories should be asked to meet in the Board-room, when the matter could be explained. This suggestion was carried.

Case of Appeal.—In the Judicial Committee of the Privy Council, on Saturday, judgment was given in an appeal of the Winnipeg Street Railways Company from a judgment of the Court of Queen's Bench in Manitoba. The point really at issue was whether the appellant company were entitled to the exclusive right of constructing railways in the streets of the city of Winnipeg, and their lordships, concurring with the Manitoba Court that they had no such right, dismissed the appeal, with costs.

New Branch.—The Electrical Installation Company, Limited, of 66 and 64, Victoria-street, S.W., have recently completed an installation for Lord Stratheden and Campbell at his seat in Roxburghshire, the dynamo being driven by water power, and supplying not only the house and stables and a battery of Epstein cells as a reserve, but also providing the current if required during the day for an electric motor erected at the home farm. The Company have opened a branch in Edinburgh at 30, St. Andrew-square. Mr. J. H. Mackail is their district engineer for that city.

Eccles.—The elective auditors of the Town Council, in the course of a comic report on the finances of the Corporation, say: "Over £600 has already been spent in furtherance of the project of electric lighting. Boroughs with greater funds at their command have left this luxury alone, and it is worth considering seriously whether any further expense should be incurred in this direction." The elective auditors apparently do not quite understand what their function is. A number of members of the Town Council protested against the tone adopted in the report.

Wrexham.—At a meeting of the Town Council, on the motion of the Mayor, seconded by Mr. Charles Davies, the corporate common seal was affixed to the joint memorial from the Wrexham and District Electric Supply Company, Limited, and the Corporation to the Board of Trade, in reference to the proposed acquisition by the Corporation of powers of electric lighting within the borough, with the sanction of the Board of Trade, by provisional order, license, or otherwise, and applying that the Corporation might become the undertakers for such supply in the place of the company. It was stated in the memorial that the price to be paid is £350.

Folkestone.—A special meeting of the Council has been held to consider an application from the Brush Provincial Electric Lighting Company, Limited, as to whether the Corporation would sanction an application by the company for a provisional electric lighting order. The Corporation would have the option of acquiring the company's property on agreed terms, at the expiration of seven, 14, or 21 years. The Town Clerk stated that the Board of Trade would not entertain any such application by a private company without the consent of the Corporation, except in very special circumstances. After a good deal of discussion, a resolution was carried that the Brush Company be informed their request cannot be granted, as the question of the adoption of a scheme by the Corporation is still under consideration.

A Question of Wages.—A deputation was received on Friday by Mr. Arnold Morley, the Postmaster-General, from the London Trades Council, and representatives of the Scientific Instrument Makers and Electrical Trade Union. Mr. G. Shipton, of the London Trades Council, in introducing the deputation, said they wished to draw the attention of the Postmaster-General to the low rate of wages paid in the Department's workshops, and also to the general treatment meted out to the employés as compared with the conditions under ordinary employers in these industries. The union representatives spoke at length on their grievances, and Mr. Morley, in promising that the whole question should have his careful consideration, said it was his desire that all the departments should be managed on strictly fair conditions, as he was of opinion that the State should be a model employer.

Bournemouth.—At Tuesday's meeting of the Town Council, letters from Mr. J. S. Raworth, manager of the Brush Electrical Engineering Company, Limited, were read at the meeting of the Roads Committee, asking permission to fit three or four of the existing street lamps with incandescent lamps of various candle-power to be supplied with current from the transformer station near the Arcade. The experiment is to be made with low-tension current, and not to involve taking up the roadway for inspection by the Town Council of Winchester, with whom they were negotiating for lighting that city. A letter from Mr. Bailey, town clerk of Winchester, was also read, stating that the Corporation of Winchester would feel obliged if this Council would permit the experiment to be made. It was recommended that permission be given subject to the details being arranged with the surveyor after consultation with the chairman of the Lighting Committee. The proposal was agreed to.

Baxendale and Co.—This Manchester company inform us that, among other contracts, they have recently received the following: Denbigh Lunatic Asylum, telephonic communication; Messrs. J. and R Brown, Manchester, incandescent lighting; Mrs. Astin, Manchester, incandescent lighting; similar illumination at the Manchester Pantechnicon; and incandescent lighting at Mr. M. S. Shepley's, Oldham, and at Stirling and Co.'s, Manchester; Slater's Directory Offices, Manchester, incandescent lighting; telephonic communication at Messrs. Bartlett and Co.'s, Manchester, and at Messrs. Bancroft and Co., Manchester; and arc lighting the North Pier, Blackpool. The last-named work is being carried out with concentric wiring, the cables employed being of the well-known paper-insulation class, manufactured by the British Insulated Company, of Prescot. The arc lamps are of the Brockie-Pell standard type, complete with hood and lamp-carrier attached to ornamental standards.

Conversion of Debenture Stock.—The National Telephone Company, Limited, announces the conversion and redemption of £1,000,000 4½ per cent. debenture stock by the issue of £1,100,000 of 3½ per cent. debenture stock, forming part of a total amount of debenture stock which is limited to £2,000,000. All outstanding 4½ per cent. debenture stock of the company not presented for conversion will be repaid and cease to bear interest from December 31, 1894. The directors invite subscriptions for the above £1,100,000 stock on the following terms: existing 4½ per cent. debenture-stock holders will receive allotment in full, at the rate of £110 of the new stock for every £100 of the old stock and 6s. 6d. in cash (less tax) per £100 existing stock upon allotment (being the difference in interest for the half-year ended December 31, 1894, between £110 stock at 3½ per cent. per annum and £100 stock at 4½ per cent. per annum), thus making up the half-year's interest to 4½ per cent. per annum.

Larne.—The principal business before the Town Commissioners on Monday was the approving of the agreement between the Commissioners and Messrs. J. E. H Gordon and Co. The contractors agree to light the town with electric light for three years from August 1, 1894, by means of 11 1,200-c.p. arc lamps, at £11 each per annum; six incandescent lamps of 32 c.p., £4 each per annum; 66 incandescent lamps, 16 c.p., at £2 each per annum, they to provide and pay the necessary staff for regulating and maintaining the lamps and the lighting of the town during the contract, and shall maintain the lighting in a state of efficiency from dusk to midnight from August 1, 1894, till the last day of the succeeding April. Mr. Picken remarked that there was no penalty clause in the agreement. Mr. English moved that the agreement be signed. After discussion Mr. Picken moved that the agreement be not signed until the penal clause is reinserted—*i.e.*, that clause 8 therein be made a penal clause. This was seconded, and on being put was declared passed.

The Rhondda Valley.—According to a Rhondda correspondent, the extensive collieries of the Ocean Company, situate in the vicinity of Treorky, have been partially lighted with electricity for 10 years. The Park Pit is lighted on the surface and also below. At the Dare Pit there is a separate plant. From the latter a private line leads current to the village of Cwmpark, where the road is lit up by 25 lamps. Two chapels have each 21 lights of 16 c.p, while the Board schoolroom is provided with 16 lights. A few of the houses in the village are also lighted electrically. Mr. B. D. Williams, the company's electrician, when not engaged in attending to the plant, has, it is stated, his hands full of work in preparing such things as portable electric light lamps of various sizes and shapes, and other appliances which are invaluable in places where the safety of life and limb is so carefully looked after. Mr. Williams points out that the time cannot be far distant when colliery companies will generally adopt the principle of the lighting of mines by electricity, which, in addition to giving a better illuminant, will render explosions caused by flames impossible.

Burton.—At a meeting of the Town Council on Wednesday, in the report of the Gas and Electric Light Committee, the chief recommendations were to make a grant of £100 to Mr. Ramsden, gas manager, for his services in designing and constructing the electric light works, and to make him manager of the latter at a salary of £50 per annum, dating from February last. Alderman Lowe, in moving the adoption of the report, claimed that Mr. Ramsden had saved them at least £1,000 by acting as engineer for the construction of the works, and that if they appointed an independent manager of the electric light they would have to pay at least £250 a year, whereas it was now proposed that they should only pay £50. Councillor Turner seconded the motion, but Councillors Graham, Thurnley, and Austin offered opposition, and amendments were moved to the effect that an honorarium of £150 should be given for the additional services, and that the question of salary should remain in abeyance until March next, when salaries have to be raised. A further amendment was made that the honorarium should be £50, and that the salary should be £25 per annum, but only three voted for each amendment, and the original proposition was carried.

Aberdeen.—A meeting of the Watching and Lighting Committee of Aberdeen Town Council was held on Saturday—Bailie M'Kenzie presiding—to consider the lighting arrangements of the new police offices. It had been proposed to introduce the electric light, and also the usual gas fittings. The Convener made an explanation regarding his statement at the Town Council meeting to which we have already referred, that the electrical engineer had advised the city architect to have the gas pipes fitted up. It had been reported that, at a subsequent meeting of the Gas Committee, Mr. Murray said he had not given such advice to anybody; but the city architect now explained that he asked Mr. Murray's advice as to whether the gas-pipes should be taken in when the electric light was to be introduced, and that gentleman's reply was that as the contractor for the gas fittings would likely have to be paid in any event, they would be as well to have the pipes taken in. Mr. Murray, who was present, admitted having given such advice under the impression, as he explained, that the fittings would have to be paid for even if they were not put in:

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but neither he nor Mr. Rust had any doubt as to the sufficiency of the electric light by itself. The Convener then asked if it was the mind of the meeting to have the buildings fitted up throughout with the electric light and no gas fittings introduced, and this was unanimously agreed to.

Hastings Accepted Tenders.—The following tenders were received for electric light wiring at the Queen's Hotel, Hastings, for the Queen's Hotel Company, Limited, Hastings:

Spiers and Pond, London	£510	0	0
Belshaw and Co., London	448	0	0
Hastings Electric Light Supply Company	358	13	4
Strode and Co., London	343	0	0
Roger Dawson and Co., London	300	0	0
Raynes, Smith, and Co., London	269	10	0
Fowler, Lancaster, and Co., Birmingham	265	0	0

The tender of the Hastings Electric Light Supply Company was accepted. For electric light fittings and fixing at the Queen's Hotel, Hastings, for the same company, the tenders were as follows:

J. Barker and Co., London	£411	0	0
Strode and Co., London	346	11	0
Hastings Electric Light Supply Company	345	18	4
Hands, London	310	9	9
Verity and Co., London	306	19	0

Burnley.—The fourteenth annual report of the Burnley Corporation officials has been issued, in which Mr. F. Thursfield, the electrical engineer, says: "It is satisfactory to be able to record that the demand for electricity has already reached, if not exceeded, the first expectation. When the canvass of the borough was made in the beginning of 1892, 32 persons signed forms undertaking to receive a supply for a total of 2,732 lamps of 8 c.p., or their equivalent. Out of these 17 only have at present become consumers, with a total of 763 lights; leaving 15 consumers who have yet to make good their promises, and add 1,609 lights to the mains. In addition to this, there are six others who signed the forms undertaking to receive a supply, who did not state what their requirements would be, and who have not yet taken any steps in the matter. So that if you had only to rely on the result of this canvass the business would be in anything but a flourishing condition. On the other hand, 51 additional consumers have been induced to come forward since the plant has been started, and they are now taking a supply for 3,592 lamps. You will see from the estimates for the coming year that a working profit of £570 is anticipated. This will probably pay about half of the interest and sinking fund due from this department; so that there is reason to hope that as soon as the output is doubled the business may be able to show a satisfactory balance-sheet, as the working expenses should scarcely increase in the same proportion."

Lighting of the City.—On Tuesday, at a meeting of the Commissioners of Sewers, Mr. Turner asked for information on the subject of two recent failures of the electric light, and moved that a return of all such failures should be placed on the table at each meeting of the Commission. This proposition having been seconded, was carried. The Engineer said he had some information as to a failure of the electric light on the 12th ult., when 11 lamps failed, and it was reported to be due to the fact that some oil had run on the carbon, and it had not been noticed by the lamp trimmer. The other failure, on the 14th ult., was due to the breaking of a lamp. At the same meeting, the following resolution by Mr. Gordon was adjourned until the next court: "That the resolution of this Court of July 25, 1893, agreeing to a recommendation of the Streets Committee that the Commissioners only consent to the use for telephonic purposes of certain tubes laid by the City of London Electric Lighting Company on a guarantee being given that telephones, with double wires and all the latest improvements, will be supplied to the citizens at a cost not exceeding £8 per annum, be rescinded, and that an offer of the said company to pay the Commissioners '10 per cent. of any annual rental, so long as such may be received for the use of any tubes for telephonic purposes, up to a sum of £10,000 per annum, and 20 per cent. on any rental in excess of £10,000,' be accepted, provided the minimum amount to be received by the Commissioners be £1,000 per annum, and subject to a proper agreement being entered into with the company, without prejudice in any way to the rights and privileges of the Commissioners under the contracts and provisional orders."

Fleetwood.—At the ordinary monthly meeting of the Improvement Commissioners, the Highway, Lighting, Fire Brigade, and Building Committee recommended unanimously that the correspondence with Messrs. Carrick and Ritchie, Edinburgh, be approved, and that their offer of a five-ton crane, erected and completed in the proposed electric lighting station, for the sum of £82, be accepted, subject to the usual conditions as to contract, sanction for borrowing powers, etc.; also that the tender received from Mr. Jonas Kirkbride for erection of new buildings, etc., in the town's yard, be increased by the sum of £10 for additional ironwork in the roof of engine and generator rooms as per amended plan now produced, and letter dated 29th ult, was read from the Brush Electrical Engineering Company, Limited. The amount of tender as now amended is £2,024. 12s. 7d. The committee further recommended that the clerk be authorised to apply for sanction to borrow the requisite sums of money required in connection with the proposed installation of electric lighting in this district, as per estimate to be submitted to the Board at the next meeting; that the tender of the Brush Electrical Engineering Company, Limited, for electrical plant, etc., be increased by the sum of £150, as under: special stoking arrangement for generators as inspected at Coatbridge, £100; preparing plans for buildings, £50; the total tender being £8,850; and that the said tender (as amended) be accepted on the usual conditions as to contract, sanction for borrowing powers, etc. Mr. C. Drummond wrote accepting the position of engineer in connection with the proposed new buildings in the town's yard, and it was recommended that the appointment of Mr. C. Drummond be approved.

The Leeds Tramways.—The first result of the visit paid to Newcastle, Edinburgh, and Glasgow by the members of the Leeds Corporation Tramways Committee, and to which we referred in our last issue, will be the presentation of a report on the subject of tramway haulage. The committee have not agreed upon any recommendation on the subject; they did not get back to Leeds until Thursday of last week; but the town clerk (Mr. John Harrison) and the city engineer (Mr. Hewson) are in possession of a mass of information, legal, technical, and general, upon which they will shortly be prepared to advise the committee and through them the Council. The committee were absent from Leeds three days, Newcastle being visited first. Here they were received by Councillor H. Morton, chairman of the Newcastle Tramways Committee, and had explained to them the position of the Corporation in regard to the proposal to adopt the cable system, besides having the opportunity of surveying some of the existing lines. The points urged in favour of the cable system in Newcastle were that, notwithstanding its costly nature, it would prove thoroughly efficient, and could be economically worked, whilst providing for a very complete service and being well adapted for heavy traffic and stiff gradients. The estimated cost per car mile was said to be about 4½d., as compared with 8½d. for an electrical service on the basis of the Budapest conduit electric system, and 10d. for horse traction. The Leeds committee had not time to stay and accept the full hospitality of their Newcastle hosts, and after having simply partaken of light refreshment, they hurried on to Edinburgh, where they were shown over the Golden Acre cable line, and inspected the Stockbridge section. One of these routes leads to a pleasant residential suburb, and the other serves a poorer district of the city. During the day the visitors were entertained by the Lord Provost and members of the Edinburgh Corporation at the Royal Hotel, and had the privilege of viewing the Corporation buildings. On their arrival the previous evening they drove out to the Forth Bridge, in the company of Mr. John Kerr, of Dick, Kerr, and Co.

Elmore's Patent Copper Depositing Company.—The directors summoned a meeting of the shareholders, which was held at the Cannon-street Hotel, yesterday, for the purposes of receiving their resignation, and appointing new directors in their place. The directors stated in the circular convening the gathering: "It will be in your recollection that the Investigation Committee recommended, in the first instance, that local directors should be selected; but that being impossible at the time, the present directors were appointed. Their work has been done at much inconvenience to themselves, to the best of their ability in the interests of the shareholders; but they feel it most difficult to exercise a proper control over the business without a sacrifice of time which their other occupations render most inconvenient. They are desirous, therefore, of placing their resignation in the hands of the shareholders, and are, they believe, fully justified in so doing under the conditions which are such as will enable them to present to the meeting the names of local gentlemen of position and ability who are now willing to take over the direction of the Company's affairs. It will be evident that the position of the business and condition of the works must be greatly improved, or the proposed new directors would not have been induced to come forward and take a large pecuniary interest in the business, and place themselves in the responsible position of controlling the affairs of the Company. After the last meeting £10,000 of 6 per cent. debentures were offered to the shareholders, but as the issue met with little response, the deposits were returned. The want of capital caused again delay in developing the business, and it was only after some time that an arrangement was come to with our bankers (through the agency of Mr. William Elmore and the guarantee of Mr. A. S. Elmore) to the extent of £15,000. This provides for the purchase of ample supplies of copper and the completion of the needful plant, so that nothing should now be wanting for the accomplishment of profitable results. The Wire Company having obtained capital, an arrangement must now be made with them for the joint use of the furnaces, and as other important agreements are waiting completion, my directors are desirous that they should be entered into by the new directors, who would then commence their duties with a fuller control of the interests of the business."

Hull.—At a meeting of the Corporation Electric Lighting Committee Mr. A. H. Gibbings, the electrical engineer, presented a report with reference to his previous report respecting oil fuel. He stated that he had visited the works of Messrs. W. S. Laycock and Co., Government and railway stores contractors, Sheffield, where he inspected three boilers, each fitted with Holden's apparatus for burning oil fuel. The steam for the injector was taken immediately from the face of the boiler in a similar way to the arrangement which he fitted up on one of the boilers for minimising the amount of smoke at the time of heavy firing. Messrs. Laycock and Co. obtain their oil fuel, which was creosote, from chemical works and different sources of supply about the neighbourhood, and they found that at 1s. 4d. per gallon it was equal to coal at 12s. per ton. He described the system of working, and, in concluding, said Messrs. Laycock's figures with reference to the comparative cost of oil fuel and coal were the same as those he mentioned at the last meeting. He was of opinion that oil fuel would be economical at any price not

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exceeding 1d. per gallon. He recommended the committee to fit up one boiler with Mr. Holden's apparatus when a favourable opportunity occurred, which would not be until he was able to bring before the committee some definite proposal with reference to the supply at an economical price of the necessary fuel. A report was read respecting an application from Walthamstreet Chapel to be supplied with electricity. The Chairman (Mr. Holder) expressed the opinion that places of worship might be placed on more favourable terms than places of business. It would be worked at a time when there was no maximum demands by the large shops. He moved "That, inasmuch as the Sunday demand for electricity will, as winter approaches, require a Sunday shift of workers at the station, and as such a shift can work the whole machines as easily as it can one, it is desirable to foster the demand for the light for illuminating churches and chapels. As an inducement, this committee recommend the Council be asked to supply places of worship requiring the light at a charge of 5½d. per unit for such electricity as they may use in such places or in the class of rooms attached thereto." Alderman Fraser seconded the resolution, which was dissented to by Mr. Millington on the ground that it would interfere with Sunday labour.

Tenders Accepted for Bedford.—The Urban Sanitary Authority met last week to consider the report of the Electric Light Committee recommending the acceptance of certain tenders for buildings, machinery, and plant in connection with the installation of the electric light in Bedford. The following is the list of the tenders that were sent in :

	£	s.	d.
Mains and Transformers.			
Pritchetts and Gold	3,465	10	0
Porter and Harrison	3,350	0	0
New and Mayne	3,282	2	6
Brush Electrical Engineering Company, Limited	3,068	0	0
Electric Construction Company, Limited	2,780	0	0
British Insulated Wire Company, Limited	2,686	10	5
India Rubber, Gutta Percha, and Telegraph Company Limited	2,598	0	0
J. Fowler and Co., Limited, Leeds	2,560	0	0
Glover and Co.	2,520	15	0
Henley's Telegraph Works, Limited	2,463	16	8
Hooper's Telegraph and Indiarubber Works, Limited	2,450	0	0
Johnson and Phillips, London	2,416	4	0
Crompton and Co., Limited	2,333	0	0
Telegraph Manufacturing Company, Limited	2,271	5	2
Siemens Bros. and Co., Limited (incomplete tender)	2,215	0	0
Plant.			
Barley, Grundy, and Barrett	9,320	0	0
Siemens Bros. and Co., Limited	6,290	0	0
J. Fowler and Co., Limited, Leeds	6,123	0	0
Brush Electrical Manufacturing Company, Limited	5,890	0	0
Crompton and Co., Limited	5,791	0	0
Allen, Son, and Co., Bedford	5,731	0	0
Electric Construction Company, Limited	5,317	0	0
Johnson and Phillips, London	5,200	0	0
Buildings and Shaft.			
G. E. Fathers, Bedford	2,022	13	6
J. J. Potter, Bedford	1,911	0	0
T. H. Coleman, Bedford	1,565	0	0
Travelling Crane.			
Bedford Engineering Company	120	0	0
Grafton and Co., Bedford	85	0	0

The tender of the Telegraph Manufacturing Company, Limited, was accepted for the mains and transformers; that of Messrs. Johnson and Phillips for the plant; that of Mr. T. H. Coleman for the buildings and shaft; and that of Messrs. Grafton and Co., for the travelling crane.

Manchester.—A report of the Electric Light Department of the Manchester Corporation for the year ended March 31, 1894, was submitted to the Council at its meeting on Wednesday. The buildings, boilers, engines, dynamos, and other plant referred to in the report of last year have been completed, and the supply of current was commenced on July 31, 1893. The number of consumers at the close of the year was 412, and the number of incandescent lamps in use was 18,478, arc lamps 250, and 11 motors representing 16 h.p. The total quantity of current supplied and charged for was 439,379 units, and the amount of revenue from both methods of charge, including fixed charge per lamp and rate per units consumed, was £10,067. 7s. 4d., which works out to about 5½d. per unit. The amount for which borrowing powers have been obtained is £150,000, and of this sum £127,830 has been borrowed. The amount of capital expenditure to March 31, 1894, less £610. 16s. 3d., being interest on loans during construction transferred to revenue account, was £127,374. 11s. 4d. The total amount of revenue from sales of current and rental of meters was £10,198. 11s 7d. The cost of generation, distribution, and management, as set forth in abstract No. 3, was £5,509. 16s. 4d., to which amount must be added for interest from the commencement of the undertaking, £3,461. 6s. 7d.; bankers' commission, £60. 9s. 11d.; and sinking fund, £1,376 17s. 7d.; leaving a debit balance of £209. 18s. 10d. to be carried forward to next year's account. The generating plant in operation was estimated to supply an average of about 20,000 16-c.p. incandescent lamps, and to be quite equal to any demand which would be likely to be made upon it for two years or more. So numerous, however, have been the applications that the plant is already loaded to its full capacity, and it was found that without extension there would be difficulty in fully supplying the demand for next winter. Under these circumstances it was decided to extend the plant by the following—namely, one Lancashire boiler, two 360-h.p. vertical compound condensing engines, and two large dynamos. These works are now in progress, and will be available for next winter. The new offices, workshops, and storerooms are also rapidly approaching completion. The applications for a supply of current outside the present area are so numerous that the committee have decided to make enquiry, and on a future day to report to the Council as to the desirableness of laying mains in certain leading thoroughfares, and of providing the additional plant and machinery required to generate the current, for which there is every probability of a great demand.

Canterbury.—A public meeting has been held at Canterbury under the presidency of the Mayor to consider the question of the introduction of the electric light. The Mayor said that the question of electric lighting had for a long time exercised the minds of the citizens, they having obtained their provisional order at a cost of £450, and offered the same to the Brush Company. It appeared now, however, that other conditions as to the capital must be complied with, and those conditions would be laid before the meeting by the company's representatives. He was sure they would all listen with interest and attention to the representatives of the company present, and he would at once call upon Mr. Sellon to address them. Mr. R. Percy Sellon said that the company entered into the negotiations with a great deal of enthusiasm, believing strongly that the electric light at Canterbury would be a first-class success, not only from the investor's but from the consumer's point of view. However, when they came to take steps to issue the prospectus, they found a certain amount of apathy towards the undertaking, and on instituting a canvass in the town, the result was not assuring to them of that minimum amount of demand for the light which was essential for them to start with. Therefore, local opinion in the past had been responsible for a considerable amount of delay. The Corporation had met them in a generous and fair spirit by granting an extension of the time so that they could satisfy their minds clearly as to local support. That extension was now drawing to a close, and it was well, they would agree, to bring the matter to a head at once. The last 10 years' experience had established the fact that the installation would not pay the investor unless there was a demand for between 3,000 and 5,000 lamps, in order to pay a dividend to the shareholder. The company were perfectly willing to provide two-thirds of the capital required, whatever the amount might be, provided local people would come forward with the remaining third. Reducing this to figures, he might say that the installation, paying a reasonable sum for land, building, and plant, would involve an outlay of about £18,000—not less than £15,000 and not more than £20,000—so that the company would find £12,000 if Canterbury would provide the balance of £6,000. On the motion of Councillor Lukey the following resolution was adopted : "That in the opinion of this meeting it is desirable that the electric light should be forthwith introduced into the city, and that a committee, consisting of the following gentlemen, be formed—Mr. Sellon and Mr. Lawson, of the Brush Company, the Mayor, Alderman Mount, Alderman Mason, Mr. F. Wacher, and Councillor Lukey—to ascertain how the necessary capital can be raised and to ascertain the probable number of customers when it is introduced."

Southampton.—At a meeting of the Town Council, the Works Committee reported the receipt of a letter from the Southampton Electric Lighting Company relative to their undertaking, and it was resolved that this committee was of opinion that it is desirable to enter into negotiations with the electric light company for the purchase of their undertaking, and for this purpose recommend the Council to appoint a committee to confer with the directors relative thereto. Mr. Lemon proposed the adoption of the report, stating that the committee were of opinion that it was desirable to enter into negotiations with the electric light company for the purchase of their interest, but the company said, and very properly, that they were not prepared to show their accounts unless the Corporation had made up their minds whether they would purchase or not, and the committee asked for the approval of the principle, subject to fair and reasonable terms being obtained. If they considered it was not desirable to purchase the interest of the company on any terms, they had better say so, and no further steps would be taken. If the Corporation approved of the principle that the interest of the company should be acquired, they asked for a committee to be appointed to confer with the directors of the electric light company to see if they could come to terms, and if they did they should report and ask the Council to consider it. The Council would not be bound by adopting the report, but were asked to say yea or nay whether they would affirm the principle. The matter came before the Corporation in 1890, when it was proposed to purchase the provisional order for £750, but it was negatived by a large majority. He was strongly of opinion that everything of the character of these works should be in the hands of the Corporation and not of a private company, but of course it was a question of price, and he hoped if the Corporation could see their way they would give instructions to do as the committee recommended. Mr. Kitcher seconded the proposition. The Town Clerk read a correspondence in connection with this matter, including a letter from Mr. J. T. Hamilton, secretary to the company, dated June 7, as follows : "Dear Sir,—Your letter of the 23rd ult. was considered by my Board at their meeting yesterday. I am desired by them to say that if the Corporation are seriously taking into consideration the question of purchase they will appoint a committee to meet a committee of the Corporation in order to discuss the whole matter.' Alderman Payne remarked that this was a very serious matter, and ought not to be hurried over. If they had purchased the gasworks the town would have made thousands every year by the transaction, and have had money to build a town hall. The

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present matter would be a gigantic affair, and as they were over head and ears in debt he hoped those favourable to making the purchase would not do so unless they could show that the town and ratepayers generally would benefit. Alderman Gilbert said that he was fully in sympathy with the idea that the gas and electric lighting concerns should be in the hands of the Corporation, but the matter was fully discussed in 1890, and they did not like to pay £700 or £800 for what was given away. He objected to the principle of purchase before they went into details as to the price. He agreed with the principle that it was a wise thing for the Corporation to keep anything in their own hands which was likely to be a monopoly, but they ought not to go further until they had more details before them. The Town Clerk pointed out that it was open to the Corporation to apply for a provisional order, and he suggested that it might be referred to committee to discuss the whole subject. Mr. Walton remarked that the company wanted a guarantee, and it would be unfair to ask them to open their books unless they had a real intention to proceed to business afterwards. Mr. Lemon agreed with the suggestion, stating that the contention of the company was only fair and reasonable. It was only a question of price, and could not do any harm to refer it. The subject was then referred back to the committee.

PROVISIONAL PATENTS, 1894.

JUNE 25.

12241. **Electromagnetic traction.** John Perry and Thomas Tomlinson, 31, Brunswick-square, London.

12253. **Electric staff and tablet detector.** Henry Powis and George Evans, 22, Benyon-street, Shrewsbury.

12283. **Improved block system on electric railways and apparatus therefor.** Eugen Langen, 28, Southampton-buildings, Chancery-lane, London.

12304. **Improvements in and relating to electric telephone systems.** Henri Noël Frenay-Olyff, 45, Southampton-buildings, Chancery-lane, London.

JUNE 26.

12313. **Improvements in or in connection with arc lamps.** Frank Michael Lewis, 2, East-parade, Leeds.

12345. **Improvements in transformer systems of electrical distribution.** Peter Wright, 323, High Holborn, London. (Complete specification.)

12349. **Improvements in or relating to heating metals electrically.** William Phillips Thompson, 6, Lord-street, Liverpool. (Charles Lewis Coffin, United States.) (Complete specification.)

12400. **Improvements in regulators for electric arc lamps or lighting apparatus.** François Suisse and Paul Eugéne Hennequin, 11, Southampton-buildings, Chancery-lane, London.

12406. **Improvements relating to electric and other motors.** Thomas Ernest Waltham, 24, Southampton-buildings, Chancery-lane, London.

12407. **Improvements in cable transmitters.** Herbert Taylor, 24, Southampton-buildings, Chancery-lane, London.

12411. **Electric igniting device suitable for lighting tobacco-pipes and cigars.** Friedrich Wilhelm Schindler, 433, Strand, London.

JUNE 27.

12476. **Improved system of switching and regulating apparatus for central stations for the generation and distribution of electrical energy.** John Smith Raworth, 46, Lincoln's-inn-fields, London.

12483. **Improvements in or connected with electric batteries.** Charles Percy Shrewsbury, Frank Lawrence Marshall, John Cooper, and John Laskey Dobell, 57, Chancery-lane, London.

12492. **An improved construction of holder for incandescent electric lamps.** William Underhill Hilliar, 6, Bream's-buildings, Chancery-lane, London.

12505. **Improvements connected with arc lamps.** John James Rathbone and Arthur Chester, 166, Fleet-street, London.

12510. **Improvements in apparatus for supplying electricity to electrically-propelled vehicles.** Emile Chabeault, 46, Lincoln's-inn-fields, London.

JUNE 28.

12541. **Improved apparatus for intermittent measurements of alternating currents.** Francis Henry Nalder, Charles William Scott Crawley, and Alfred Soames, 16, Red Lion-street, Clerkenwell, London.

12549. **Improvements in cables for telephonic and telegraphic purposes.** Moritz Immisch, 52, Chancery-lane, London.

12552. **Improvements in protecting, and in fittings for connecting lead-covered or other armoured electric cables with naked or other conductors.** George Hinde Nisbett, 6, Lord-street, Liverpool.

12557. **A system of luminous electric skipping-rope.** Gustave Trouvé, 53, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, sec. 103, June 18, 1894, being date of application in France.)

12566. **A dust-proof electrical switch.** Albert Edward Williamson, 77, Chancery-lane, London.

12605. **Improvements in or in connection with long-distance telephones.** Wasili Alexandrowicz Nikolajczuk, 34, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JUNE 29.

12620. **Improvements in electric arc lamps.** Job Thomas Niblett and Malcolm Sutherland, 20, Devonshire-road, Greenwich, London.

12650. **Improvements in storage battery plates.** Bernard Mervyn Drake and John Marshall Gorham, 66, Victoria-street, Westminster.

JUNE 30.

12707. **Improvements in or connected with electric lamp-holders, sockets, or connections.** John Benjamin Verity, Plume Works, Aston, Birmingham.

12748. **Improvements in mounting electric and other lamps.** William Newbigging, 55, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1891.

9079. **Electrolytic extraction of metals.** Hoepfner. (Second edition.)

1893.

11168. **Arc lamps.** Death.

11294. **Electric exchange.** Pippette.

13217. **Electric batteries.** Lithanode and General Electric Company, Limited, and Niblett.

14562. **Alternate-current dynamos, etc.** Ravenshaw and Atkinson.

14969. **Dynamos, motors, etc.** Newton and Hawkins.

15073. **Electric arc lamps.** Cooper and others.

16025. **Electromotors.** Siemens Bros. and Co., Limited. (Siemens and Halske.)

1894.

1849. **Arc lamp.** Taylor.

4429. **Electrical switches.** Metzger.

5158. **Splice coverings for electric wires.** Dewees.

7239. **Electric motors.** Coerper.

8835. **Electrical propulsion of cars.** Still.

8917. **Electro-deposition of metals.** Alexander.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	5	5¼-5⅝
Bournemouth Electric Company	—	—
Brighton and Hove Company Original	100	210-215
—— "A" Ordinary	—	162-166
Brush Company, Ordinary	3	2⅞-3
—— Nom. Cum., 6 per cent. Pref.	2	2⅛-2⅜
—— 4½ Debenture Stock	100	109-112
Charing Cross and Strand	5	4½-5½
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	12½-13½
—— 6 per cent. Cumulative Pref.	10	13⅞-14¼
—— 5 per cent. Debenture Stock	115	127-130
City and South London Railway, Consolidated Ordinary	100	36-38
—— Debenture Stock	100	119-121
—— 5 per cent. Pref. Shares	10	12½-13
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2¾-3½
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	96-100
Elmore's French Company	2	⅛-⅜
Electric Construction, Limited	2	2-2⅛
—— 7 per cent. Cumulative Pref.	2	1⅞-1⅞
Elmore's Copper Depositing	2	1⅞-1⅞
Electricity Supply Company for Spain	5	—
Elmore's Wire Company	2	⅞-1⅛
Fowler-Waring Cables	5	⅜-1⅛
W. T. Henley's Telegraph Works, Ordinary	10	6⅞-7⅛
House-to-House Company	5	1-1⅛
India Rubber and Gutta Percha Works	10	23½-24½
—— 4½ per cent. Debentures	100	103-105
International Okonite, Ordinary	10	1-2
Kensington and Knightsbridge	5	4⅜-5⅛
Liverpool Electric Supply, Ordinary	5	6⅜-6⅝
—— Pref.	4½	5⅞-6⅛
Liverpool Overhead Railway	10	8⅛-8½
—— Pref.	10	12⅜-13½
—— 4 per cent. Mortgage Debentures of £100	100	110-112
London Electric	5	¾-1⅛
Metropolitan Electric Supply	10	8½-9
—— 5 per cent. Reg. Debentures, 1-10,000 in Bonds of £10, £20, and £40	—	108-111
National Telephone, Ordinary	5	4¾-5⅛
—— 6 per cent. Cum. First Pref.	10	15-16
—— 6 per cent. Cum. Second Pref.	10	14½-15½
—— 5 per cent. Nom. Cum. Third Pref.	5	5⅛ 5⅜
—— 4½ per cent. Deb. Stock	—	112-115
Notting Hill Company	10	4½-5½
Oriental and Electric Company, £1 shares	1	⅛-⅜
—— £5 Shares	—	5⅞-6⅛
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7-7½
—— 7 per cent. Pref.	5	8½-9
Swan United	—	—
Telegraph Construction and Maintenance	12	40-42
—— 5 per cent. Bonds	100	102-105
Westminster Electric Supply, Ordinary	5	6⅛-6⅜
Yorkshire House-to-House	4½	4⅛-4⅜

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NOTES.

Electric Traction at Mulhouse. — The electric tramway here is nearly ready for opening.

Aschaffenburg.—A provisional electric light installation has been started for the lighting of the railway station.

Nyasaland.—The construction of the telegraph is now making rapid strides, and the line will reach Zomba by the end of June.

Electric Traction at Abazzia.—The Austrian Ministry of Commerce has given a concession for an electric railway from Abazzia *viâ* Ika to Lovrana.

The Blackfriars Accident.—A verdict of accidental death has been returned in the case of A. Bungay, who received a fatal shock at the Blackfriars transformer station.

Street-Lighting at Leipsic.—The Municipality are having 50 electric lamp-posts made for street-lighting at a cost of £1,050. The municipal budget provides £1,400 for maintaining these lights.

Electric Lighting at Schneidemuhl.—It is proposed to establish a central electric light station at Schneidemühl. Subscribers have been obtained for 500 incandescent lamps, 30 arc lamps, and five motors.

Glasgow Technical College.—The governors of the Glasgow and West of Scotland Technical College have applied to the Treasury for a share to this college of the grant to university colleges in Great Britain.

Not Sheet Lightning.—Lightning has been playing havoc during the past week. It has killed men, poultry, and dogs. If it had been the "yaller dog" it would not have mattered; it's got the jaundice bad enough.

On the War Path.—The *Cable Gazette*, without taking the trouble to ascertain its facts, last week credited Mr. A. Dickenson with reading a paper before the Tramways Institute. Better leave the agenda alone next time.

Telephony at Fiume.—The Fiume Chamber of Commerce are petitioning the Hungarian Minister of Commerce to establish a telephone line between Fiume and Budapest, and ultimately between Fiume and Trent.

Electric Lighting at Neutich.—The proprietors of the Neutich Sugar Refinery, West Prussia, are going to light the whole of their works electrically. They also propose to supply current to the town and to other works.

Gas Amenities.—At a meeting of the Wolverhampton Town Council, the Mayor stated that he had received what he styled "a scurrilous letter" from a gas firm with regard to his statement as to the cost of electric lighting.

An Electric Ballet.—At the Winter Gardens, Blackpool, Mr. William Holland is presenting a "Carnival Electrique," in which electric lights of a total of 35,000 c.p. are employed. The electrical effects have been devised by M. Collet, of Paris.

Electric Traction at Genoa.—The Allgemeine Elektricitäts Gesellschaft, of Berlin, have acquired the Bucher concession for electric tramways in Genoa for £48,000. Part of the lines have been constructed and part are in course of construction.

Electrical Engineering in England.—Those who are desirous of perusing Mr. Kapp's paper on this subject, read before the recent meeting of the Union of German Electrical Engineers at Leipsic, will find an abstract of it in *L'Electricien* of July 7.

Electric Drills.—Herr Scheidl, one of the Austrian Governmental head mining managers, advocates, in the *Oesterreichische Zeitschrift für Berg und Hüttenwesen*, the use of electrically-operated drills in mining operations in preference to those operated hydraulically.

Electric Traction at Basle.—The municipal authorities have decided to construct an electric railway between the Central railway station and the Badische railway station. The estimated cost is £28,000, and the money will be supplied from the treasury of the canton.

Electric Lighting at Stuttgart. — The local authorities have purchased a site for a central electric light station. They have, however, decided not to run it on their own account, but to let the undertaking be carried out by Messrs. Schuckert and Co. of Nuremberg.

German Licensed Victuallers and Electricity. In August next there will be a meeting of the South German Licensed Victuallers at Darmstadt, in connection with which an exhibition will be held. The exhibits will include electrical appliances, lighting and signalling, and small motors.

Bordeaux International Exhibition.—The Department of Science and Art has received a despatch from her Majesty's Consul at Bordeaux calling attention to an international exhibition of arts, industries, etc., which it is proposed to hold in that city in 1895, under the patronage of the French Government.

Exhibition at Graz.—In September next there will be held at Graz an exhibition of machinery for small industries, and especially of machines driven by electric motors such as we have recorded as having taken place at Budapest. The Technological Trade Museum of Vienna will be one of the largest exhibitors.

Charing Cross-Hampstead Railway.—The Earl of Morley's committee have passed the Bill of the Charing Cross, Euston, and Hampstead Railway, which confers further powers upon the company and enables them to acquire additional lands, etc. The Bill was read a third time in the House of Lords on Monday and passed.

Telegraphy in South Africa.—The British South Africa Company state that the telegraph line to Buluwayo is to be completed by the end of this month. The company's line of telegraph is to be immediately extended from Buluwayo along the high veldt to a point between Charter and Victoria, where it will strike the line already laid.

Too Smart.—The *Daily Chronicle*, notwithstanding its seven or eight young men, is becoming almost as bad as the *Daily News*. One of its smart young sub-editors holds forth in a leaderette, scissored from *Industries and Iron*, concerning the schiesophone, an apparatus which it is declared will indicate flaws in iron and steel. Surely the *Daily Chronicle* remembers describing the same thing several years ago!

The Lowrie-Hall System.—The Leeds and London Electrical Engineering Company, Limited, of Hunslet, Leeds, and of 15, St. Helen's-place, E.C., have sent us a copy of their catalogue of electric lighting plant on the Lowrie-Hall system. This catalogue, which was referred to in the *Electrical Engineer* of September 1, 1893, has now been amplified by the addition of prices of some of the apparatus described in the list.

An Unnecessary Invention.—An American electrical contemporary, while objecting to electrocution, is desirous that some inventor should discover an electrical method of excruciating torture for Anarchists, such as the assassin of President Carnot. Surely what the Mikado described as "something lingering, with boiling oil or melted lead,' though old-fashioned, would serve the purpose quite well

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without drawing electricians from more useful labours to find new methods.

Proposed Industrial Exhibition at Sunderland. Suggestions were made some time ago for the holding of a trades and industrial exhibition at Sunderland, and the scheme has been received with so much favour, and preparations are so much advanced, that it has been decided to open it in November. The prospectus explains that the undertaking will be an exposition of marine, manufacturing, electrical, engineering, and other industries.

"Invention" on Niagara.—That original (!) paper *Invention* says: "Prof. Forbes appears very sanguine about the success of the Niagara power scheme. . . . Applications for supply of power have been received from fully 350 miles distant: can this be wisely undertaken from a sound commercial aspect?" Fancy *Invention* endeavouring to set up as a critic! Our contemporary will soon begin telling us something about inventions and how to make fortunes out of them.

New Electrical Terminology. — Somebody in America has received an electric shock, and has sued for damages, when, if we are to believe a lay paper, the following evidence was tendered by experts: "'Ohm' is the term used to show the resistance; 'ampere' is the term used to describe a volt. A voltage of 1,500 would be styled an amperage of 10. A voltage of 6,000 would be required to propel an ampere three-quarters of an inch in length through a horse into a man under these conditions."

The Joule Studentship.—The president and council of the Royal Society have, upon the recommendation of the Joule Studentship Committee, elected Mr. J. D. Chorlton, B.Sc., of Owens College, Manchester, to the first Joule studentship. This studentship was founded for the purpose of enabling students to carry on certain researches on lines laid down by Dr. Joule, more especially with the view of determining the constants of some of the instruments employed by him, which his representatives can place at the student's disposal.

Electric Power Drill.—An electric auger drill for mining purposes has been brought out by the Jeffrey Manufacturing Company, of Columbus, U.S.A. It is capable of developing from 4 h.p. to 5 h.p. at the auger, though only half that is usually required. The motor is well protected by being enclosed in a steel casing on the sides, and by a steel plate on the side facing the coal or material to be drilled. The rear end of the motor is covered by a switchboard. Tests show that the efficiency of small sizes is 77 per cent., and of larger sizes 80 per cent.

The Giffard Prize for 1895.—The committee of French civil engineers selected to fix a subject for competition for next year's Giffard prize have fixed upon the following: "Transmission of power by means of electricity, either to machine tools in a workshop, or to the machinery of a railway or tramway line, or to the apparatus of a bridge, ship, dock, or public works." The competitor is to commence his paper by a summary of what has been done in the branch which he selects, following it by a description of work executed or a project capable of being carried out. The value of the prize next year will be £240.

Telephony in Germany.—Direct telephonic communication has been established between Berlin and Crefeld, a distance of about 240 miles. Two new telephone lines have been put into operation between Berlin and Friedrichshagen. A telephone line has been opened between Berlin and Heringsdorf, *vid* Stettin. During the present financial year Weimar and Jena will be connected telephonically, and both towns will be in communication with Wiemar, Erfurt, Gotha, Eisenach, Naumburg, Halle, Weissenfels, and Leipsic. Telephone exchanges have been established in connection with the telegraph offices at Adlig Liebenau and at Blonzmin.

Cable Stations.—In the House of Commons on Tuesday, Sir U. Kay-Shuttleworth, in reply to Sir G. Baden-Powell, said that soundings were taken by her Majesty's ship "Egeria" during a period of about two and a half years, from 1888 to 1890, between the North Cape of New Zealand and the Phœnix Islands, about 200 miles south of the equator; and the positions of several islands on that line were fixed and some were surveyed with a view to determining their suitability for cable stations. This was done in the ordinary course of hydrographic survey, in accordance with communications from the Admiralty to the Colonial Office. The distance between the extreme points of the area examined is over 2,000 miles.

A Marvellous Discovery.—Inventions which are prophesied to revolutionise something or other are more plentiful than blackberries, especially in America. The latest electrical revolutionary discovery is recorded by a San Francisco paper, which gives the following very lucid description: "In the ground generator, they simply insert zincs and carbon directly in the ground without any containing vessel or cell, and saturated with a very weak solution of acids. Then, when the power of the generator begins to run down, all that is required to restore full electro-force is to add another supply of the fluid. By this means the carbons are depolarised without removing them from the ground, consequently the generator can be run day and night until the zincs are worn out."

Telegraph Rates Between India and Europe.—We understand that the Indian Telegraph Department continues opening new offices, no fewer than 76 new combined offices having (according to the *Indian Engineer*) been opened since April last. The following extract from the recently published report of the council of the Society of Arts is of considerable interest in this connection: "On February 8, Mr. C. O. Walker read a paper on 'Telegraphic Communication Between England and India: its Present Condition and Future Development.' Speaking with a full knowledge of the subject, gained by long connection with the Indian Telegraph Department, Mr. Walker urged that a reduction of rates is both desirable and practicable, a view that would appear to be supported by all the Indian Chambers of Commerce."

The Photogene.—Our French contemporary *Electricité* describes in its issue of June 30 the photogene devised by M. Barruet. It states that the inventor, by the aid of his photogene and accessory clockwork mechanism, can charge successively, and without any interruption, the cells forming a battery of accumulators, which can at any time energise incandescent lamps and even one or two arc lamps. The photogene is a sulphate of copper battery which is automatically maintained. The E.M.F. of the photogene, which according to its size gives constantly from six to twelve amperes, is equal to one volt per cell. Several small installations on this system are said to have been in operation for two years, supplying lamps of from 5 c.p. to 16 c.p. of 24, 36, or 48 volts. The cost per kilowatt-hour is greater than that incidental to dynamos.

Institution of Mechanical Engineers.—The programme in connection with the forthcoming visit of the Institution of Mechanical Engineers to Manchester has been issued. Among the papers offered for reading and discussion at the meeting, which will be held in the Owens College, are the following: "Description of the New Electric Lighting Works, Manchester," by Dr. John Hop-

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kinson, F.R.S., and "Electric Welding." by Mr. B. A. Dobson. The proceedings open with a reception of the council and members of the institution by the Lord Mayor of Manchester (Sir Anthony Marshall) and the Mayor of Salford (Sir William H. Bailey), at the Owens College, on Tuesday morning, the 31st inst., to be followed by the reading and discussion of papers on that and the subsequent Wednesday morning, the visit extending over until Friday.

Action Between Cable Companies.—The dispute between the Anglo-American and the French Paris and New York Telegraph Companies was decided by the High Court of Appeal in Paris on Tuesday. In 1886 the French Government protested against the treaty of 1880 between the two companies, and threatened to revoke the French company's concession. The latter accordingly denounced the treaty. The Anglo-American Company appealed to the French Courts, which gave judgment in its favour, but, on appeal, the question was referred to the Council of State to decide whether the French Company had acted under Government pressure. A fresh notification from the Government settled this point, and the Anglo-American Company consequently claimed damages for breach of contract. The Court on Tuesday held that damages were payable, and appointed three experts to appraise them.

A New Telephone System.—Señor R. Roderiguez Merino has devised a system of telephony in which the subscribers do not have batteries, and this has been laid by him before the Madrid Telegraph Department. He points out that the old system presents inconveniences, and that it would be better to have all the batteries at the exchange, where they could be easily controlled. Instead of sending the current from the battery through the microphone and the primary wire of an induction coil, while the telephone is connected with the secondary wire of this coil and the line, he connects the line conductors with the microphones and the primary wires of the induction coils, while the telephone is only connected with the secondary wire of the coil. The return takes place under the same conditions as before. The battery from which the microphone is worked can be placed at any part of the line, and it can therefore be placed in the exchange.

Telegraphy Between Australia and Canada.—It is reported that a proposal has been made by Mr. A. Siemens to the Government of the Dominion of Canada for laying a cable under the Pacific Ocean, from Victoria, British Columbia, to Sydney, New South Wales. He undertakes to complete the construction within three years. The offer is now being considered. According to the *Times* of yesterday, it appears that Mr. Siemens, who was unable to reach the Intercolonial Conference in time to present his views, issued a pamphlet to the delegates on Wednesday, giving his opinion as a cable expert that the existing surveys of the Pacific furnish an adequate basis for the immediate construction of a cable. He says that the technical obstacles which existed in 1887 to the laying of cables at uncertain depths have been removed by the test system now brought to perfection. His company would not hesitate to undertake the successful laying of the cable immediately, with an estimated total expenditure of £2,000,000.

Telephonic Extension in Yorkshire.—The National Telephone Company have at length completed the erection of their new trunk wire between Leeds and Scarborough. The work has been long in hand, the company having been greatly retarded by landowners and others. Owing to their opposition, it is said, the line, which is 73 miles in length, and has required 10 tons of copper wire, has had to be re-erected in part no less than three times, and the cost has been upwards of £10,000. Under such circumstances, it is stated that it cannot be expected to pay, but it was necessary in the development of the company's system, and, that being so, the enterprise has been prosecuted to the end. The new trunk wire was inaugurated on Monday, when at the Leeds end the Mayor (Mr. Leuty) took the principal part in the ceremony, whilst at the Scarborough end Alderman Champney took the place of the chief magistrate of that borough, who was prevented by family breavement from lending his aid on the occasion. Mr. Leuty switched on Scarborough at the Leeds exchange, and a conversation followed.

Hotel-Lighting.—A noteworthy feature of the Swiss hotels, and particularly those in the mountainous districts, is the fact that the watercourses frequently existing in the neighbourhood allow of the power being utilised in turbines for electric lighting purposes. One of the most recent instances in this direction is to be found at Ragaz, which is located in the Rhine valley, and in close proximity to the Tamin watercourse. There is an available fall of water of 50ft., and by using this it has been possible to obtain 480 h.p., which is employed for the lighting of the hotels and the principal local avenues. The plant laid down comprises three Girard turbines, having vertical shafts, and put down by MM. Rieter and Co. These turbines drive on to a common shaft from which the dynamos are operated by belting. The dynamos, of which there are four, are of the Oerlikon type, each of 72 kilowatts capacity, and giving 600 amperes at 120 volts when running at 420 revolutions a minute. The total number of lamps supplied comprises 2,000 incandescent and 42 arc lamps, whilst two lifts are actuated by electric motors.

Lighting of the Embankment.—The Highways Committee of the London County Council reported on Tuesday that they had considered the general description and specification of the engines, boilers, dynamos, and other machinery and plant which will be required for the generating station in connection with the electric lighting of the Victoria-embankment and Waterloo and Westminster Bridges, and that they had also had submitted to them an estimate of the cost. It appeared to the committee advisable that the supply of this machinery and plant should be the subject of two separate contracts, the one relating to the boilers and accessories, and the other to the engines, dynamos, etc.; and that having regard to the extreme importance of the electric light installation being completed and in operation before the end of the year, tenders should be invited without any avoidable delay. The committee therefore recommended that, subject to an estimate being submitted to the Council by the Finance Committee, tenders should be invited for the supply of the machinery and plant. This motion was carried, as was also a second proposal suggesting that designs should be obtained for the electric lamp standards to be erected on the Victoria-embankment. This matter has been referred to the Highways Committee to take the necessary measures for the purpose, and to advise the Council what premium should be offered for the best design.

Electric Light and Power Plant.—The preparation of a complete catalogue of electric lighting plant is not an easy matter, and that reason may be adduced for the non-appearance until the present of the catalogue of Messrs. Russell and Co., who some time ago opened offices at 11, Queen Victoria-street, E.C., and whose works are situated at Walham Green. Some idea of the extent of its size may be gathered from the fact that the catalogue covers 200 quarto pages. Boilers of various types first attract attention, these being followed by different kinds of steam-engines and combined boilers and engines for electric

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lighting purposes, and gas and oil engines. In this connection a noteworthy feature may be cited in the case of a three-cylinder vertical type of oil-engine which has been designed for driving dynamos on board ship, and for other purposes where steady running and high speed are necessary. Then comes a list of dynamos for arc and incandescent lighting, together with some useful notes and data referring to the electrical transmission of power. Examples are given of the application of electric power in engineering works and factories, to cranes, capstans, and hoists, and for the operation of tramways. The practical utilisation of water power for electric lighting is demonstrated, as is also the use of electric search-lights. A large amount of space is also devoted to different types of measuring instruments, switches and switchboards, electric light fittings and accessories, telephones, etc. The catalogue will be useful both for the home and the export trade.

Tic Douloureux and Electricity.—In reference to a previous communication on this subject in the *Lancet*, Mr. Julius Althaus, M.D., of Harley-street, writes to that journal as follows: "The result of the use of the 'hydro-electric dipolar bath' in a severe case of trigeminal neuralgia certainly seems to have been magnificent in Dr. Hedley's hands, but the apparatus required for such a treatment is out of reach of most practitioners. It may therefore be useful to state that a much longer application of the continuous current, used in the ordinary way by moistened electrodes than was resorted to in the case alluded to, would probably have had the same effect. To apply the current in cases of severe tic douloureux for five minutes only, as was done by Dr. Hedley, can only be exceptionally useful. For a number of years past I have been in the habit of commencing the treatment in such cases with an application continued for at least 30 minutes, and have occasionally prolonged it for an hour. The result of a single such long application is generally most satisfactory, but the treatment has habitually to be continued daily for two or three weeks before the patient is thoroughly relieved. In order to avoid blistering the skin by such long applications it is advisable to use a very gentle force, say one milliampere. In one case, in which there was extreme sensitiveness to electricity, I have successfully used a current of 0·60 milliampere only. I generally apply the anode to the painful part, but in one most obstinate case I found it more effective to reverse the direction of the current in the metallic circuit every five minutes."

Country-House Electric Light Plant.—The popularity of electric lighting in country mansions and houses is increasing, and among those firms who have prominently taken up this branch may be mentioned Messrs. Drake and Gorham, who have just issued a revised illustrated catalogue of their specialities. The firm draw particular attention to the data given concerning the brake horse-power which can be economically and safely obtained from the different sizes of engines. This is generally a difficult thing to ascertain, and the figures contained in the cata logue are all the more valuable as having been obtained from the firm's actual practice in connection with semi-portable, vertical, and horizontal fixed steam-engines. Similar data are published relating to locomotive and Cornish boilers, the brake horse-power being obtained from the average results got in practice. Passing on from the dynamos, we note that there has been embodied in the "D. P." battery list some testimonials received by the firm. The object of the "Nevile" automatic accumulator switch, which is described in the catalogue, and for which the firm are sole agents, is to prevent the current from a battery of accumulators discharging itself through the dynamo when for any reason, such as a belt breaking, or the gas supply of a gas-engine being accidentally cut off, the E.M.F. of the dynamo falls below that of the battery. Then follow references to the firm's different types of switches for various purposes, and which are now well known. The remaining parts of the catalogue deal with the Cardew earthing device and voltmeter, ammeter, fuse-boxes, lamps, and estimates for electric lighting plant for installations of from 50 to 100 16-c.p. lamps. The catalogue—which, on the whole, deals with everything required in a complete installation—will prove of exceptional value to shippers and others.

Action of Electric Currents on Water-Pipes. At a recent meeting of the New England Waterworks Association, a paper on this subject was contributed by Messrs. Chas. A. Stone and Howard C. Forbes. So much attention has lately been given to electrolytic action that premature corrosion of water-pipes from any cause is likely to be attributed to electricity. Ordinary rusting does not take place at a uniform rate, varying, for instance, with the character of the soil, but often natural corrosion is hastened by the action of electric currents. The authors are now making experiments at the request of Mr. Wm. Jackson, M.Am.Soc.C.E., city engineer of Boston, to find a method of distinguishing between electrolytic and natural corrosion. The various methods proposed to prevent electrolysis may be classed under three heads, as follows: (1) complete remedies, such as the double trolley and storage battery systems, complete insulation of the pipes and possibly the alternating system. For the present, the first three systems are considered as in themselves impracticable, and it is yet too early to pronounce upon the latter. (2) Partial remedies, such as very heavy return wires from the tracks to the power station, with good bonds between the rails; also returns from sections of track every 500ft. along the route; but this can never entirely do away with the difficulty; the three-wire system, regarding which little is actually known and which is not as yet promising; insulation of tracks, which, as indicated, only tends to reduce the injury. (3) Schemes which are useless, as connections from the tracks to the pipes, bringing the pipes to uniform potential and reversing the current at frequent intervals. In addition to the above methods, the connection of the pipes to the negative plate at the power station has been tried several times, and with beneficial results. The problem here is to get the current through the joints in the pipe without injuring the latter.

The Pacific Cable Question.—In the course of an editorial on the Ottawa Conference, and to which we referred last week, the *Times* says: "The immediate practical question which was submitted to the delegates was the motion approving the construction of a Pacific cable, directly connecting Canada and the Australian colonies and free from foreign control. That this plan will be ultimately carried into effect and extended, as the colonies concerned demand, by subsidiary links with New Zealand on the one hand and South Africa on the other, can hardly be doubted. But the delegates have shown their common sense by declining to commit themselves to a comprehensive and, perhaps, a very costly scheme until the facts of the case are fully before them. The data before the conference were regarded as insufficient to justify a vote for the immediate construction of the Pacific cable, and last week a motion to that effect was accordingly rejected. It was resolved to recommend a careful and exhaustive survey, the cost of which, estimated not to exceed £25,000, should be borne partly by Canada and the Australasian colonies and partly by the Imperial Government. We can

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see no objection whatever to this proposal, and we cannot doubt that if the results of the survey are satisfactory, the work will meet with approval both here and in the colonies. In the present stage of the question, however, the colonists are quite right to hold their hands. The opposition which the project of a Pacific telegraph cable connecting Canada directly with Australia has met with in this country is quite natural. A practical monopoly of a large and lucrative business cannot be expected to welcome competition. We fully recognise the advantages which the existing telegraph companies connecting England with the East and with Australasia have secured for business men, but we do not think it has been shown that their routes would be as safe in time of war as a Pacific line entirely under British control. The subject, however, is for the present relegated to the region of enquiry and experiment." The Inter-Colonial Conference on Monday passed a resolution asking the Canadian Government, after the rising of the conference, to make all necessary enquiries and generally to take steps expedient to ascertain the cost of a Pacific cable, and promote the establishment of the undertaking in accordance with the views expressed by the conference.

The Cance Rheostat. — In a recent issue of *L'Electricien* an illustrated description is given by "A. M." of the Cance rheostat. The apparatus, which is of the fixed drum type, consists of a vertical tube of cylindrical form made of enamelled iron, on which is wound a wire of ferro-nickel, and of increasing section. This tube is bolted to a base-plate by means of three bolts, which also keep in position a slate plate, the object of which is to insulate the lower part of the tube. A vertical shaft turning in a socket fixed on the base-plate is contained inside the tube, a bronze disc maintaining the upper part of the shaft in position. This shaft has arranged on it an iron wheel, which supports three vertical copper rods, connected together at their lower ends by means of a copper crown. The latter is supported by rollers, when the apparatus is revolved by means of a handle. Two copper crowns can move along the vertical rods, with which electrical connection is maintained constantly by the aid of brushes. These two crowns serve as support to three rollers, the axes of which are placed vertically; suitable springs cause them to press continually on the wire wound on the cylindrical tube. A single roller would have been sufficient to ensure the collection of current, but M. Cance has found that three rollers assured a concentric guide in the rotation of this part of the apparatus, and gave at the same time an electrical contact as perfect as possible. The current is obtained from two terminals arranged on the base-plate. One of these is connected to the upper end of the ferro-nickel resistance, whilst the other is united to a brush, which presses upon the central shaft conjointly with the iron wheel, and consequently with the three copper rods and the three rollers carried by the two crowns. As the enamelled iron cylinder is insulated, the current arriving by one terminal enters through the upper part of the wire, follows it until it meets the rollers, and returns to the other terminal by the intermediary of the two crowns, the three copper rods, the wheel and the central shaft. The working of this rheostat, our contemporary states, is easy of comprehension. The rollers are constantly pressing on the wire forming the fixed resistance, and they are at the same time conjointly liable with the two crowns, which can only ascend or descend along the copper rods by turning with them. These rollers constitute then a kind of single-threaded screw screwing itself up or down the ferro-nickel winding. "A. M." states that with this type of rheostat it is very easy to insert in the circuit any desired resistance with great precision, both in the case of very weak or very strong variations.

The Wiring of Ships.—A short article on the wiring of ships, by M. M. Leroy, appears in *L'Electricien* of the 7th inst. The author states that there are no Government vessels in France where the return is formed by the mass of the vessel, but that some companies, and particularly the steamers of the Compagnie des Messageries Maritimes, use the hull as the return. M. Leroy considers that the latter method possesses such considerable advantages, from the point of view of economy and simplicity, as to appear to be the only practical system. The circuits from the dynamo to the lamps are carefully insulated, and the leading-out wire from each lamp and the second pole of the dynamo are placed in connection with the hull. Suitable cut-outs being placed at each branch conductor, the author states that accidents arising from any contacts established between the insulated cable and the hull will simply melt the branch fuse, and the fault will thus be localised. Moreover, the economy realised by the laying of conductors on this system allows of the choice of the best quality of insulated conductor, thus rendering accidents less frequent. In practice the only circuits which are found in the worst condition are those which traverse the holds of vessels, which are always damp either through the condensation which is produced on the internal walls or through the percolation of sea-water due to the washing of the bridges. The circuits from which the head lights and bridge lights are energised are also exposed to the action of sea-water. Whether the circuits are double or single wiring, M. Leroy believes from this point of view that the effects of the water are equally disastrous. Slow electrolysis, the formation of salts on the conductor, and the destruction of the insulating material will, he says, inevitably be produced. The only resource available lies in the quality and thickness of the insulation. As it is more economical to have a single conductor having an insulation superior to that of two wires, he considers that in such a case the advantage of a double circuit is illusory. The author says that some persons have attributed to lighting circuits with a single wire the deviation of the compass, which is generally itself lighted by a lamp placed underneath it. This action, he continues, is absolutely nil, unless, owing to negligence, a circuit of great intensity is carried at the side of it. The iron masses surrounding closely the compass constitute a magnetic screen, which protects it against the effects of the currents. It would, moreover, be possible to wrongly affect the compass indications with a double-wire circuit, if the latter wires, as is frequently the case, are not side by side. When, however, the circuits supply both incandescent lamps and projectors, M. Leroy is not of the same opinion. In fact, the currents traversing these conductors are, on the one hand, powerful, being from 70 to 80 amperes per projector; on the other hand, the external position of the projectors renders them liable to be often wet by the salt water. The cables which convey the current to the projectors must allow of displacement in every direction, and they are therefore supple, and consequently badly insulated. These circuits should be kept distinct from others, and the author states that M. Leblond goes so far as to state that a dynamo should be laid down for each search-light. The author concludes that circuits should be insulated throughout on war vessels, where the question of economy disappears before that of security. On steamers, however, M. Leroy says that he is in favour of single wiring, notwithstanding the campaign organised against this method recently in England.

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PHYSICAL UNITS.

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(Continued from page 7.)

§ 32. The units hitherto discussed, the symbols used for them, and the dimensional expressions obtained for them, may be put into a tabular form.

Name.	Symbol.	Dimensions in L M T.
Plane angle	θ	—
Solid angle	Ω	—
Strain	—	—
Specific gravity	—	—
Curvature	$1/\zeta$	L^{-1}
Tortuosity	$1/\zeta^1$	L^{-1}
Area	S	L^2
Volume	V	L^3
Linear velocity	v, $\dot{L}$	$L\,T^{-1}$
Angular velocity	ω, $\dot{\theta}$	T^{-1}
Linear acceleration	α, $\dot{v}$, $\ddot{L}$	$L\,T^{-2}$
Angular acceleration	ω, $\ddot{\theta}$	T^{-2}
Moment of inertia	I	$L^2\,M$
Density	D	$L^{-3}\,M$
Momentum	$M\,v$	$L\,M\,T^{-1}$
Impulse	$F\,t$	
Force	F	$L\,M\,T^{-2}$
Moment of momentum	$I\,\omega$ / $G\,t$	$L^2\,M\,T^{-1}$
Torque	G	$L^2\,M\,T^{-2}$
Work / Energy	W $F.s$ / $G.\theta$; E $\frac{1}{2}M\,v^2$ / $\frac{1}{2}I\,\omega^2$	$L^2\,M\,T^{-2}$
Energy per unit area	—	$M\,T^{-2}$
Energy per unit volume	—	$L^{-1}\,M\,T^{-2}$
Activity	A	$L^2\,M\,T^{-3}$
Stress / Pressure	P	$L^{-1}\,M\,T^{-2}$
Surface tension	τ	$M\,T^{-2}$
Rigidity modulus	n	$L^{-1}\,M\,T^{-2}$
Bulk modulus	k	
Young's modulus	M	
Torsional rigidity	N	$L^3\,M\,T^{-2}$
Flexural rigidity	N^1	
Viscosity	μ	$L^{-1}\,M\,T^{-1}$
Diffusivity	κ	$L^2\,T^{-1}$

§ 33. These dimensional formulæ may be used: (1) to find the change that takes place in any derived unit when the fundamental unit is altered; (2) to check any result we may have arrived at in an investigation by counting the dimensions; and to a limited extent, (3) to anticipate results of a dynamical investigation by reasoning based on dimensions. Examples are appended to illustrate these statements. W. Williams, in a paper entitled "On the Relation of the Dimensions of Physical Quantities to Direction in Space," printed in the *Proceedings* of the Physical Society, vol. xi., 1890-92, uses three rectangular directions, X, Y, Z, and hence shows that "the dimensional formulæ may be taken as representing the *physical identities* of the various quantities, as indicating, in fact, how our conceptions of their physical nature (in terms, of course, of other and more fundamental conceptions) are formed—just as the formula of a chemical compound indicates its composition and chemical identity."

§ 34. How many ergs are there in a foot-pound?

The dimensional formula for work is $[L^2\,M\,T^{-2}]$. Let x be the number of ergs corresponding to 32·2 foot-poundals, then

$$x\,\frac{(1\text{ft.})^2\times 1\text{lb.}}{(1\text{ sec.})^2} = 32{\cdot}2\,\frac{(30{\cdot}48)^2\times 453{\cdot}6}{1^2};$$

$$\therefore x = 13{\cdot}56\times 10^6 \text{ ergs},$$

or, 1 foot-pound = 30·48 cm.-lb.;

$$= 30{\cdot}48\times 453{\cdot}6 \text{ cm.-gm.};$$

$$= 30{\cdot}48\times 453{\cdot}6\times 981 \text{ cm.-dynes};$$

$$= 13{\cdot}56\times 10^6 \text{ ergs}.$$

2. Determine the unit of time in order that, the foot being the unit of length, g may be expressed by unity.

The dimensional formula for acceleration is $[L\,T^{-2}]$.

Therefore, $32\times\frac{\text{ft.}}{(\text{sec.})^2} = \frac{\text{ft.}}{t^2}$

$$\therefore t^2 = \frac{1}{32}$$

$$t = \frac{1}{4\sqrt{2}} \text{ second.}$$

$$= \tfrac{1}{8}\sqrt{2} = \cdot 177 \text{ second.}$$

3. If the acceleration due to gravity be taken as the unit acceleration, and the velocity generated in one minute as the unit of velocity, find the unit of length—38,400 yards.

The velocity acquired by a falling body in one minute is $32\times 60 = 1{,}920$ft. per second.

Hence
$$32\times\frac{\text{ft.}}{(\text{sec.})^2} = \frac{l}{t^2} \quad \ldots\ldots (1)$$

$$1{,}920\times\frac{\text{ft.}}{(\text{sec.})} = \frac{l}{t} \quad \ldots\ldots (2)$$

$$\therefore t = \frac{l}{1{,}920}.$$

Substituting in (1) $l = 32\,t^2 = \frac{32\,l^2}{(1{,}920)^2}$;

$$\therefore l = \frac{(1{,}920)^2}{32} = 60\times 1{,}920 \text{ feet};$$

$$= 38{,}400 \text{ yards};$$

$$= 21\tfrac{9}{11} \text{ miles}.$$

4. A body moving uniformly passes over a mile in 15 minutes. If 64 be the measure of velocity, and 11ft. the unit of length, find the unit of time.

A mile in 15 minutes $= \frac{88}{15}$ft. per second.

$$\tfrac{88}{15}\cdot\frac{1\text{ft.}}{1\text{sec.}} = 64\,\frac{11}{t};$$

$$\therefore t = \frac{64\times 11\times 15}{88} = 120 \text{ secs.} = 2 \text{ minutes}.$$

5. If the force of gravity be taken as the unit of force, and a rate of 10 miles an hour as the unit of velocity, what must be the units of time and length?

The dimensions for force and velocity are $[L\,M\,T^{-2}]$ and $[L\,T^{-1}]$ and 10 miles an hour $= \frac{44}{3}$ft. per second.

Hence
$$32\times\frac{\text{ft.}}{(\text{sec.})^2} = \frac{l}{t^2} \quad \ldots\ldots (1)$$

and
$$\tfrac{44}{3}\times\frac{\text{ft.}}{(\text{sec.})} = \frac{l}{t} \quad \ldots\ldots (2)$$

where l and t are the required units of length and time.

From (2) $l = \frac{44}{3}\,t$, and substituting in

(1) $t = \frac{44}{3}\times\frac{1}{32} = \frac{11}{24}$ second.

Therefore $l = \frac{121}{18}$ft.

This is equivalent to saying that a falling body acquires a velocity of $\frac{121}{18}$ft. per $\frac{11}{24}$ second at the end of $\frac{11}{24}$ second of its fall, or 32ft. per second per second $= \frac{121}{18}$ft. per $\frac{11}{24}$ second per $\frac{11}{24}$ second.

6. A shot weighing a lbs. is fired from a gun with a velocity of v ft. per second. If its kinetic energy, the impulse it has received, and the acceleration due to gravity be denoted by k, i, and f respectively, find the units of length, mass, and time.

$$\tfrac{1}{2}\,a\,v^2\,\frac{(1\text{ft.})^2\,(1\text{lb.})}{(1\text{sec.})^2} = k\,\frac{l^2\,m}{t^2} \quad \ldots (1)$$

$$a\,v\,\frac{(1\text{ft.})\,(1\text{lb.})}{(1\text{sec.})} = i\,\frac{l\,m}{t} \quad \ldots (2)$$

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$$g\frac{(1\text{ft.})}{(1\text{sec.})^2} = f\frac{l}{t^2} \quad . \quad . \quad . \quad (3)$$

From (1) and (2) $m = \frac{a v^2 t^2}{2 k l^2} = \frac{a v t}{i l}$;

$$\therefore \frac{l}{t} = \frac{v i}{2 k} \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

and from (3) $\frac{l}{t} = \frac{g t}{f}$;

$$\therefore \frac{g t}{f} = \frac{v i}{2 k} \text{ and } t = \frac{v i f}{2 k g}.$$

From (4) $l = \frac{v i}{2 k} \times t = \frac{v^2 i^2 f}{4 g k^2}$.

Hence $$m = \frac{a v}{i} \times \frac{t}{l} = \frac{2 a k}{i^2}.$$

For example, if $a = 2$oz., $v = 800$ft. per second, and $k = i = f =$ unity, then $t = \frac{v}{2g} = 15$secs., $l = \frac{v^2}{4g} = 5{,}000$ft., and $m = 2a = \frac{1}{4}$lb.

§ 35. 1. A person deduces from some investigations the following equations. Determine whether they are possible or not.

$$(a)\ 6\,M^2\,V + 2\,g^3\,F\,L^2\,D\,T^8 - 3\,F^2\,L\,T^4 = 0;$$

$$(b)\ v^3\,T - 4\,M\,a\,L + 3\,F = 0.$$

Substituting the dimensional expressions for each of the terms in equation (a) we get

$$M^2\,L^3, \left(\frac{L}{T^2}\right)^3 \times \frac{L\,M}{T^2} \times L^2 \times \frac{M}{L^3} \times T^8, \left(\frac{L\,M}{T^2}\right)^2 \times L \times T^4,$$

which reduces to

$$L^3\,M^2,\ L^3\,M^2,\ L^3\,M^2.$$

The three terms are of the same dimensions, therefore the equation is possible.

Substituting dimensions in equation (b) we get

$$\left(\frac{L}{T}\right)^3 T, M \times \frac{L}{T^2} \times L, \frac{M\,L}{T^2},$$

which reduces to

$$\frac{L^3}{T^2}, M\frac{L^2}{T^2}, \frac{M\,L}{T^2}.$$

The three terms are not of the same dimensions, and therefore the equation is physically impossible.

§ 36. 1. The centrifugal force acting on a body depends on the mass of the body, the velocity of the body, and the radius of the circle the body is describing.

Let the index of each of these be x, y, z, then $F = m^x \cdot v^y \cdot r^z$.

Substituting dimensions

$$L\,M\,T^{-2} = M^x \times (L\,T^{-1})^y \times L^z;$$
$$= M^x \times L^{y+z} \times T^{-y}.$$

Equating coefficients of L, M, T, we get

$$1 = y + z;\ 1 = x;\ -2 = -y.$$
$$\therefore x = 1;\ y = 2;\ z = -1.$$
$$\therefore F = m \cdot v^2 \cdot r^{-1} = \frac{m v^2}{r}.$$

2. The velocity of a distortional wave through a material depends on the rigidity modulus of the material and on its density. Let us suppose that it varies as the xth power of n and as the yth power of D.

Then $$v = n^x \cdot D^y;$$
$$L\,T^{-1} = (L^{-1}\,M\,T^{-2})^x \times (L^{-3}\,M)^y.$$

Equating the indices of L, M, t:

$$1 = -x - 3y;$$
$$0 = x + y;$$
$$-1 = -2x. \quad \therefore x = \tfrac{1}{2}, \text{ and } y = -\tfrac{1}{2}.$$
$$\therefore v = \sqrt{\frac{n}{D}}.$$

If the modulus be expressed in gravitation units this could be written $v = \sqrt{\frac{g\,n}{D}} = \sqrt{g\,L}$, where L is the length modulus of rigidity. Generally the corresponding length modulus is the modulus in gravitation measure divided by the density. Hence we can say that the velocity of any wave-motion through any material is the velocity a body would acquire in falling through a height equal to half the proper length modulus.* The proper length moduluses for the following wave-motions are:

1. Longitudinal vibrations along a bar or cord, $L = M/D$.
2. Waves of simple distortion, $L = n/D$.
3. Waves along a bar or cord which is prevented from lateral shrinking, or waves of simple longitudinal extension and contraction in a homogeneous isotropic infinite solid—that is, waves analogous to sound, $L = \left(k + \frac{4n}{3}\right)/D$.
4. Sound-waves in a fluid, $L = k/D$.
5. Sound-waves in air, $L = k/D$, or $P/D =$ height of the homogeneous atmosphere.
6. Long waves in water of uniform depth, L = depth.
7. Deep-water waves, L ÷ wave-length/2π.
8. Transverse pulse in stretched cord, L = length of cord amounting in weight to the stretching weight = W/m, where W is the stretching weight, and m the mass of the cord per unit length.

(To be continued.)

AN AUTOMATIC VARIABLE STEAM CUT-OFF OPERATED BY ELECTRICITY.

Acting on the supposition that mechanical contrivances for varying the point of cut-off in steam admission to an

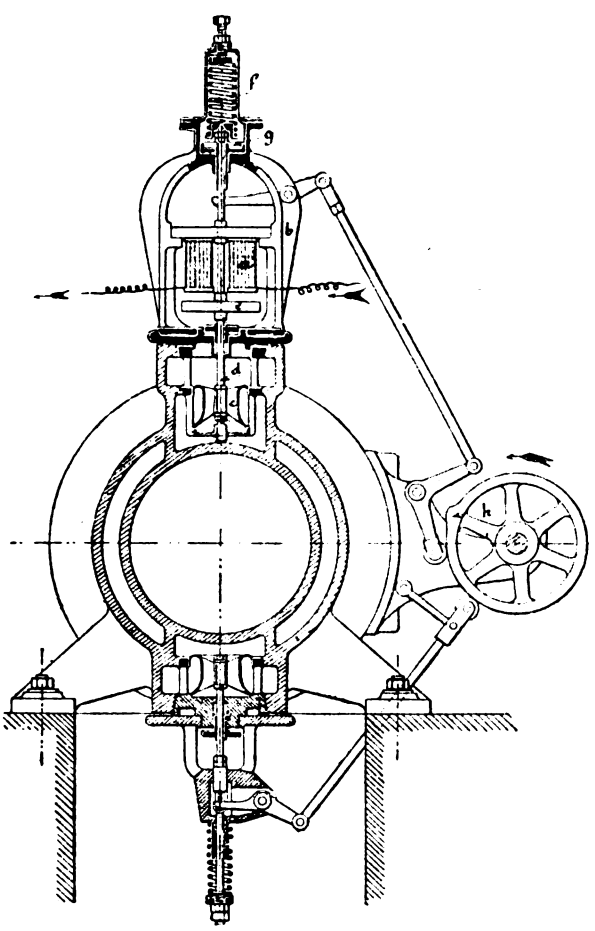

FIG. 1.

engine cylinder are usually required to be extremely sensitive and quick in their result, a French engineer named Décombe has devised, says *La Revue Industrielle*, an electrical appliance by means of which the steam admission is

* See Lord Kelvin's "Mathematical and Physical Papers," vol. iii., § xcii., p. 40, and § civ. p. 519.

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automatically regulated in accordance with the load. This device is illustrated in the annexed engravings, which represent it as applied to a horizontal engine of the Sulzer type. The idea is, of course, that the appliance will be specially suited for the electricity supply stations, where it is not only important that the engine speed shall be maintained as constant as possible, but where there is also a supply of electric energy at once available for operating the contrivance without the necessity of special apparatus for giving an electric current.

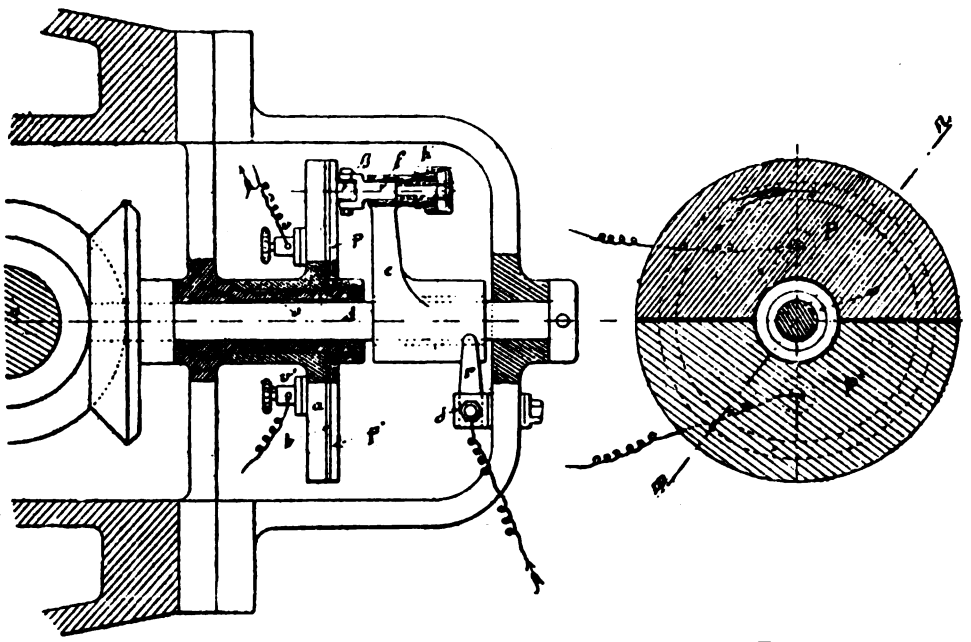

FIG. 2.

FIG. 3.

In this device the actual opening of the steam-valve is effected in the usual manner by a rocking shaft and bell lever, and the lifting impulse is given by means of a cam or projection upon the circumference of a wheel shown in Fig. 1, at *h*. This raises the valve, *c*, and valve stem, *d*; on the latter is fixed an armature, *e*, which comes into contact with the poles of an electromagnet, *a*. The coils of this magnet are energised in a way shortly to be described, for a length of time varying inversely with the engine speed—that is, the magnet retains the armature and with it the valve in a raised position, exactly according to the position of the engine governor. When current ceases to pass through the coils, the armature, with the valve, is caused to drop by the action of a coiled spring shown at *f*, provided with a dashpot, *g*, to prevent too sudden a descent of the valve upon its seat.

The magnet thus employed to determine the point of cut-off receives current from any suitable source through a commutator, which is shown sectionally in Fig. 2. This commutator is formed of two semi-circular, thin, flat plates, P and P^1, of brass, mounted on a disc, *b*, of ebonite and insulated from one another. The entire arrangement is fixed to a face-plate, *a*, which is capable of a slight angular motion upon the sleeve, *s*, cast in one piece with the adjacent supporting bracket. In this position it is subjected directly to the action of the governor, moving round in one way or another according as the governor rises or falls.

Through the sleeve, *s*, passes a small spindle, *d*, rotated by bevel gear from the engine crankshaft. It carries on the outer end an insulated crankpiece, *e*, with a rolling contact wheel, *g*: this latter is forced outwards by the spring, *h*, against the metal plates already alluded to, which are shown in front view in Fig. 3. At *i* is a small screw adjustment to regulate the pressure of contact. Another contact—by means of a spring or brush—at *r* serves to put the wheel and plates into connection with the source of electricity; and two insulated terminals, *v*, *v*^{1}, lead the current from the respective plates to each end of the engine cylinder, as shown in Fig. 4.

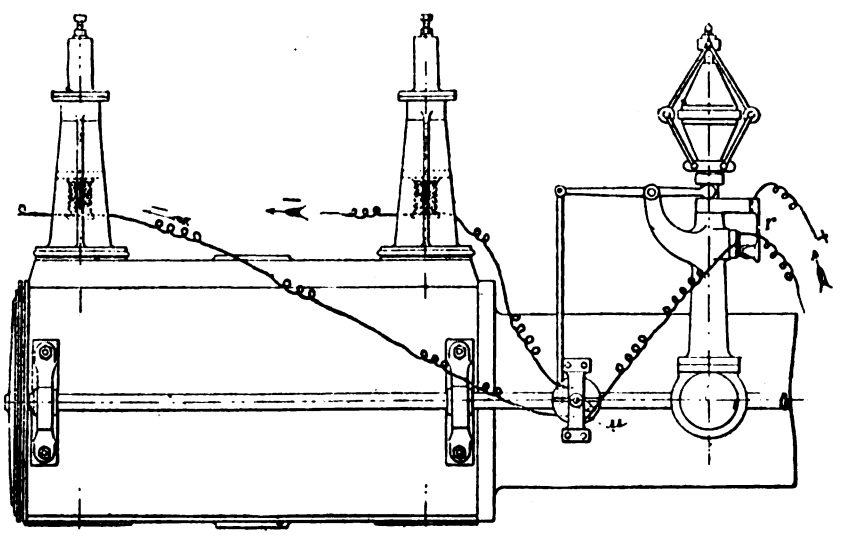

FIG. 4.

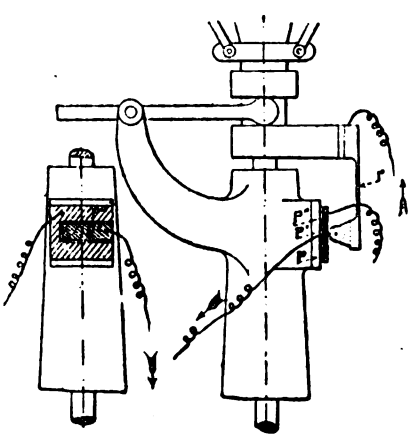

FIG. 5.

FIG. 6.

Since the point of admission is constant, owing to the use of a mechanical device of cam and lever for opening the valve, it may be defined as lying on a straight line, *m n* (Fig. 3). The two dotted rings in this illustration represent the path of the small contact wheel, *g*; as soon as this arrives at the line, *m n*, the valve is opened at one or other end of the cylinder, according as the wheel is on plate P or P^1. The cut-off takes place as soon as the wheel touches the insulation between the plates.

It depends, therefore, upon the angular position of the face-plate, *a*, in respect to the line *m n*; and, as already

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stated, this may be varied to a slight extent (sufficient for the purpose) by a lever connected with the governor, as shown in Fig. 4, where the crank and disc are referred to by the letter *u*.

In the same illustration may be noted the arrangement for automatically stopping the engine when its speed (and therefore that of the governor also) rises above a proper limit. At *r* is fixed a spring contact with rubbing wheel—shown in greater detail in Figs. 5 and 6—by means of which the current actuating the regulating magnets just described is caused to pass through the middle contact-plate, P^1, to the crank arm and disc, *u*, or else passes through the U-shaped plate above and below P^1 to another electromagnet, which releases a detent and by counter-weights closes the steam-admission valve.

PRACTICAL NOTES ON DYNAMO CALCULATION.–V.*

BY ALFRED E. WIENER.

13. *Total Length of Armature Conductor.*—The amount of inactive or "dead" wire required to join the active portions of the armature conductors into continuous turns depends upon the shape of the armature, the height of the winding space, and the manner of winding. In an armature, for instance, having a core section of great length of parallel to the pole faces, and but a small thickness perpendicular to the same, this useless addition to the generating wire will be comparatively small, while in short armatures with great core depth the proportion of the dead to the active length will be considerably greater. Furthermore, if two armatures of same length, same core diameter, and same radial depth, have equal lengths of active conductor, but are wound with different heights of the winding space—as well be the case if the one has a smooth core with winding covering the entire circumference and the other a toothed body—then the external diameters, and consequently the lengths necessary to join the active conductors, are greater in the latter case, and therefore it is evident that the armature with the higher winding space requires a greater total length of armature conductor. If, finally, two otherwise entirely equivalent armatures are wound by different systems, a considerable difference may be found in the total lengths of wire required to produce equal lengths of active conductor.

(*a*) *Drum Armatures.*—The active length of the armature conductor being known, the simplest method of expressing its total length, for a drum armature, is

$$L_t = k_3 \times L_a \quad . \quad . \quad . \quad . \quad . \quad (19)$$

where L_t = total length of armature conductor, in feet (parallel wires considered as one conductor);
L_a = active length of armature conductor, in feet, from formula (3);
k_3 = constant, depending upon shape of armature and system of winding (see Table XIX.).

The ratio, k_3, of the total to the active length of the armature conductor in a drum armature depends chiefly upon the ratio of length to diameter of the armature core. In modern machines the lengths of drum armatures usually vary between one and two diameters; in special designs, however, a value as low as 0·75 or as high as 2·5 may be taken for this ratio. Table XIX. gives average values of the constant k_3 for various shape-ratios, for smooth as well as for toothed drum armatures.

Another form often used for expressing the total length of wire on a drum armature is indicated by the formula:

$$L_t = K \times (l_a + k_4 \times d_a) = L_a \times \left(1 + k_4 \times \frac{d_a}{l_a}\right). \quad (20)$$

K = total number of conductors all around armature circumference;
k_4 = constant depending upon system of winding.

This formula (20) has the advantage over (19) that no special table is required for its constant, since for a certain type of armature, and a certain system of winding, k_4 is very nearly constant for all sizes and shapes. The value of k_4 for the smooth drum armatures considered in Table XIX.

* From the *Electrical World* (New York).

TABLE XIX.—Ratio between Total and Active Length of Wire on Drum Armatures.

Ratio of length to diameter of armature core. $l_a : d_a$	Value of k_3. Smooth armature.	Toothed armature.
0·75	2·50	3·10
0·8	2·45	3·05
0·9	2·40	3·00
1	2·35	2·95
1·1	2·30	2·90
1·2	2·25	2·85
1·3	2·20	2·80
1·4	2·15	2·75
1·5	2·10	2·70
1·6	2·05	2·65
1·7	2	2·60
1·8	1·95	2·55
1·9	1·90	2·50
2	1·85	2·45
2·25	1·75	2·35
2·5	1·70	2·25

lies between 1·3 and 1·7, and as an average 1·5 may be taken, thus making the formula for the total length of conductor for smooth drum armatures:

$$L_t = L_a \times \left(1 + 1{\cdot}5 \times \frac{d_a}{l_a}\right). \quad . \quad . \quad (21)$$

Formula (21), then, means that the additional length of dead wire to every conductor of a smooth drum armature is one and one half times its core diameter, or that the total length of one conductor in a smooth drum is equal to the length of the body plus one and a half times the core diameter. The reason why k_4, even for the same type and same winding method, has not the same value for all sizes, is that the proportion of the core diameter to the thickness of the armature shaft is very much different for different sizes. In a small drum, for instance, the shaft takes up considerably much more room than in a large one, and, therefore the dead lengths are comparatively larger in a small machine. In fact, $k_4 = 1{\cdot}5$ gives too high values for small ratios of length to diameter, which occur in large drums, while the values found by (21) for large ratios of length to diameter, which are met in small armatures, are below those given in Table XIX.

For $l_a : d_a = 1$, or $d_a : l_a = 1$, for instance, we obtain, by comparison of (19) with (20) and (21):

$$k_3 = \frac{L_t}{L_a} = 1 + k_4 \times \frac{d_a}{l_a} = 1 + 1{\cdot}5 \times 1 = 2{\cdot}5,$$

while Table XIX., which is averaged from actual practice, gives $k_3 = 1{\cdot}35$ for this ratio, to which number would correspond the small value of $k_4 = 1{\cdot}35$.

On the other hand, if $l_a : d_a = 2$, or $d_a : l_a = 0{\cdot}5$, we get:

$$k_3 = 1 + 1{\cdot}5 \times 0{\cdot}5 = 1{\cdot}75;$$

the table-value for k_3 is 1·85 for this shape-ratio, and therefore the high value of $k_4 = 1{\cdot}70$ would answer in this case.

For toothed drum armatures the numerical value of k_4, in the practical limits of the ratio of shape, lies between 1·9 and 3, the average being about 2·5; hence formula (20) for toothed drum armatures becomes:

$$L_t = L_a \times \left(1 + 2{\cdot}5 \times \frac{d_a}{l_a}\right) \quad . \quad . \quad . \quad (22)$$

that is to say, the average length to be added to each active conductor in a toothed drum armature is $2\frac{1}{2}$ times the core diameter of the drum, or the average dead length in each turn (consisting of two active conductors) is five times the diameter at the bottom of the slots.

(*b*) *Ring Armatures.*—In a Gramme-wound ring armature of a core section of given dimensions, the ratio of the total to the active length of the conductor depends upon the arrangement of the field-magnet frame. There are, altogether, eight different possibilities of arranging the poles around a ring armature; these eight methods, however, can be classified into but five principally different cases—viz.:

Case I. Pole-pieces facing *one* long armature surface, see Figs. 4 and 5;
Case II. " " *two* long armature surfaces, see Figs. 6 and 7;

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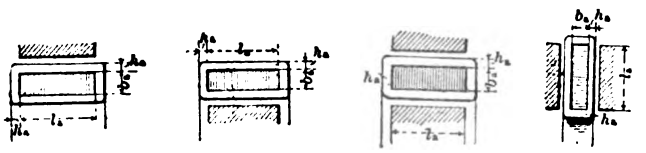
Case III. Pole-pieces facing *one* long and *two* short armature surfaces, see Fig. 8;

Case IV. „ „ two long and one short armature surface, see Figs. 9 and 10;

Case V. „ „ one long, two short, and part of second long surface, see Fig. 11.



FIGS. 4, 5, 6, AND 7.

Denoting with l_a the length, and with b_a the breadth of the cross-section, and assuming the winding height, h_a, to be the same all around the section, we obtain the following formulæ for calculating the total length of conductor on a ring armature:

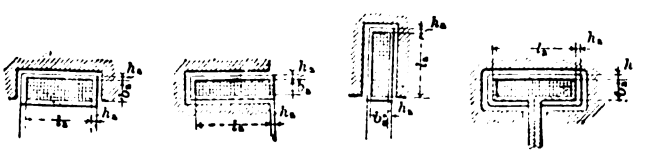
$$\text{Case I}: L_t = \frac{2 \times (l_a + b_a + h_a)}{l_a} \times L_a \quad . \quad . \quad . \quad (23)$$

$$\text{„ II.}: L_t = \frac{l_a + b_a + h_a}{l_a} \times L_a \quad . \quad . \quad . \quad . \quad (24)$$

$$\text{„ III.}: L_t = \frac{2 \times (l_a + b_a + h_a)}{l_a + 2\,b_a + h_a} \times L_a \quad . \quad . \quad . \quad (25)$$

$$\text{„ IV.}: L_t = \frac{2 \times (l_a + b_a + h_a)}{2\,l_a + b_a + h_a} \times L_a \quad . \quad . \quad . \quad (26)$$

In these formulæ l_a, b_a, and L_a are known by virtue of equations (12), (18), and (3) respectively, and h_a can be taken from Table XV., if the actual winding depth is not already known by having previously determined the winding and its arrangement.



FIGS. 8, 9, 10, AND 11.

A formula for Case V. is not given, because, in the first place, the arrangement shown in Fig. 11 is not at all practical, and the makers who first introduced the same have long since discarded it, and second, because the distance of the internal pole projecting depends upon the construction and manner of supporting of the armature core, and consequently cannot be definitely expressed.

(c) Drum-Wound Ring Armatures.—In modern ring armatures of the types indicated by Figs. 4 and 5, the conductors facing two adjacent poles of opposite polarity are often connected in the fashion of a bipolar drum, by completing their turns across the end surfaces of the armature body, thus converting the multipolar ring armature into the combination of as many bipolar drum armatures as there are pairs of poles in the field frame (see Chapter 25).

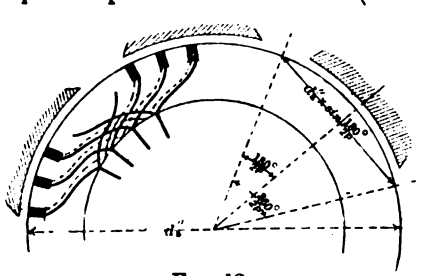


FIG. 12.

By this arrangement, which is illustrated in Fig. 12, not only a considerable saving of dead wire is experienced, but also the exchanging of conductors in case of repair is rendered much more convenient, especially when in bending of the connection strips the Eickemeyer method is applied.

The total length of the armature conductor can in this case be calculated by applying for both smooth and toothed bodies the above formula (21), replacing in the same the core diameter, d_a, by the chordal distance of two neighbouring poles, measured from centre to centre along the circumference of the armature over the winding. The formula for the total length of conductor on a drum-wound ring armature, therefore, is (see Fig. 12):

$$L_t = \left(1 + 1{\cdot}5 \times \frac{d_a'' \times \sin \frac{180\text{deg.}}{2\,P}}{l_a}\right) \times L_a. \quad (27)$$

Inserting in this formula the numerical value for the size of half the pole angle, we obtain the following set of formulæ for the various pole numbers that may be used in practice:

TABLE XX.—Total Length of Conductor on Drum-wound Ring Armatures.

Number of poles. 2 P.	Half pole-angle. $\frac{180°}{2\,P}$	Length of pole-chord (Diameter = 1) $\sin \frac{180°}{2\,P}$.	Total length of armature conductor (formula 27) $L_t = \left\{1 + \left(1{\cdot}5 \times \sin\frac{180}{2\,P}\right) \times \frac{d_a''}{l_a}\right\} \times L_a$
	Deg.		
4	45	·707	$L_t = \left(1 + 1{\cdot}161 \times \frac{d_a''}{l_a}\right) \times L_a$
6	30	·500	·750
8	22½	·383	·574
10	18	·309	·464
12	15	·259	·388
14	12⅞	·222	·333
16	11¼	·195	·293
18	10	·174	·261
20	9	·156	·235
24	7½	·131	·196
30	6	·105	·157

(To be continued.)

ELECTRICAL RESONANCE AS RELATED TO THE TRANSMISSION OF ENERGY.*

BY WM. A. ANTHONY.

Much interest is being taken at the present time in the subject of electrical resonance; and the possibility of taking advantage of this condition in the use of electrical apparatus, especially in the transmission of energy, has been discussed, and some of the conditions necessary to its successful employment have been pointed out. The conditions of electrical resonance itself have been investigated analytically, and many interesting results have been derived by various writers; and Dr. Pupin, in a lecture before the American Institute of Electrical Engineers in May, 1893, gave a most clear and beautiful popular exposition of the subject. In this lecture Dr. Pupin made most excellent use of mechanical analogies, and demonstrated his deductions by a series of very successful experiments. In this discussion Dr. Pupin confined himself to the conditions necessary to establish resonance and the effects produced when the circuits were properly tuned. He did not attempt to discuss the question of taking advantage of resonance in the electrical transmission of energy.

In a series of articles by Mr. F. W. Dunbar now (May, 1894) appearing in the *Electrical World* it is shown by mathematical analysis, that when a circuit is tuned to unison with a source of alternating E.M.F. a greater current may be transmitted to a distant point by a given E.M.F. than when the circuit is not so tuned. Although Mr. Dunbar states that his results indicate that copper may be saved in lines used for the transmission of energy, by tuning them in unison with the source, he does not point out how the condition of resonance upon the line is to be utilised for the transmission of energy, or what will be the effect upon the line were the conditions of resonance obtained.

For what follows, I propose to consider the subject entirely in the light of mechanical analogues, with which every student of physics is familiar, and shall try to point out by reference to familiar experiments with vibrating bodies just what we may expect when we attempt not only to maintain by resonance a given current upon a

* From the *Electrical Engineer* (New York).

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circuit, but also what conditions must be fulfilled, and what results will follow when we attempt to transmit energy to a distant point.

I ought, perhaps, to apologise for treating the subject in the extremely elementary way I have adopted, but the principles of the transmission of vibrating motion, and the various phenomena connected with it, the formation of stationary waves, the relation of a periodic force to the motion produced by it, are so outside our ordinary experience and involve such entirely new sets of idea and new trains of thought, that I believe many readers will be glad to start at the foundation principles. I have, therefore, at the risk of appearing diffuse, detailed at some length the elementary phenomena connected with the foundation of stationary waves.

In Mr. Dunbar's articles he frequently compares a non-resonant circuit to a light, slack string, in which the wave impulses rapidly die away, and, as he says, "are absorbed by the string and their energy dissipated in the form of heat." This does not seem to me a fair comparison. A slack string does not absorb any considerable amount of energy, nothing like what is absorbed by the same string tuned to unison with the exciting source, because it is impossible to impart to it so great an amount of motion. The familiar experiments of Melde, in which the laws of vibration of strings are illustrated by the use of tuning-forks as the vibrating source of energy, will illustrate this point. So long as the string is out of unison with the fork, either from being too slack or too tense, the vibrations of the fork die away very slowly, but as the tension of the string, or its length, is varied to bring it into unison with the fork, the string will, when the unison point is reached, suddenly assume a vibration of wide amplitude, and the fork will be very quickly brought to rest. So long as the string is out of unison its motion is small and

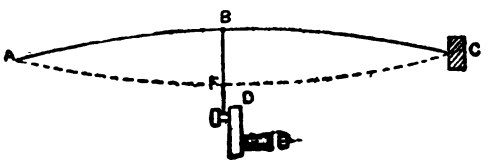

FIG. 1.

it absorbs very little energy. When in unison its motion is large, it quickly consumes the energy stored in the fork and brings it to rest. The energy of the fork is not transmitted: it is simply absorbed and dissipated in consequence of the great velocity at the antinodes of the string due to the wide amplitude. Dr. König, the well-known investigator and manufacturer of acoustic apparatus, once told me that someone had discovered and complained to him that the resonant boxes on which his tuning forks were mounted were not in exact unison with the forks. "But," said Dr. König, "if I made them in exact unison, the air would rapidly absorb the vibration, the fork would be quickly brought to rest, and then they would complain that my forks were not well going."

So in a non resonant electric circuit fed from an alternating source, a given current may be maintained by a given E.M.F. Tune that circuit to unison with the source without changing its resistance, a sudden increase of current will occur, accompanied by an increased absorption of energy, not because energy is transmitted, but because it is absorbed and dissipated by the circuit.

Let us now consider the case of the transmission of energy for some useful purpose. A vibrating string might be used to transmit energy by connecting it at an antinode to some device by which motion could be imparted to a machine. In Fig. 1, let A B C be a string attached to a fixed support at C, and at A connected to some source of energy capable of maintaining a constant vibration in the string. Let the point B be connected to a crank, D, in such a way that the vibration of the string causes the shaft, E, to revolve. It is supposed that the vibration is maintained by properly timed impulses at A, where the motion is very small compared to the double amplitude, B F, at the antinode. It is plain that the mass of the string must be such that its inertia is sufficient to more than supply the force required to revolve the shaft, E. That mass must be assumed, therefore, not only with reference to tuning the string to unison with the source of energy at A, but with reference to the work to be done. It is plain, also, since energy is force multiplied by the space through which it acts, that whatever force is exerted by the string over the space, B F, to revolve the crank, a force greater in proportion as the movement is smaller must be applied to the string at A to maintain the motion.

Again, suppose the string to be divided by a node in the middle, as in Fig. 2. The energy imparted to the revolving shaft from the point B must now be transmitted from A through the node, N. But since N is a place of comparatively small motion, the force exerted there must be proportionally large. The connection to the crank might be made from the node, N, and the power transmitted by means of the large force and small motion that occur there.

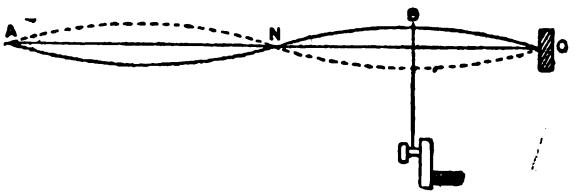

FIG. 2.

Consider now the apparatus represented in Fig. 3. Let the cylinders and connecting tubes be filled with an elastic fluid. Suppose the piston in G to have a reciprocating motion. It will alternately compress and rarefy the fluid at C D F E, and the piston, M, will be subjected to varying pressures tending to move it in synchronism with G. The apparatus is a transmission system in which G is the generator and M the motor, and C D F E the conducting circuit. If we assume the fluid to be perfectly elastic, and that no loss occurs from the compression and rarefaction, and the only loss in transmission is that due to friction in the connecting pipes.

Now we can assume for this apparatus such a fluid of such a mass and elasticity that for a certain period of vibration of the piston, G, the fluid in the pipes, C D and E F, would tend to vibrate in the same period like the air in an organ pipe, with a node in the middle, as shown by the dotted lines at A and B. In order that energy may be transmitted under such conditions, it is necessary that the fluid should have such a mass that it may in virtue of its inertia absorb the energy of the generator and then deliver it to the motor. It is no longer merely a medium for the transmission of pressure, but a medium for the absorption

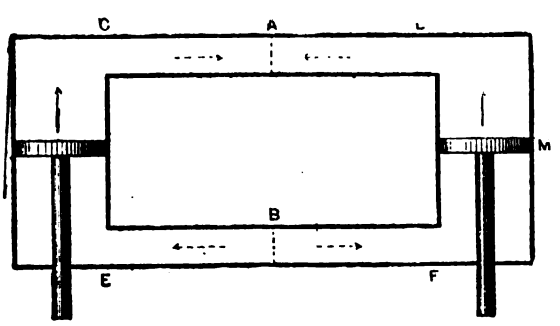

FIG. 3.

and redelivery of energy. As in an organ pipe, the nodes A B are places of comparatively little motion, the fluid on opposite sides of A and B moving in opposite directions, as shown by the arrows. Only at the ends of the pipes near the cylinder is the motion as great as in the non-resonant pipe throughout its whole length. The loss from friction in the resonant pipe is, therefore, much less, and the system of transmission is much more efficient. But since the energy must be transmitted through A and B, there must come with the diminished motion a corresponding increase in pressure. If the motion at A is one-tenth as great as near the ends at C and D, the force or pressure exerted at A must be 10 times as great.

But now the question arises, if the pipe is strong enough

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to bear the pressure to which it is subjected at A, why may it not bear that pressure throughout its length, and then why not discard the condition of resonance, use the high pressure and small motion throughout the length of the pipe, and so reduce the friction losses all along the pipe to the value they previously had at the nodes? In short, the power transmitted by a belt, a cord, a fluid is the product of two factors—force or stress, and velocity. If one is diminished the other must be increased. In transmission by means of a fluid, as in the case we have considered, friction losses may be reduced by reducing the velocity and increasing the pressure to the highest practicable limit, and the least loss from friction will occur when the highest practicable uniform pressure and the lowest velocity is used throughout the length of the pipe. For, if a variable pressure is used, its mean value will be less than (since its maximum value can only equal) the constant pressure that might be employed, and the mean velocity and frictional losses must be greater than would correspond to the constant pressure.

This will be entirely clear to those who are familiar with the mathematics and mechanics of wave motion. But to make the subject plain to those who are not familiar with the mathematics let us go back to first principles and trace out what takes place in the different parts of the circuit represented in Fig. 3.

I must assume that everyone knows that when a disturbance is produced at a given point in an elastic fluid that disturbance is propagated with a certain finite velocity which is greater, the greater the elasticity, and less, the greater the density of the fluid. If a disturbance be produced at G, Fig. 3, if, for instance, G be suddenly moved toward C, the fluid immediately in front of G is moved forward, causing a compression; by this compression the motion is communicated from particle to particle at a certain definite rate, and, in a certain time, travels round the system of pipes and returns to the starting point from the direction E. This time of travelling around this system of pipes depends only upon the nature of the fluid and not at all upon the nature of the disturbance, so long as the disturbance is not too great.

Now suppose the piston, G, to be moved back and forth through a small distance just as the piston of an engine moves in its cylinder, and suppose the complete period of its vibration be exactly the time required for a disturbance in the fluid to travel completely around the circuit. When G starts towards C a wave of compression is started in front of it, and travelling through C, A, D, reaches M just as G has completed half its period—that is, just as it reaches its farthest point toward C. G then begins to return, starting a wave of compression toward E, and these two waves of compression, the one that has just reached M on the way round toward F and the one just starting from G, travelling with equal velocities, meet at B, and since the particles of the fluid at B tend to move to the left by one impulse and to the right by the other, they do not move in either direction, but the two compressions are added, causing a double compression. In consequence of this compression the particles tend to move from B in both directions, and the effect is the same as though the two impulses which met at B continued on unchanged, the one toward G and the other toward M. Following the one toward G, it reaches G, having made the complete circuit, just as the piston completes its vibration and is on the point of returning toward C. It is aided in its return by the impulse which its previous motion started, and which has just completed the circuit of the system.

But to go back to the first movement of G; when it first started toward C, and so started a compressed wave in that direction, it left a rarefied space behind it. Into this space the particles are pushed by the elasticity of the fluid, and this disturbance in which the fluid particles are all moving toward the piston moves back through E and B, and reaches M at the same time as the other disturbance travelling through C and A. Although the disturbances or wave impulses are travelling in opposite directions, they both tend to move the particles at M in the same direction, toward F, and M, therefore, moves in that direction with a double impulse. It will be noted also that both impulses reached M just as G is on the point of returning toward E. G and M, therefore, move together, the one toward E and the other toward F.

If we continue the analysis of the motion, we shall find that G and M are always moving synchronously, and the fluid is, therefore, undergoing compression in one branch at C D, while it suffers a rarefaction in the other. It will be seen, too, that A and B are planes of no motion, but of greatest rarefaction and condensation, and, therefore, greatest variation of pressure.

It will be noted that the condition that brought about this state is, that a motion of the fluid particles started by the piston, G, is transmitted from layer to layer around the circuit, returning to G just as G is ready to impart a new impulse in the same direction. This will occur if G makes one, two, or more complete vibrations during the time required for an impulse to travel around the circuit. If G makes one vibration in this time, we have the condition shown in the figure with nodes at the middle points, A and B, of the tubes. If G made two vibrations in the same time, it would be easy to show that instead of the nodes A and B there would be four nodes, dividing the circuit into four segments.

Since at each return of the transmitted movement to G it finds G ready to give a new impulse, adding to the motion already existing, the effect of the impulses at G is cumulative, and, if there were no loss from friction or otherwise, it would require but a few small impulses at G to set up a powerful vibratory motion in the tube. Assuming that there was no friction and no energy taken from the system in any way, such a vibration once started would never cease.

It will be plain that when this vibration has become established all the particles of the fluid between G and A and between M and A move toward or from A simultaneously, and that as we recede from G or M the amplitude of the motion continually decreases until at A it is zero. Such a wave, in which all the particles between two adjacent nodes move simultaneously in the same direction, is called a stationary wave.

But while the particles at M and G move over the greatest distances, the particles adjacent to these move over so nearly the same distance that there is very little approach or recession and consequently very little change of pressure, while the contrary is the case near A and B.

Consider the particles at G and M to be moving at their greatest velocities toward C and D through their positions of equilibrium. They are gradually brought to rest at the extreme point of the vibration by the small opposing elastic force of the fluid. Their kinetic energy is absorbed by a small force acting over a comparatively large space. As we go toward A, however, the space becomes less and less, and the force, as it should do, becomes greater and greater. It may be considered that the kinetic energy of the particles at M is transferred from particle to particle back through D and A toward G. At the same time the kinetic energy at G is transmitted through C and A toward M. On the supposition that no energy is lost to the system, an equal amount of energy is transferred through A in each direction, and the particles at A remain at rest.

Now suppose the particles or piston at M be called upon to do outside work. On the same supposition as before, that M is moving toward D, since part of its energy is consumed by the outside work only a part is transferred through A to G, hence G receives less energy from M than would have been received if M had not done any outside work.

There is then a lack of energy to maintain the vibration at G, and unless energy is supplied, the whole system will soon be brought to rest. Let energy be supplied to G. It must come from a periodic force tending to maintain the vibration. Such a force acting upon G through its amplitude imparts energy to the fluid which is transferred through A and B to M to make up for that taken away from M. But now since more energy is transmitted in one direction than the other through A and B, the particles there can no longer remain entirely at rest. The amount of motion at A and B will depend upon the relation that the excess of energy transferred in one direction over the other bears

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to the whole energy transferred, and in order that the nodal character of A and B may be maintained, it is important that this excess of energy should be small compared to the whole.

This leads to a most important consideration, that if the resonant character of the system is to be maintained the energy taken from M must be only a fraction of that stored in the vibrating system. It should be noted, further, that when energy is taken from M, and consequently motion takes place at A and B, the motions of G and M, although always isochronous, are no longer synchronous, and the departure from synchronism is greater as the amount of energy used is greater.

Bearing in mind the relative motions of the various particles of the vibrating fluid, it will now be clearly seen that the energy required to make up for that lost to the system, which is applied in the form of a force acting through the comparatively large space represented by the amplitude of vibration at G, as it is transferred toward A and B to particles whose range of motion is less and less, must appear as a greater and greater force acting through a smaller and smaller space.

Considering now that when vibration takes place without loss to the system the nodes A and B are places of great elastic stress, while at G and M there is almost no stress whatever, and that when force is applied at G to make up for the loss in the system, that force is magnified at A and B and appears there as an added elastic stress, it becomes evident that under such a system of transfer of energy the pressure at the nodal points must be many times greater than elsewhere in the system.

We may now apply these considerations to an electric circuit. Difference of potential or electric stress corresponds to pressure or elastic stress in fluids. Electric flow corresponds to fluid flow. Electric current corresponds to velocity. Self-induction is a sort of electric inertia corresponding to mass inertia. Elasticity in a fluid corresponds to the rate of change of electric stress with charge. That is, the elasticity of a fluid is the ratio of any small change of pressure to the corresponding change of volume. So we might call electric elasticity the ratio of any small change of electric pressure to the corresponding change of charge. Obviously the change of pressure (electric) due to the unit change of charge will be inversely proportional to the capacity of a body.

It is obvious that an electric impulse or displacement will travel on a conductor with a perfectly definite velocity depending upon the electric inertia or self-induction which tends to hold back or retard the motion, and the electric elasticity which tends to hasten it. Such a propagation results in a stationary wave if impulses are properly timed, precisely as in a vibrating string or organ pipe, or in the fluid circuit represented in Fig. 3. Such a stationary wave must have its nodes where there is no current, just as the string or organ pipe has nodes where there is no motion. That such nodes exist in a resonant electric circuit is demonstrated by the fact that less energy is lost on a resonant circuit than on a continuous-current circuit carrying the same current as exists at the terminals of the resonant circuit. For, since the energy lost in the resistance of the circuit is C^2R, the loss can only be diminished by diminishing C, and if $C^2 R$ is less on the resonant circuit than on the continuous-current circuit, it is plain that the mean C^2 must be less, and hence that C along the line of the resonant circuit is less than at the terminals. In fact, if we assume a simple harmonic wave and nodal points of absolutely no current, the current strengths along the circuits will be represented by a sine curve, and the mean C^2 is in that case just half the maximum C^2. Hence, just half the energy is saved, or we can waste the same amount of energy and save 50 per cent. of the copper in the line.

Such a mode of absolutely no current cannot, however, exist if any energy is lost to the system either as waste, dissipated from conductors, or as useful energy taken from translating devices. In this case, just as in the vibrating string or fluid circuit, more energy is transferred through the node in one direction than in the other, and this cannot be without some current. It is plain, therefore, that in any practical system of transmission not quite half the copper can be saved by tuning it to resonance.

But let us consider the other conditions that must exist on a resonant circuit.

Just as we have already found for mechanical resonance, so in electrical resonance, the inertia must be large in comparison to the energy to be taken from the system. In other words, in order that resonance may be maintained, the self-induction of the circuit must be such that energy may be stored in it, in amount several times what it is proposed to take away. This requires a relatively large electrical elasticity, which may be obtained by making the capacity small.

As in the resonant fluid the nodes of no motion are the places of greatest pressure, so in the electric circuit the nodes of no current are places of greatest electric stress. In other words, the antinodes of the curve of stress correspond to the nodes of current, and *vice versâ*.

It will be remembered that the condition of resonance in the fluid system of Fig. 3 was that any given movement started by the piston, G, must, after travelling completely round the circuit, return to G to find the piston moving in the same direction—that is, the impulse given by the piston must always coincide in direction with the motion the fluid already has from previous impulses. So with the electric circuit, and for the same reason, the condition of resonance is that the impulses given by the generator to compensate for the energy taken from the system must always coincide in direction with the current already established; or, in other words, the phase of the impressed E.M.F. must coincide with that of the current. But just as the pressure exerted by the piston, G, is multiplied as it passes through the nodes A and B, so the electric pressure of the generator must be multiplied as it passes through the points of minimum current. These points are, therefore, for two reasons, points of many times greater electric stress than exists at the terminals of the line, and the question at once arises, as in the case of the fluid transmission, if the insulation of the line will bear this great electric stress, why not so design the system that this stress, with its accompanying small current, shall exist throughout the line.

All this might have been said in a very few words. Everyone familiar with the characteristics of harmonic vibration and wave propagation knows that the force is a maximum when the velocity is a minimum, and the velocity a maximum when force is a minimum; and that for all stationary waves, the two curves representing respectively force and velocity at different points, the ordinates of one are always a maximum where those of the other are a minimum.

An electric circuit tuned to resonance with the generator, affords an example of a stationary wave where the maximum current is at the generator and motor and the minimum current at the nodes on the line. This gives a minimum of energy consumed in the transmission. But the E.M.F. curve has its nodes at the generator and motor, and its antinodes correspond to the nodes of the current curve on the line. Therefore, whatever the electric pressure at the generator and motor, they must be small compared to the pressure on the line at the current nodes.

While, therefore, a line tuned to resonance with the source may transmit energy with less $C^2 R$ loss, we must, to secure that result, give to it a self-induction capable of storing several times the energy it is proposed to transmit, and subject it to electric stresses several times what would be required with the same current to develop the power consumed.

Electric Transmission at Buccari.—The authorities of the little town of Buccari, near Fiume, which has only 3,000 inhabitants, but which is coming into notice as a health resort and bathing-place, have made use of water power for providing for the public and private electric lighting of the town. The installation has been carried out by the International Electricity Company, of Vienna. A Ganz turbine is employed, and in addition there is kept as a reserve a 20-h.p. steam-engine. A 6,500-watt continuous-current dynamo supplies current at a pressure of 100 volts. There are 50 incandescent lamps in the streets, and about 120 in private houses.

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TO CORRESPONDENTS.

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Vol. XII. of new series of "The Electrical Engineer" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

A NICE PROBLEM.

It is not possible for us just now to discuss the history of Woodhouse and Rawson United, Limited, but there are questions of a general character which, without trespassing upon the jurisdiction of the Court, may perhaps be discussed. When does a debt become a debt has created a diversity of opinion in respect to a correct answer, or, rather, when does a profit upon a commercial transaction become a profit? From the accountant's point of view there ought to be no difficulty in determining the time, but in this, as in every other case, the exception may prove the rule. It seems to us that if Messrs. A., B., and Co. on the last day of their financial year—nay, if you like, during the last hour of that day, or the last minute of that day, sell a dynamo to Messrs. C., D., and Co., the profit or loss accruing from that transaction belongs to the financial year in which the transaction is concluded. The dynamo no longer belongs to Messrs. A., B., and Co.: it cannot be valued as stock, but must appear, if the transaction is *bonâ fide*, as a good book debt. Thus, as a good book debt it goes to swell the assets of the firm, and assists in making the total assets. So far, we imagine, all are agreed, but the agreement is not so general when something less tangible is bought and sold. But should this be so? Let Messrs. A., B., and Co. sell a mine for money and shares at a similar period of their financial year. Ought they to ignore the transaction in the balance-sheet, or to take the sale price as a good asset—a good book debt? Undoubtedly the safest way would be to treat the matter in a suspense account, but is there any legal or moral necessity for doing this when the transaction is *bonâ fide*? Yes, say a large number of people—apparently the larger number—for paper shares should never be treated exactly in the same way as cash, or commercial bills, or debts for goods supplied; there is never any absolute certainty as to the value of shares till they are quoted in the market. These opinions are not unimportant, because in many cases business men are almost compelled to take shares or debentures or some such security for a debt for which they cannot obtain cash. Again, the safest plan is to put the amount to a suspense account; but is this always possible? The business man may be convinced that the face value of the security is its real value; and in an estimation of his affairs is he to ignore that which to him is as safe as the Bank of England? To electric light engineers the question is of great importance. Many good enterprises now in thorough working order could not have been started unless part payment had been made in shares, and if the recipients of these shares had to treat them as bad debts, or as something not forming an asset, their affairs would not be too promising. During the past ten or fifteen years enormous numbers of shares have thus been paid over and have been accepted as assets. In many instances, too, these shares have realised their face value, but, of course, in many others they have never realised a cent. The nice problem for the moment is how and when and at what price such shares should

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appear in the books of the firm or company. We incline to the opinion, that in the case of a sale when the sale is completed—that is, upon the day when the books record the transaction. If, for a central station cash and shares are to be taken, the profit or loss upon the transaction cannot be taken on the day when the agreement for the station is signed and sealed. In the ordinary course of book-keeping for balance-sheet purposes, the amount expended at the close of the financial year would be estimated, and if the necessities of the case demanded a proportional profit on that expenditure might be assumed to have been earned; but further than this no one ought to go. The difference between this total and the amount received on account would, of course, figure in the books as a good debt. There are many funny little business transactions of this kind that would form good subjects for discussion by the Electrical Section of the London Chamber of Commerce, but that body is not altogether immaculate in eagerness to touch outside business, or preferably we may call them detail business questions.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

OIL FUEL AT HULL.

SIR,—Kindly allow me to correct an error in your issue for July 6, with reference to my report to the Electric Lighting Committee on "oil fuel." In the fourth sentence it is stated that "Messrs. Laycock found that at 1*s.* 4*d. per gallon* oil fuel was equal to coal at 12s. per ton." This is an obvious error for 1½*d. per gallon*, as in the following sentence the words *not exceeding* 1*d. per gallon* are correctly reported.—Yours, etc., ALFRED H. GIBBINGS.

Hull, July 6, 1894.

[The paragraph referred to was given on pages 26 and 27 of our last issue.—ED. *E. E.*]

GAS v. STEAM FOR CENTRAL STATIONS.

SIR,—I have read your opportune and interesting article on "Gas *v.* Steam for Central Stations," which appeared in your impression of July 6, 1894. The tabulated data of comparison contains many serious discrepancies, and of such an obvious character as to absolutely destroy their value for reference purposes.

For instance, in comparing the cost of the preliminary installation of 160 h.p., the six-ton overhead traveller is stated to cost £200 in the steam installation, and £300 for the gas installation. In the complete installation of 1,400 h.p. the cost of gas-engines and dynamos is given as equal to £12,820, whereas the Willans engines and dynamos for the same power is given as equal to £10,825. I think any unprejudiced engineer who understands these matters knows this to be a misleading and unfair statement.

In the working expenses (preliminary installation), the coal for the gas plant is stated to be 24s. per ton, whereas the steam coal is fixed at 6s. per ton. Surely there is not such a discrepancy between the cost of anthracite and steam coal as is here indicated, not to say we have heard of a gas producer using coke. In the complete installation working expenses account the water for the steam-driven plant is stated to be 4,000,000 gallons, at 7d. per gallon, costing £117, whilst the 500,000 gallons of water used for the gas-driven plant are stated to cost £150.

There are other equally misleading figures which if corrected would prove that the gas plant, both in first cost and in working cost, would be very considerably the more economical of the two plants.

If the gentleman who has drawn up the tabulated data is interested in the subject, and is anxious to find out the real advantages of gas plants over steam, I shall be glad if he will call upon me, when I shall be pleased to show him an electrical installation being erected to be driven by a gas-engine, and gas plant to burn slack coal.—Yours, etc.,

G. THRELFALL, Chief Engineer,
The Motor Gas Plant Syndicate.

London, E.C., July 12, 1894.

REVIEWS.

Electricity One Hundred Years Ago and To-Day. With copious Notes and Extracts. By EDWIN J. HOUSTON, Ph.D. (Princeton). New York: The W. J. Johnston Company, Limited, 253, Broadway.

The author of this work, in tracing the history of electrical science from practically its birth to the present time, has, as much as possible, consulted original sources, and he was fortunate in having at his disposal the library of the Franklin Institute, which contains one of the most complete collections of scientific publications of the last century. As a result of his researches, several revisions as to the date of the discovery of some important principles in electrical science are claimed to be necessary. The compass of the book does not permit of any other than a general treatment of the subject, but at the same time numerous references are given in footnotes, which would better have been embodied in the general text. One of its admirable features is the agreeable style in which the work is written, its philosophical discussion as to the cause and effect of various discoveries, and its personal references to great names in electrical science.

THE NEW TELEGRAPH CABLE IN THE ST. GOTHARD TUNNEL.

A recent issue of a French contemporary contains an article dealing with this new cable. It appears that the first telegraph cable for the St. Gothard tunnel was made by Messrs. Felten and Guilleaume, of Mulheim-on-the-Rhine, and was laid in 1882. In the year 1890 the St. Gothard Railway Company put down for their own service a telegraph cable with three conductors, and also a concentric telephone cable. Although the older cable was thus relieved, the Swiss telegraphic authorities found it necessary to lay another cable during September and October, 1893. The conditions present inside the tunnel render great care necessary. The water trickling down the walls contains sulphuretted hydrogen, sulphur dioxide, ammonia, and carbon dioxide, besides other products from the smoke of the locomotives. The conditions are so bad that even the rails and sleepers themselves have been affected. The temperature of the tunnel reaches 73·5deg. F. at the middle. It was essential to have a strong protective covering, as workmen are continually employed inside the tunnel, where labour is very difficult. The Swiss Telegraph Department has spared no expense in obtaining a satisfactory cable for the international telegraphic communication. Messrs. Felten and Guilleaume were chosen as contractors, and the cable was formed of six conductors grouped around a central conductor. Each of these consisted of seven copper wires of 0·097in. diameter properly stranded together. Each conductor was insulated with alternate layers of Chatterton compound and guttapercha to a diameter of 0·235in. The whole seven conductors formed a cable, which was covered with bitumenised ribbon, and over this was placed a double lead covering to keep out water. Other layers of insulation were placed over the lead pipes, and the whole was protected against injury by a layer of 25 iron wires of Z section wrapped over one another. The layer was protected externally by a spun covering impregnated with a preservative compound. The cable has an external diameter of 2·05in., and a total length of 9·8 miles, divided into portions about 815 yards long, and each weighing 15·14 tons. Besides the main cable, some short lengths having four or five conductors were also required. The

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cable was laid under the superintendence of Dr. V. Wietlisbach, of Berne, and it was decided to place the new cable in the same trench along with the old ones. The latter were therefore covered with sand, and the whole finally filled up with sand and covered with flagstones. Owing to the large amount of traffic upon the line, the work of laying the new cable could only be proceeded with between 7 p.m. and 9 p.m., and the joints had to be made during the night. The extremities of the cable are situated at Göschenen and Airolo, and are fitted with lightning protectors.

The prescribed conditions are given in column 1, and those found by actual experiment in column 2:

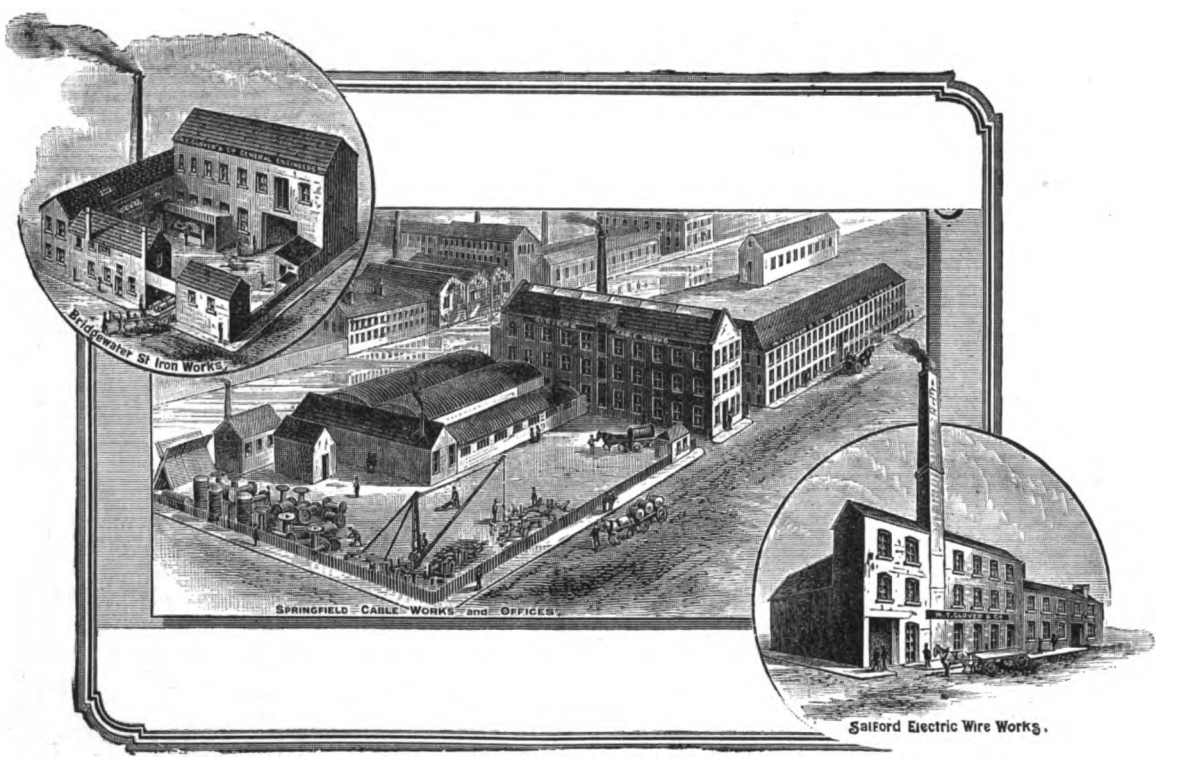
—	Column 1. Per kilometre.	Column 2. Per kilometre.
Lineal resistance of the copper not to exceed	7 ohms	6·55 ohms
Insulation resistance not to be below.....	1,000 megohms	7,500 megohms
Lineal capacity not to exceed.....	0·25 microfarad	0·193 microfarad

MESSRS. W. T. GLOVER AND CO.'S EXTENSION OF WORKS.

The increasing business of Messrs. Walter T. Glover and Co., of Salford and London, the well-known electric wire and cable makers, has necessitated the provision of new offices and storerooms, which have been erected contiguous to the company's Springfield Cable Works in Salford. The opening of the new buildings was recently celebrated by Mr. Henry H. Edmunds, the principal, who gave a supper and entertainment to his staff and employés.

A reference to the company's price-list of electric light wires and cables shows the large variety of manufactures turned out at the Salford works, an illustration of which is annexed. The vulcanised wires and cables, immediately after vulcanising, are immersed in water, and after a period of 24 hours they are tested at a temperature of 60deg. F.; until they have passed satisfactorily through this test they are not subjected to any further process of manufacture. When coils are issued from the works, they are accompanied by a certificate from the electrical department. The company also make lead-covered cables and concentric cables, in addition to a large assortment of telephone, telegraph, and multiple cables, which are detailed in a separate list, and cotton and silk lapped high-conductivity copper and German-silver wire for dynamos, transformers, resistance coils, bells, etc. Among other manufactures may be mentioned the company's patent armature bars having solid ends. This method is a great improvement on either brazing or soldering. The bars and solid ends can be made to any required shape, and the solid ends may be of the same shape as the bar itself, or they may differ from it to suit any special connections.

On the occasion of the above-mentioned ceremony nearly 400 people sat down in one of the sheds to an excellent repast, the room being decorated, and on a platform at one end arrangements were made for a musical and conjuring entertainment. During the course of the evening Mr. Edmunds took the opportunity of welcoming all present, and reminded them of the growth of the business, and of the necessity of individual care on the part of all present in connection with every detail of their large but important manufacture in connection with electrical cables. He expressed the hope that a meeting of this kind would be productive of a good understanding between master and man, which, judging from the hearty response on the part of all present, would augur well for the future relations of the business. An excellent conjuring entertainment was given, and a Bradford young man surprised those present by his clever execution on the violin. During an interval the employés inspected the new dining-rooms and lavatories, and also the new offices which have been constructed in the buildings adjoining Glover's old cable works, and have a frontage extending some 190ft. In addition to the offices and warehouse, stores are provided for raw materials, such as cotton and copper, and for the finished manufactures, such as electric light cables, wires, telephone and telegraphic materials, etc.



Messrs. Glover and Co.'s Works.

THE TRAMWAYS INSTITUTE.

A general meeting of this institute was held on Thursday of last week at the Holborn Restaurant, there being an attendance of 50 or 60 members and visitors, under the presidency of Mr. W. J. Carruthers Wain. The first part of the proceedings was largely of a formal business nature, and included the adoption of the report and balance-sheet for the past year, the election of certain officers (amongst whom should be named Mr. Wain, re-elected president of the institute), and other items of a similar kind. There next followed the reading and discussion of several papers concerning tramway topics. One of these was by Mr. F.

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Purdon, C.E., upon the important, yet sometimes overlooked, matter of car bearings. This contribution we abstract as follows.

Roller Bearings for Tramcars.

BY F. PURDON.

The advantage of having good tramcar bearings is obvious, and a great many efforts have been made to improve them, either by alteration of the form and materials of the bearings, or the method of lubrication. These efforts have met with more or less success, but even when the best of them are employed, the tractional force necessary to start a car and maintain its speed is very high; probably only the horse knows how high. I have endeavoured to get some reliable estimate of what this tractional force is, but have found authorities differ widely owing mainly to the varying conditions under which the experiments have been made. Mr. D. K. Clark, in his valuable work on tramways, gives as an average 25lb. as the tractional force required to keep one ton moving continuously, and the starting effort as 50lb. per ton, or double. For the present I think it will be admitted that the work the tramcar horse is asked to perform is very severe, and although his daily mileage (about 12 miles) is not high, his life is short, which fact is no doubt due to excessive strain upon his muscles.

The cyclist, who has been put much in the same position as a horse, but who has the advantage of being able to speak and demand alleviation, very early discovered the advantages to be derived from roller bearings, and the universal adoption of the ball bearing for cycles is the result. The ball bearing, however, admirable as it is for the light weights carried on the cycle, has never succeeded under heavy loads, owing mainly to the fact that all the weight is carried by only one or two balls at any moment of time, and the balls only touch the races, or ball paths, on a point, the result being that either the balls crush or the races are indented. The ball bearing, from its design, requires lubricant, which is in itself a collector of dirt, and in large vehicles is also an item of considerable expense. In a true rolling bearing—that is, one in which there is no scrubbing of parts—no lubrication is necessary, and the fact of lubrication being wanted or not becomes a test as to whether a bearing is a true rolling bearing or not. That lubrication is not required for rolling motion is shown by the fact that we do not put oil or grease on the rail, and yet the periphery of the wheel, where it is in contact with the rail, has a much greater speed than has its boss where it touches the journal, but this latter requires much lubrication. The explanation is that in the first case there is rolling motion, and in the second sliding or scrubbing motion.

In connection with my partner Mr. Walters and Mr. Woodcock, the bearing now to be described has been devised, for which it is contended that it is fully capable of bearing the weight of a tramcar, that it requires no lubrication, that it has no sliding or scrubbing parts, that it shows great endurance, and gives remarkable ease of traction. Great reduction of working expenses must result from its application to tramways, and it therefore in my opinion needs no apology for presenting itself before this institute. The conditions of a good roller bearing are severe.

(1) Sufficient bearing in lineal inches must be provided to bear the weight, which in the case of a tramcar may be taken as 1¼ tons per bearing. It is this condition which prevents the use of balls, and compels the adoption of rollers, which can be made the whole length of the journal.

(2) The rollers must not move laterally, and must remain exactly parallel with the journal, from which position the least deviation reduces contact to a point and sets up a spiral movement of the whole series of rollers upon the journal.

(3) The rollers must not touch one another, as if they do (like balls in a ball bearing) the surfaces in contact revolve in opposite directions, and scrubbing must take place and lubrication be required.

(4) No dust must be allowed to get in, though dirt or dust is not so injurious a factor in roller bearings as it is in oil-boxes.

(5) No sliding or scrubbing must take place between the parts of any device for the separating of the rollers, otherwise the evil is only removed from one place to another,

(6) The journal must not move laterally under the load, as this would set up the spiral movement referred to above.

The above conditions, it is claimed, are all met by the bearing now to be described.

Rollers are provided to carry the weight. They are driven by the axle, and are the full length of the journal. Knobs on subsidiary rollers act as spacers to keep the main rollers from touching each other. These subsidiary rollers are driven by the main rollers, and effect a similar condition as would occur if teeth were provided in the axle, rollers, ring, and path. The speed at which the "knobs" are driven is regulated by the diameter of the main rollers at the points of contact, and this is so proportioned that the subsidiary rollers perform one revolution round their orbit (which is the path contrived in the end covers) in the same time as the main rollers perform one revolution round their orbit, which is the casing of the bearing. The subsidiary rollers do not touch the casing, and they are prevented from moving inwards by the "path," and outwards by a "live ring," which embraces them, and which they drive at their own speed. Lateral motion is prevented by the "knobs" on the subsidiary rollers, which are so constructed that they engage the rollers and the "path" at their normal diameters, so that there is nothing in the nature of a flange which involves scrubbing. End movement of the axle in the box is prevented by single balls at each axle end, which roll truly, and have an adjustment by which the rollers and the journal are always kept in the same relation to each other. In order to allow of some end play, which in the ordinary box is managed by collars on the brass and journal, the box is carried on a trunnion, and as the centre line of the box is not exactly coincident with the centre line of the spring, some play is given in the guides, but without allowing the axle to slide under the rollers. This arrangement works admirably in practice, and its effect is very noticeable to anyone riding in the car, as instead of the jolt which we are familiar with at points, or other irregularities in the road, a gentle swing of the car is all that is felt. This arrangement is mainly due to Mr. Greg, the superintendent of machinery at the Lancaster Carriage and Wagon Company's Works; and it did much to overcome a difficulty that occurred in the early experimental bearings in connection with end play.

Passing now to practical experiments, Mr. W. Shackleford, the general manager of the Lancaster Company, who has taken a warm interest in the bearing, has made a large number of practical experiments. He has made and run a railway wagon with results as reported in the *Engineer*, April 14, 1893; also bearings for line shafting, dynamo shafts, and others (with which I do not intend to trouble you to-day), before taking the tramcar in hand, and after a good deal of experience had been gained and many difficulties surmounted, a set of tram boxes was made, which have worked admirably. These were fitted to a truck, and the following tests were made for starting effort, compared with a similar truck having ordinary oil-boxes. The trucks were loaded up to 4 tons 15cwt., and a piece of line was selected on a gradient of 1 in 44, with a long straight and level piece at the bottom. The trucks were let go from the same height up the gradient, and the distances they travelled were measured. The next test for starting effort was by standing the truck on the level, with a cord attached, passing over fixed pulleys, and measuring the starting effort by placing weights in a basket at the end of the cord. The following table will show the results of these tests.

1. GRAVITY TEST.—Cars let loose from a point 44ft. up an incline of 12⅜in. rise:
   Ordinary box ..... 33ft., average of three runs.
   Roller-box ..... 211ft., " "
   Result ..... 6·39 to 1.

2. GRAVITY TEST (*continued*).—Cars let loose from a point 56ft. up an incline with 1ft. 6½in. rise:
   Ordinary box ..... 57ft., average of three runs.
   Roller-box ..... Ran into stops at about 320ft.

3. STARTING TEST.—Amount required to start by falling weight:
   1. Ordinary box ..... 81lb. Roller-box ..... 18½lb.
   2. " " ..... 75lb. " " ..... 24lb.

4. STARTING TEST.—As above, but with a weight of 4 tons 15cwt. on truck:
   Ordinary (by former trial) ..... 198lb.
   Roller ..... 31lb.
   Result ..... 6·39 to 1 (as before).

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A saving will also be effected on gradients both in starting and running, but the proportion of saving will, of course, decrease as the incline increases. The following table shows the estimated saving in percentages of tractive force for gradients from 1 in 20 to 1 in 140:

COMPARATIVE TRACTIVE FORCE required to start a tramcar of five tons total weight, fitted with ordinary oil bearings and with roller-boxes, on various gradients.

Gradient.	Tractive force. Oil bearings in pounds.		Tractive force. Roller bearings in pounds.		Saving per cent. by use of roller bearings.
1 in 20 ...	Gravity	560	Gravity	560	
	Friction	125	Friction	21	
		685		581	15·2
1 in 50 ...	Gravity	224	Gravity	224	
	Friction	125	Friction	21	
		349		245	29·8
1 in 80 ...	Gravity	140	Gravity	140	
	Friction	125	Friction	21	
		265		161	39·25
1 in 110 ...	Gravity	102	Gravity	102	
	Friction	125	Friction	21	
		227		123	45·8
1 in 140 ...	Gravity	80	Gravity	80	
	Friction	125	Friction	21	
		205		101	50·7

The above table is founded on the supposition that the frictional resistance to traction in cars fitted with ordinary oil-boxes is 25lb. per ton, and in cars fitted with roller bearings only 4⅕lb. per ton, which figures are in accordance with the results of the experiments made at Lancaster. Frictional resistance will therefore be 125lb. for a car of five tons gross weight in the former case, and 21lb. in the latter.

The next thing was to get the bearings attached to a car in actual work, and to see how it behaved on the curves and under the stresses to which such cars are subjected. This was done by permission of the Morecambe Company, where the car was put to work in February, 1894, and ran for about two months, or, say, 3,000 miles, giving great satisfaction. The ease to the horses was quite unmistakeable, and the trunnion arrangement worked admirably. At the end of this time the boxes were taken off and examined and were found quite unworn. While running at Morecambe they were inspected by Mr. Holroyd Smith, the engineer to the Blackpool Corporation electric tramways, who was struck by their ease of running; and he made the following suggestion—viz., that as no precise result, showing the relative advantage of roller bearings as against ordinary boxes, could be obtained under the condition of horse traction, the roller-boxes should be placed under one of his cars on the Blackpool electric tramways, where the amount of current required to drive the car fitted with the roller-boxes could be measured as against a car fitted with ordinary boxes. Mr. Smith has since reported as follows: "I find that the power required to drive car No. 6 with the roller bearings is fully 30 per cent. less than the power required for car No. 5 with ordinary bearings. I have reported above to the Tramway Committee, who consider it so satis factory that they have instructed me to order roller bearings for the two bogie cars now being built."

The first cost of these bearings is undoubtedly high, but when made in quantities they can be supplied at a reasonable cost. Moreover, there are many ways of realising undoubted advantages in traction, so as to pay for the greater first cost of the roller-boxes, and also to improve the dividend-paying power of companies when these boxes are used. Taking a hypothetical case of a tramway six miles long, with a 10-minute service all day, and assuming that it takes a car 2 hours and 20 minutes to make the round journey, there will then be 14 cars on the road when in full work, and supposing that the first car leaves the depôt at 8 a.m., and the last at 9.50 p.m., then there will be 84 car journeys per diem, and the total car mileage will be 1,008. If each pair of horses is worked 12 miles per day with one day off in seven, then the total number of horses required to work the foregoing traffic will be 196. If by the introduction of roller-boxes the traction is so much reduced that each pair of horses is able to travel 16 miles per diem with six days off in 28, then the total number of horses required to work the traffic will be 160, showing a saving of 36 horses, or 18·4 per cent., which at the rate of £55 per horse per annum for keep and renewals, would show a total saving of £1,980 per annum, or 1·28d., say, 1¼d. per car mile, without considering the saving in the cost of lubricant.

Tramway working expenses absorb so large a proportion of gross receipts that any saving in the latter soon becomes appreciable in the dividend payable; 55 per cent. of the average 80 per cent. representing total expenses is due to horses, showing that that is the item where saving will be the soonest appreciable in dividend. Assuming a tramway paying 5 per cent. dividend, with 80 per cent. working expenses, then 20 per cent. gross receipts equal 5 per cent. dividend, and a reduction of 4 per cent. working expenses will equal 1 per cent. dividend. Now, taking 55 per cent. of the working expenses as due to horses, and reducing the number of horses by 18 per cent. as above, there should be a saving of 18 per cent. of 55 per cent., or about 8 per cent., reducing working expenses to 72 per cent., and increasing dividend to 7 per cent. instead of 5. These figures are hypothetical, but they cannot be gainsaid on broad lines, and they show clearly that there is a great advantage to be derived from reducing the work and consequent number of horses. Similar conditions, of course, apply in the case of lines worked by mechanical powers.

In asking the members to give their opinions upon this communication, the PRESIDENT said that for his part he would undertake to afford Mr. Purdon any opportunity he might desire to try the device on the lines with which he (the president) was connected.

Mr. WHYTEHEAD (North Staffs.) said that he had tried a bearing with one roller in it some two years ago, and found that it made a great difference in the starting effort required. He could not, however, detect any great saving in the coal bill, owing to the necessarily dirty roads and rails throughout his district.

Mr. PURDON stated that the extra cost of the bearing would be about £10 per axle, though this might be reduced when making quantities.

Mr. HOLT (Crossley Bros.) spoke favourably of the device from a theoretical standpoint.

The last-named gentleman was next called upon to read a short communication which he had prepared on the subject of gas motors for tramways. This dealt chiefly with the requirements and conditions of such, concluding with a few particulars of the Lührig gas motor now under trial on the Croydon tramways. The cost of fuel used in such a system was stated by Mr. Holt to be about 1½d. per car mile, and the capital expenditure, including station plant, about £600 per mile.

In a brief discussion which followed, Mr. ALFRED DICKINSON (South Staffs.) said that the cost of fuel in such a case was not any lower than when steam-engines are employed, and he gave these figures to show comparison between the various systems:

	Cost of fuel per car mile.
South Staffs., steam motors	2·34d.
Birmingham ,, ...	1·81d.
Dudley and Stourbridge ,, ...	1·94d.
Birmingham Central ,, ...	1·92d.
,, ,, electric accumulator	1·76d.
,, ,, cable	1 60d.
South Staffs., electric overhead	·48d.

Mr. Dickinson was announced on the agenda to read a paper on "Electric Traction," but owing to the details contained therein being also embodied in a prior communication (not yet published) to the Institution of Civil Engineers, he was prevented from bringing forward what would without doubt have proved a most interesting subject for debate. There was no desire evinced by the

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members (at the late hour to which the proceedings had by now attained) to take up the adjourned discussion upon M. Victor Popp's paper, "Traction by Means of Compressed Air," read at the previous meeting, and it was again postponed.

SOME STORAGE BATTERY PHENOMENA*.

BY W. W. GRISCOM.

(Continued from page 17.)

A curious feature in charge is the intersecting of the curves of the positive and negative plates at several different points. At the beginning of charge, the two plates are at nearly the same potential, the positive potential rises rapidly until it reaches 2·22 volts, when it begins to rise in a straight line strictly proportional to time. The negative, on the other hand, rises gradually until it reaches 2·18 volts; then it rises rapidly, intersecting the positive curve in 14½ hours and at 2·24 volts, and continuing to rise until it reaches 2·40 volts in 16¾ hours, whereafter it remains constant for the five hours which the positive requires to reach the same potential.

To trace the history of a negative during discharge, it fell in five minutes ·135 volt, in the next six hours ·035 volt, in the following hour ·250 volt, and in 15 minutes more 1·500 volts, showing less capacity than the positive plate. In half an hour after stopping discharge it recovered to 1·9 volts—jumping instantly on charge to 2·08 volts, and in 12 hours of charge arose only ·05 volt. Of course the rate will not modify the general characteristics of the curve.

Within the working limits of charge or discharge, the negative did not vary over 2 per cent. of potential difference.

The history of the positive in this curve is not so satisfactory. Falling rapidly to 2·04 in 10 minutes, it fell thereafter in a gradual curve ·115 volt during the normal time of charge, a fluctuation of about 6 per cent. Ultimately the positive shows more capacity than the negative.

The total fluctuation of the cell during the six hours after the first five minutes was 6 per cent. in discharge down to 1·9 volts. This was the fluctuation of the potential difference—that is to say, it was the fluctuation which would be noticeable to the engineer in practical service, and included all changes due to internal resistance.

The usual construction of storage batteries—all the plates of one name being permanently fastened to one heavy conductor—has heretofore interfered with the study of the individual plates of a cell. To the end, therefore, of facilitating this investigation, the author constructed some cells with independent plates, connecting all those of one name to a common mercury trough, either directly or through intermediate resistances.

The resistances were made such that one ampere would give 10 divisions on a dead-beat galvanometer, and as each division could be divided by the eye into tenths, the current passing could be read within one-hundredth of an ampere. An independent ammeter and an adjustable mercury resistance were inserted, and the total current kept constant. The cells tested in this way were of three types—the pasted cell of the Accumulator Company, the chloride cell, and the Planté cell. The object in testing a chloride cell was to ascertain whether the exceedingly good contact produced by casting the grid around the active material while the latter was hard, and allowing the molten metal to contract upon it, would operate to lessen the somewhat remarkable variations in the behaviour of all storage battery plates. But this was not the case, neither was there any marked difference in the behaviour of the Planté cell. The accompanying characteristic readings were obtained from the three types of cells at their normal discharging rates.

PASTED CELL.

At start. Amperes.	At start. Volts.	Eight hours after start. Amperes.	Eight hours after start. Volts.
6·00	2·035	6·00	1·77
5·93	2·025	6·15	1·79
5·90	2·024	6·125	1·795
5·89	2·021	6·05	1·78
5·92	2·025	6·025	1·78
5·92	2·02	5·85	1·74
5·95	2·022	6·10	1·80

* Paper read at the American Institute of Electrical Engineers.

PLANTE CELL.

—	At start. Amp	At start. Volts.	One hour after start. Amp	One hour after start. Volts.	Two hours after start. Amp	Two hours after start. Volts.	Three hours after start. Amp	Three hours after start. Volts.	Six hours after start. Amp	Six hours after start. Volts.
1	4·73	2·00	4·72	1·995	4·72	1·99	4·70	1·965	4·67	1·00
2	4·72	—	4·72	—	4·71	—	4·71	—	4·64	—
3	4·71	—	4·71	—	4·70	—	4·70	—	4·72	—
4	4·69	1·95	4·71	1·99	4·70	1·985	4·69	1·955	4·67	1·90
5	4·71	—	4·70	—	4·69	—	4·63	—	4·42	1·85
6	4·73	—	4·74	—	4·72	—	4·79	—	4·91	—
7	4·75	2·005	4·77	2·003	4·74	1·995	4·81	1·985	4·96	1·956

CHLORIDE CELL.

Positive.	At start. A.	At start. V.	One hour after start. A.	One hour after start. V.	Three h'rs after start. A.	Three h'rs after start. V.	Four h'rs. after start. A.	Four h'rs. after start. V.	Six hours after start. A.	Six hours after start. V.	Eight hr. after start. A.	Eight hr. after start. V.	Negative.
1	5·30	2·03	5·75	2·01	5·75	1·94	5·80	1·90	5·80	1·735	5·60	1·80	1
		2·065		2·04		2·00		1·965		1·89		1·78	2
2	5·43	2·035	5·40	2·015	5·45	1·965	5·40	1·935	5·45	1·86	5·30	1·80	2
		2·045		2·03		1·98		1·94		1·88		1·81	3
3	5·40	2·035	5·35	2·02	5·35	1·975	5·30	1·94	5·35	1·865	5·80	1·80	3
		2·035		2·02		1·96		1·95		1·87		1·80	4
4	5·43	2·045	5·40	2·03	5·40	1·985	5·40	1·955	5·40	1·88	5·85	1·80	4
		2·03		2·015		1·965		1·93		1·86		1·64	5
5	5·70	2·055	5·65	1·99	5·70	1·99	5·70	1·96	5·55	1·86	3·60	1·56	5
		2·02		1·925		1·925		1·87		1·66		1·26	6

A. Amperes. V. Volts.

The curious phenomenon was presented of variations of current amounting to 30 per cent. in plates manufactured rigorously alike, kept in parallel and subjected to like treatment during their previous life. In cases where the discharge is pushed below 1·8 volts I have observed even more serious differences, amounting to a variation of 225 per cent., one reading being 2·8 amperes, another 6·4 amperes for perfectly good new plates carefully treated.

And perhaps a still more curious fact was the differences of E.M.F. of the plates in the same cell discharging through equal resistances and connected finally in parallel to the same circuit—the E.M.F. ranging from 1·60 volts to 1·85 volts for neighbouring plates in parallel in the same cell, at the same time. On interrupting the circuit at the end of the discharge of a cell, a considerable flow of current, as might be expected, passed from one plate into another, and it was hours before the batteries reached equilibrium after the external circuit was open.

The discharge of one positive into its neighbour was a rather unexpected result. It had been thought that if one plate had less capacity than its neighbour it would simply stop discharging at a certain point, but that its E.M.F. would always be equal to that of its neighbours, and that therefore no current would flow.

The explanation of the phenomenon appears to be that the deficient plate keeps on discharging at a lower rate than the perfect plate, and finally reaches a much lower point of discharge. On interrupting the current the plate which has not been discharged so far rapidly recovers a higher voltage than its neighbour, and therefore discharges into it.

This effect must also take place in the different parts of any one plate, and may be a cause for the formation of peroxide on the surface of a negative plate after a discharge, a phenomenon which I have never noticed, but which has been remarked by too many observers to be ignored.

The two outside negatives give more than their proportional amount of current on discharge, the current being actually less than on the other plates, the potential remains higher, and the discharge is therefore a little greater. This in turn affects the positives next to them, and these positives are usually the first to disintegrate in a carefully used cell. This fact was most noticeable in batteries used on the Eckington and Soldiers' Home Railway at Washington, where out of 20,000 positive plates there did not occur a single instance of buckling, and yet the outside positives always showed greater disintegration than the others.

The tendency of one part of a plate or one portion of

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peroxide to discharge faster or slower than its neighbour is one of the reasons which induced us to adopt the equipotential methods of connecting up the several plates of the storage battery. It is to be noted that these phenomena occur to a serious extent only when the batteries are discharged below 1·95 volts of potential difference per cell.

The foregoing tables afford the most complete proof of the irregularity of the chemical actions which produce the E.M.F. of the battery. Now one plate is giving current, now another; and most remarkable of all, the different sides of the same plate exhibit differences of potential at their terminals which I can only attribute to differences of internal resistance, both in the electrolyte within the plates and in the porous active material itself.

The active material during charge and discharge is undergoing chemical change irregularly, not merely in the different plates, but in the different sides of the same plates, and as the active material is made up of large numbers of little pellets isolated from one another by the grid, the conclusion seems inevitable that one side of a given pellet is active to a different degree from the other side. It is not necessary to conceive that the E.M.F. generated on one side of a pellet is as different from the E.M.F. of the other side as would be indicated by the potential difference at the plate terminals. The more reasonable conception appears to be that the internal resistance of one side of a pellet is sometimes greater, sometimes less, than that of the other side, varying with the unequal chemical action. But I cannot escape the conclusion that there must be some real difference of potential, and consequently local action—not merely between the parts of the grid, but between opposite sides of the same pellet or paste. This would account for the fact observed by Ayrton that a working cell is always above the temperature of the air, even when its own temperature is falling in discharge.

In 1890, Prof. Ayrton in his most valuable contributions to storage battery literature independently noticed the fall of temperature in a discharging cell, and published a curve.

The explanation for at least a part of this phenomenon is simple. If, as we all know, the addition of sulphuric acid to water raises the temperature, it is natural to infer that the removal of the acid from the water will lower the temperature. The former occurs on charge, the latter on discharge.

(To be continued.)

THE GOVERNMENT AND THE NATIONAL TELEPHONE COMPANY.

The following correspondence between the Postmaster-General and Mr. Henniker Heaton, M.P., with reference to the bargain with the National Telephone Company has been published:

House of Commons, June 22, 1894.

Dear Mr. Arnold Morley,—I have to thank you for your reply to my question on the subject of the negotiations with the National Telephone Company, which is satisfactory so far as it goes. It still, however, leaves us quite in the dark as to the terms on which any full and final bargain can be effected.

May I therefore ask you to be good enough to state what, in the view of the Post Office, the Company is entitled under the existing license and agreement to claim consideration money for in the event (*a*) of an immediate purchase of all its rights and property by the State; and (*b*) in the event of a termination of the license by notice, or by effluxion of time, and of the Department desiring to acquire the company's wires, stock, and stations of exchange.

I am, dear Mr. Arnold Morley, yours faithfully,

J. Henniker Heaton.

P.S.—What I really desire to know is whether it is clearly stated in the license granted to the company that at the termination of the license they shall have no claim for goodwill or prospective profits. H. H.

The Right Hon. Arnold Morley, M.P., Postmaster-General.

Post Office, July 6, 1894.

Dear Mr. Henniker Heaton,—On the termination of the license in December, 1911, the right of the National Telephone Company to carry on telephone exchange business will cease and determine. All they will have to sell will be their plant, and even this the Government will be under no obligation to buy.

Believe me, yours very truly,

J. Henniker Heaton, Esq., M.P. Arnold Morley.

THE TENDERS FOR AYR.

We give below the list of tenders sent in for the supply of electric lighting plant for Ayr. The tenders, as mentioned in our "Business Notes," have been referred to the Electric Light Committee for determination.

Boiler-house Plant.	
James Neilson and Son	£1,762
John Cochrane	1,820
Yates and Thom	1,898
S. Z. de Ferranti	2,010
Siemens Bros. and Co.	2,058
Anderson and Lyall	2,075
Babcock and Wilcox	2,089
Woodhouse and Rawson	2,404
George Sinclair	2,431
Tinkers, Limited	2,700
Penman and Co. (part)	980
Wm. Arnott (part)	1,563
Daniel Adamson	1,505
Engine-house Plant.	
Woodhouse and Rawson	4,865
Siemens Bros. and Co.	5,940
Johnson and Phillips	6,365
John Fowler and Co., Leeds	6,602
S. Z. de Ferranti	7,412
Yates and Thom	7,626
S. Z. de Ferranti (alternative)	7,730
S. Z. de Ferranti (alternative)	7,786
J. Cochrane	7,885
G. and J. Weir (part)	290
Switchboard and Instruments.	
Woodhouse and Rawson	629
John Fowler and Co., Leeds	706
Siemens Bros. and Co.	758
S. Z. de Ferranti	795
Johnson and Phillips	902
Underground Work.	
Callender's Bitumen Company	1,842
Indiarubber Company	2,104
Indiarubber Company (alternative)	1,952
Fowler-Waring Cables Company	2,111
British Insulated Wire Company	2,146
S. Z. de Ferranti	2,231
John Fowler and Co., Leeds	2,509
Henley's Telegraph Works Company	2,540
Siemens Bros. and Co.	2,571
Hooper's Telegraph Works	2 651
Telegraph Manufacturing Company	2,774
G. E. Simpson	2,799
Walter T. Glover and Co.	2,886
International Electrical Submarine Company	2,897
Reid Bros.	3,043
William Pollock	4,038
Transformers and Boxes.	
Swinburne and Co.	420
J. Fowler and Co., Leeds	459
S. Z. de Ferranti	525
Manchester Edison-Swan Company	575
Siemens Bros. and Co.	581
Johnson and Phillips	665
Pritchetts and Gold	686
C. A. Parsons and Co	700
Arc Lamps and Posts.	
International Electric Company	318
John Fowler and Co., Leeds	476
Siemens Bros. and Co.	487
Johnson and Phillips	541
S. Z. de Ferranti	603
Woodhouse and Rawson	656
Claud Hamilton, Limited	712
Meters.	
Westinghouse Electric Company	423
Siemens Bros. and Co.	492
John Fowler and Co., Leeds	497
Chamberlain and Hookham	535
S. Z. de Ferranti	590
R. Millar	640
Overhead Crane.	
R. Millar	148
Carrick and Ritchie	192
Siemens Bros. and Co.	203
Appleby Bros.	216
Fullerton, Hodgart, and Barclay	223
Alex. Chaplin and Co.	228
Marshall, Fleming and Jack	234
Thos. Broadbent and Sons	235
Thos. Smith	241
Southgate Engineering Company	246
Bedford Engineering Company	254
Yates and Thom	264
Stothert and Pitt	270
S. Z. de Ferranti	291
Cowans, Sheldon, and Co.	297
John Fowler and Co., Leeds	302
Woodhouse and Rawson	304
Thornton and Crebbin	313

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THE HISTORY OF WOODHOUSE AND RAWSON UNITED, LIMITED,

As Detailed in the Bankruptcy Court.

The enquiry into the affairs of this Company was resumed on Friday before Mr. Registrar Hood, at Bankruptcy Buildings, Carey-street, Lincoln's-inn.

Mr. Samuel Pope, Q.C., in reply to the Official Receiver, stated that he was not one of the original directors, but was appointed on August 5, 1889, along with Sir Rawson Rawson and Admiral Sir Leopold McClintock. He did not see and was not a party to any prospectus which had been issued previously to the date of his election on the Board. At the first meeting he attended he enquired whether proper investigation had been made into the properties and he was assured by Lord Aberdare, the chairman, that the most careful enquiries had been instituted, and that it was unnecessary for him to lose more time or incur further expense in looking into the matter, because the directors had exercised the utmost care in ascertaining the truth and correctness of the statements in the prospectus. He did not, therefore, enquire whether the profits for 1888 of the old company, as shown by the balance-sheet of June 30 of that year, had been realised or not. He was not aware that the balance-sheet was to some extent qualified by a report of the auditors. He had an interview with Sir John Coode, who informed witness that he was retiring because he was not satisfied with the amount of the applications for shares. Asked whether he understood that the business was to be mainly industrial or financial, witness said he believed it to be of a mixed character, and although the industrial portion was to be the "backbone" of the business, yet it was contemplated that a large amount of profit would be derived from promotion and financial transactions. He considered that the fact of the Company having a good industrial business would be the means of giving them greater facilities for floating electrical companies. The mistake made by the directors was in believing that the "boom" in electrical companies would be perpetual. If it had continued, the Company would not have been in its present position. He made no enquiry into the value of the assets acquired. He was not aware that certain patents which the new company was to acquire had lapsed long before 1889. In 1890 the patents were valued in the balance-sheet at £66,000. Witness did not personally take any steps to ascertain whether that was their real value or not, but he had no doubt that the directors as a body obtained the opinion of those best qualified to value the patents. So far as he was concerned he would never have passed the accounts as being correct if the figures were not *bonâ fide*. One source of profit to the Company was the manufacture and sale of incandescent lamps. Proceedings were instituted by the Edison and Swan Company to restrain the United Company from making the lamps, but a compromise was effected, each party paying their own costs. He was not aware that the industrial business showed a loss in 1890 until some long time afterwards. He was appointed chairman of the International Okonite Company, and a cheque for £30,000 was paid to the United Company on account of promotion money. The cheque was held over for a week at the request of the former.

The **Official Receiver**: Did you know that in the meantime the United Company, through Mr. F. L. Rawson and certain nominees, was applying for shares, and that a portion of these application moneys were used in supplying the funds to meet this cheque?

Witness said he did not know this, and could not say whether the applications were authorised by the Board. He always endeavoured to keep his interest as a director of the Okonite Company distinct from his interest in the United Company. If he had been aware that the industrial branch of the business was being carried on at a loss, he would not have been a party to the representation made to the shareholders that it was not. The balance-sheet of 1890 included a sum of £88,106 in respect of profits made in the financial business, out of total profits amounting to £109,000. According to the figures given to him by the Official Receiver there would have been a loss on the industrial branch of £13,000, but he did not agree with the Official Receiver's arithmetic, and thought the matter was more for an accountant than a lawyer. In 1892 he became aware that there was a great leak in the industrial branch of the business, and he immediately began to adopt special measures to stop it. He was present at the meeting of shareholders when it was decided to return the dividend guarantee fund of £75,000 to the liquidators of the old company, and he thought that transaction was beneficial to the new company. The liquidators, according to the balance-sheet, was entitled to a credit of £42,000, and the result of the negotiations was that a sum of £12,000 was deducted from the total amount due.

The **Official Receiver**: But that credit was subject to the realisation of the profits?

Witness said he could not understand the term "realised profits." It might be a very prudent thing for a partnership to decide not to divide their profits until they were received. The whole matter seemed to turn upon the question whether, at the date of the balance-sheet, the assets were fairly and reasonably valued. The shareholders were entitled to claim their share of the profits, and the directors could not refuse to credit them with those profits. So far as he was aware, the assets of the Company had always been fairly valued. He believed that the Okonite Company was now a prosperous company. The American shareholders of that company had intervened and turned witness and all the other English directors out. He would not have been connected with the company if he had not caught the "electric fever." The Epstein Company was formed on the last day of the financial year, and a profit of £35,145 was credited in respect of the promotion of that company, and he considered that the shares were very valuable, and would still be valuable if money could be found to work the patent, which was a very good one. At present there was no market for the shares, but they might yet be of value.

The **Official Receiver**: The shares have been sold for a shilling apiece.

Witness explained that this was merely part of an arrangement, and did not represent the actual value of the shares.

Mr. H. G. Rawson said the suggestion was that the shares were only worth a shilling.

The **Official Receiver** said he did not suggest that; he only wished to give the Company the benefit of the shilling.

Further examined, the **Witness** said that during 1890 the United Company appeared to have been continually borrowing money. It was said that the directors wished to avoid making a call on the shares, but he had no scruples himself on that point. In November, 1891, the directors decided that greater care ought to have been exercised by the managers of the Company, and they set to work to endeavour to stop the continuing loss on the industrial business. From accounts extracted by the secretary, it appeared that during 1892 a total loss had been made by the industrial branch of £15,000. Witness was not aware of that circumstance when he agreed to the declaration of a dividend. The auditor had never represented to him that it would not be advisable to declare a dividend for that year. There was an issue of a debenture stock prospectus in February, 1891, in which it was stated that the proposed stock would, after the existing stock had been paid off, become a first charge on the entire undertaking. He was one of the trustees for that issue, which had not become a first charge, as the previous one had not been paid off. It might have been desirable that the circular should have set out the nature of the security more clearly.

By **Mr. Pilling**: He was a shareholder in the old company. According to his ledger of bad debts his interest was £1,498, which he transferred to the new company, applying for a further £250 worth of shares in order that there might be no question as to the legality of his election to the directorate. He had never disposed of a single share. The shareholders of the old company were given the option of taking cash in lieu of shares in the new company, and he very much regretted that he had not exercised that option.

Mr. Pilling: Were you ever informed that your shares were very much enhanced in value, even to the extent of four times their original value?

Witness: Like Lord Aberdare, I can say that no such dream ever entered my imagination.

Questioned upon another point, **Witness** said that Mr. Pilling was entirely at liberty to make any suggestion he pleased, but whether he accepted it was quite another matter.

Mr. Pilling: Were you not conscious throughout from circumstances which came to your knowledge that the Company had paid too large a price for the business?

Witness: You are asking me to make an admission that I was consciously committing a fraud, and you cannot expect me to answer that in the affirmative.

Continuing, **Witness** said he supposed, as a shareholder, that he had received all the profits he was entitled to. He had always done his best to look after the interests of the shareholders.

Mr. Pilling said that the directors appeared to know very little about the affairs of the Company.

Mr. Registrar Hood said that no doubt Mr. Pope was well able to protect himself, but the Court could not listen to the speeches made by Mr. Pilling, who was only entitled to elicit facts.

In reply to Mr. M'Kay, **Mr. Pope** said that he had never repudiated any responsibility for the prospectus of 1889, nor had he admitted any with regard to the statements which it contained. The same answer applied to the subsequent prospectuses. He declined to volunteer an opinion upon matters now submitted to him, as he never gave an opinion without being paid for it. He did not pretend to be an expert upon any subject, but if a case were submitted to him for his opinion he would be pleased to consider it.

By **Mr. H. G. Rawson**: He had recently invested money in the Epstein shares.

At the close of his examination, **Mr. Pope** said he desired to state that he had one crumb of comfort in knowing that neither he nor his colleagues on the Board had put one single penny into their pockets at the expense of the shareholders.

Mr. Stutchbury, formerly secretary of the Company, was also examined as to certain accounts.

TUESDAY.

Mr. W. T. Stutchbury, formerly secretary and afterwards general manager of the Company, was recalled and further cross-examined on Tuesday by Mr. Jenkins. He stated that he had prepared an analysis of the various balance-sheets issued by the Company. It appeared that the account for the year 1891 showed a loss on the industrial business of £24,603. The accounts he prepared, showing the position of the Company as a whole, disclosed a loss of £15,000. Witness was of opinion that the stock was taken at a higher figure than it ought to have been. He was not an expert, but thought that something ought to have been written off on account of depreciation. He believed that on one or two occasions he represented his view of the matter to some of the directors.

Mr. Jenkins: Did they take any notice of your representations?

Witness said that generally his suggestions were politely

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ignored. He had always been of opinion that the industrial business was a good one if it had been properly managed, and sufficient capital found to work it. He attributed the loss in this department to a great extent to the fact that there were too many departments, which were all, more or less, cutting the throats of the others; that there was no guiding hand over the whole concern; and that the works were scattered throughout the kingdom, necessitating a large expenditure for management. He also thought that sufficient care was not exercised in carrying on the business. At a meeting of the shareholders, held in 1892, witness made a speech in which he said that he believed the industrial business could be carried on at a profit, and that it only required more working capital to make the Company a success. He also said that his programme was "consolidation, retrenchment, and reform."

Mr. Jenkins: You considered that, although there might have been mismanagement in the past, the business was a good one, and could, with assistance, be developed into a paying concern?

Witness said that was so. He was informed by Mr. North, the former general manager, that in the earlier part of 1891 the industrial business was carried on at a loss. In spite of the loss the turnover of the business gradually increased. In April, 1892, witness was appointed general manager, and he immediately sent a circular round to the managers of the various branches expressing a desire that the businesses should be conducted in such a way as to work out at a profit. The shares and debentures in the International Okonite Company were included in the balance-sheet of 1891 at about £37,000. Witness had several conversations with the managing director as to the value of the shares. He did not pretend to be an expert so far as they were concerned, but he thought that as the Company had not realised any large amount for the shares or debentures they ought to have been taken at a lower value, and he still thought that would have been the wisest course to pursue. In the same balance-sheet, the Epstein shares were valued at £35,000. Witness did not think it was best to include the shares at par, and pass the amount as profit which had been realised, because they had no means of ascertaining the real value of the shares. The invention might have been, and might still be, a valuable one, but very few of the accumulators had been purchased. If he had been concerned in the matter he should have eliminated the £35,000, and included the amount expended upon the patent as a good debt. He knew nothing about the position of the Phœnix Trust, Limited, when the sum of £15,000 was included as the value of shares in that Company in 1891. He understood, however, that the profits of the trust were chiefly derived from floating companies in connection with the United Company.

By **Mr. Muir M'Kenzie**: He did not form any opinion as to the value of the patents at the time he joined the Company. He believed that the Company had a good future before it if it was properly managed. It seemed to him that the sum paid for the goodwill of the businesses (£97,000) was rather large. He understood that the old company was generally known as a promoting company.

Examined by Mr. F. L. Rawson, **Witness** said that if the stock and plant at the Kidsgrove branch had been revalued at £3,800 more than the Company gave for it the directors were perfectly justified in increasing the value to that amount. The Epstein shares were included at a discount of 10 per cent. at the suggestion of Mr. F. L. Rawson. Witness did not remember that Mr. Pope, Q.C., had said it was all "nonsense" allowing the discount, because they were worth their full face value. He had conversed with Sir Rawson Rawson as to the business of the Company, and he understood that gentleman was desirous of seeing the industrial branch extended. He did not think that the shareholders expected the profits on that business alone would pay the dividends of 15 per cent. Most electrical companies had made large losses, some to the extent of £15,000 or £20,000 a year. The competition experienced by the Company was so severe that the profits realised by it on each contract were so small as to be entirely swallowed up by the expenses. The Company had to keep up a large standing expenditure in the hope of getting more work in the following years. Witness endeavoured all he could to cut down the expenses.

By the **Registrar**: The competition was severe because the Company carried on dual businesses.

Witness further said that Mr. Rawson and the heads of departments had expended a considerable amount of labour and time in preparing the large catalogue, which time and labour was not charged for in the books. He should think that a sum of £2,000 would be sufficient remuneration for that work. The witness, shown a smaller catalogue prepared for Woodhouse and Rawson, Limited, thought that the charge for Mr. Rawson's time and the time of officials spent on its compilation and that charged directly in the books would be about £200.

Mr. Rawson: Would you be surprised to hear that it was worth £1,500?

Witness said that he would. He was not aware that the Press, in commenting upon the work, called it a history of electricity.

In reply to Mr. H. G. Rawson, **Witness** said that his relations with the chairman of the Company (Sir Rawson Rawson) were always cordial and confidential. That gentleman had given careful consideration to the views expressed by witness, and had on more than one occasion advocated them before the Board. Considering his age, witness considered that Sir Rawson Rawson was indefatigable in connection with the affairs of the Company. When the chairman told him that he expected the bulk of the profits would come from the financial branch, witness did not understand that he in any way discouraged the industrial side. He did not show Sir Rawson Rawson the trial balance-sheet of 1891, which disclosed a loss of £15,000. It did not appear to him to be reasonable to take into consideration the time spent upon a patent by an expert, because the invention might be valued at £20,000, and prove to be only worth 6d. With reference to the founders' shares, amounting to £25, which were subsequently included at £15,000 in a balance-sheet, witness said that before he consented to allow the latter sum to be included, he required Mr. F. L. Rawson to give him sufficient evidence that the shares were worth the amount. The evidence was produced and the shares were included in the amount stated.

By the **Registrar**: The reason for the severe competition and the small profits of the Company was that although their work was considered to be of the best kind, yet, owing to their financial business, their credit was not so good.

By **Mr. F. L. Rawson**: The directors were led by a former manager to believe that they had tided over all the difficulties of the industrial branch in 1891.

Sir Rawson W. Rawson, C.B., K.C.M.G., who was examined by the Official Receiver, stated that he was elected a director of the United Company on August 5, 1889, and attended the Board meeting held on the following day. He did not see, nor did he take any part in the preparation of, the prospectus before he joined the Board, as he was in the country at the time. He had not discussed the formation of the Company or the prospectus with his son.

The **Official Receiver**: Were you interested in any way in Woodhouse and Rawson, Limited, or any of the Woodhouse and Rawson companies?

Witness said that he was not. He was connected with another electrical company, but had nothing whatever to do with his son's companies. He was appointed a member of the works, finance, and contract committees, but there was not much work to do in connection with the last mentioned.

The **Official Receiver** then put to the witness a statement of Mr. Stutchbury's, which was to the effect that he had an interview with Sir Rawson Rawson upon the subject of the Company, when the latter stated that the industrial branch had been somewhat neglected, and that the directors looked to the financial business for a greater portion of the profits because they would probably bring out 10 companies where, in the past, they had only brought out one.

Witness said he did not think the statement was correct. He might have said that the directors hoped to obtain considerable profits from the financial business, but he had no recollection of making the other statements. He considered that the principal portion of the business consisted of the introduction of new electrical patents, and as the capital of the Company was so limited from the beginning, they were not in a position to work them, and it was therefore considered that it would be more profitable to the shareholders if the patents were transferred to other companies, from whom they might not only obtain an immediate sum, but also might become possessed of a future interest in the working of the patents.

The **Official Receiver**: Have you throughout parted with a single patent which you have acquired?

Witness said he could not remember whether they had done so or not.

The **Official Receiver**: Were not all these companies formed to purchase patents which you acquired after they had come into existence?

Witness said that he did not think this was the case. Further examined, he said he did not go minutely into the nature of any of the business acquired by the Company in order to ascertain whether they had been carried on at a profit or a loss. He could only remember that certain departments were represented as having made a profit. The gross income for the year ending June 30, 1890, was £109,000, a surplus of £61,085 being shown. He did not think that these profits ought to be considered exceptional, and they might have been repeated but for the Baring failure and the financial depression which followed. There was reason to believe that the statements in the prospectus would be realised. The Company confined itself to electrical matters, and the prospectus afforded ample scope for its operations. He contended that the statement in 1891 that the Company had a good reserve and favourable prospects was justified at the time.

The enquiry was then adjourned until the 20th inst.

LEGAL INTELLIGENCE.

A QUESTION OF TELEPHONE RENTAL

Judge Ellison has given judgment in the Sheffield County Court in the case where the National Telephone Company sued Messrs. Morris Bros., chemical manufacturers, Doncaster, whose works are at West Stockwith-on-the-Trent, to recover £50 rent due for a private wire. There was a counterclaim for £50 damages for alleged ineffective service of the telephone.

Mr. Ellison (instructed by Messrs. Webster and Styring) appeared for the telephone company, and Mr. Parkin (Messrs. Parkin and Co., Doncaster) represented Messrs. Morris Bros.

His **Honour** said the claim for rent was admitted, and therefore judgment would be entered for the amount. The counterclaim, with which he had only now to deal, was the damage alleged to have been suffered owing to the defective working and construction of the telephone. The damages were caused by delay in communicating between the works and the office of Messrs.

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Morris, which had caused delay in executing orders for goods, put the defendants to additional expense for delivery, and had caused their customers to refuse payment, and loss of time in unsuccessful attempts to obtain telephonic communication. The contract entered into was that Messrs. Morris should pay £100 per annum in advance for a term of years for the use of a private telephone wire and three sets of instruments between the works at Doncaster and the works at West Stockwith. The conditions of the contract were that, subject to the performance by Messrs. Morris of the conditions laid down, the company would maintain the telephone in good working order. One of the conditions was the payment of rent in advance, and in point of fact it had always been in arrear. Another clause was, "In the event of the said wire or apparatus not being in good working order, the company shall repair and restore the same at its own expense, and with all possible despatch, but the company shall not be held responsible or liable to the lessee in damages or otherwise howsoever for any delay provided it uses every reasonable endeavour to restore the communication as speedily as possible." From the letters and evidence, it appeared that on numerous occasions the wire was out of order, caused by all kinds of accidents, such as the falling of branches of trees, shooting, rain, and the fumes from Messrs. Morris's works. In every case where a complaint was made to the telephone company it was at once acknowledged and attended to. He thought the telephone company had a right to complain of the way in which Messrs. Morris had brought the counterclaim. It was very well observed the other day that in nearly all cases a counterclaim was the result of an afterthought, and until this action was brought Messrs. Morris never thought of claiming. When the claim did come, it was in the most unfair way a claim could come against a company. How could a company explain everything that happened to one particular wire during three years? The counsel for the defence relied somewhat on a letter written by Mr. F. W. Carr, who stated, "We guarantee that the communication between your office and works will be absolutely satisfactory to you, and that any repairs, should there be any, will be attended to at once." There was nothing to show that this gentleman had authority to bind the shareholders, and there was no consideration for this, as was the case in the contract itself. On the whole, he thought the telephone company had performed their contract as well as such a contract could be performed, because the wire must be subject to sudden accidents of all kinds. They seemed to have remedied the cause of complaints as soon as they were mentioned, and in his opinion had taken a great deal of trouble in doing so. In more than one instance a clerk walked the whole length of the wire—22 miles—to find out where the fault was. That was extreme carefulness on the part of the company. He found a verdict for the company. His Honour gave costs on the higher scale.

COMPANIES' MEETINGS.

ELMORE'S PATENT COPPER DEPOSITING COMPANY.

As stated in our last issue, an extraordinary general meeting of Elmore's Patent Copper Depositing Company, Limited, was held on Thursday last week at the Cannon-street Hotel, Mr. Joseph Todhunter, J.P., presiding, for the purpose of receiving the resignation of the directors, and appointing new directors in their stead.

The **Chairman** first alluded to the failure of the Board in their endeavour to raise £10,000 in debentures last November. Arrangements were made with the Company's bankers at Leeds, through the intervention of Mr. William Elmore, for an overdraft, not to exceed £15,000. As a result of a consultation which the directors subsequently had with Mr. Elmore, that gentleman secured the services of three gentlemen who were willing to take over the direction of the Company's affairs, who were well acquainted with the details of the trade.

It was resolved that the resignation of the directors be accepted, and that Messrs. John Marshall (of Sunderland), John North (of Leeds), and Edward Reynolds (of Sheffield) be appointed in their stead.

BUSINESS NOTES.

Barrow.—St. Mary's Church is to be lighted by electricity.

Great Northern Telegraph Company.—For the month of June the receipts were £24,000.

Station-Lighting.—Electric light is being introduced into the joint railway station at Aberdeen.

Cape Town and Suburban Electric Lighting Company.—A dividend of 5 per cent. has been paid.

Western and Brazilian Telegraph Company.—The receipts for the week ended July 6 were £2,378.

Birmingham.—Electric lighting is to be introduced in the Town Hall on the occasion of the Royal reception.

Telegraph Stores.—The South Indian Railway Company invite by the 24th inst. tenders for telegraph and other stores.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 8th inst. amounted to £918.

Putney Electric Supply Company, Limited.—This Company has been registered with a capital of £1,000 in £2 shares.

Telegraph Construction and Maintenance Company.—This Company have declared an interim dividend of 12s. per share.

Wakefield.—The Wakefield Corporation Electric Light Order has been read a third time in the House of Commons and passed.

Commercial Electricity Supply Company, Limited.—This Company has been registered with a capital of £2,000 in £1 shares.

Great Western Electric Light and Power Company, Limited. This Company has been registered with a capital of £1,000 in £10 shares.

Torquay.—The Holloway Electricity Supply Company intend to apply for a provisional order for the electric lighting of Torquay.

Notting Hill Electric Lighting Company.—A half-yearly dividend at the rate of 6 per cent. per annum has been declared on the preference shares.

Anglo-American Cable.—The steamer "Britannia" has arrived at Hearts Content, Newfoundland, with 190 miles of cable for the new Anglo-American cable.

Coventry.—The Corporation has affixed the corporate seal to the contract with Mr. C. G. Hill for the erection of the buildings for the electric light station.

Appointment Vacant.—An assistant engineer is wanted by the Derby Corporation for the electric light station. Particulars are given in our advertising columns.

Tenders for Nelson.—Tenders are invited for the wiring and fittings in connection with the new technical school. Particulars are given in our advertising columns.

Aberdare.—The Committee of the House of Commons on Unopposed Bills have passed the Electric Lighting Provisional Orders (No. 4) Bill, relating to Aberdare.

St. Pancras.—The Vestry has accepted the tender of Mr. J. O. Richardson, of Albert Works, Peckham, for £7,117, for erecting the central-station buildings, King's-road.

Globe Telegraph and Trust Company.—This Company announce a dividend of 3s. per share on preference and 3s. 9d. on ordinary shares, carrying forward £500.

American and Parisian Massage Company, Limited.—This Company has been registered, with a capital of £10,000, for the carrying on of massage and medical electricity.

Tenders for Cheltenham.—The Corporation invite tenders for six 12-kilowatt transformers and ten 6-kilowatt transformers. Particulars will be found in our advertising columns.

City and South London Railway.—The receipts of the Company for the week ended July 8 were £879, against £1,069 for the corresponding week of 1893, or a decrease of £190.

Edison and Swan United, Limited.—The eleventh ordinary general meeting of the shareholders will be held at the Cannon-street Hotel, E.C., on Thursday, the 26th inst., at 11 a.m.

Dover.—The electric light company have given notice to the Town Council that they intend to lay mains in Camden-crescent, Wellesley-terrace, the Castle end of East Cliff, and round The Lord Warden.

Accident at Prescot.—Last week a boy named Reuben Rogers received a fatal shock at the works of the British Insulated Electric Wire Company at Prescot. A verdict of accidental death has been returned.

Payment of Coupons.—The Submarine Cables Trust give notice that on and after the 13th inst. the sum of £1. 5s., balance of the coupon due April 15, 1894, will be paid by Messrs. Glyn, Mills, and Co.

New Companies.—The capital of the new electrical companies registered during the first six months of the current year amounted to £1,969,500, as compared with £1,002,000 in the corresponding period of 1893.

Egyptian Tramways Construction Company, Limited.—This Company has been registered with a capital of £6,000, to acquire, develop, and deal in tramway and railway concessions in Egypt and elsewhere.

Lighting of Locks.—Messrs. J. P. Hall and Co., of Blackriding Ironworks, Werneth, Oldham, have completed electric light installations for the Manchester Ship Canal Company at the locks at Barton, Irlam, and Latchford.

Plymouth.—The Bill confirming a provisional order of the Board of Trade, conferring powers on the Corporation of Plymouth for the electric lighting of the borough, has been read a third time and passed by the House of Commons.

The Hastings Tenders.—Last week we gave a list of tenders received for the supply of electric light fittings for the Queen's Hotel, Hastings. We now learn that the tender of Messrs. B. Verity and Sons has been accepted.

Islington.—The Special Electric Lighting Committee of Islington Vestry have approved the designs of Mr. A. H. Tiltman, F.R.I.B.A., for an electric lighting station to be erected in Holloway-road, at an estimated cost of £17,542.

Lighting of the Embankment.—The London County Council have received the following tenders for the erection of a generating station in connection with the electric lighting of the Victoria-embankment: Foster and Dicksee, £5,562; and Kirk and Randall, £5,916.

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Tenders for Bilston.—The Bilston Township Commissioners invite tenders for the electric lighting of their market house. Particulars are given in our advertising columns.

St. Luke's.—The St. Luke's Vestry have received notices from the engineer and manager of the County of London and Brush Provincial Electric Lighting Company, Limited, of the intention of the company to commence works in the parish.

Keighley.—At a meeting of the Keighley Town Council held on Tuesday, the town clerk was instructed to give a month's notice of a special meeting of the Council to authorise an application to the Board of Trade for electric lighting powers.

Yeadon.—The Board of Trade Provisional Order Bill empowering the Yeadon Local Board to supply electrical current by meter to consumers in Yeadon has passed through committee stage in the House of Commons. The Lords have already passed the Bill.

Portsmouth.—The Town Council propose to erect a refuse destructor at Eastney, and one of the Council suggested that it ought to be placed where it could be used in connection with the electric light station, but this proposition did not meet with support.

Hartlepool.—The Town Council have adopted a recommendation of the Lighting Committee empowering the Council to apply for a provisional order for electric lighting powers, but a special meeting of the committee will deal with the question before doing so.

Waterloo and City Railway Company.—Notice is given that the half-yearly general meeting of the shareholders of this Company will be held at the Waterloo Station, London, on August 9 for the transaction of the general business of the Company.

Lamp Agency.—According to an advertisement in one of the dailies, one of the largest factories of electric incandescent lamps seeks agents for England and the colonies. Applications are to be addressed to Incandescent, care of Mr. F. Algar, 11, Clement's-lane, E.C.

Helensburgh.—The Scottish House-to-House Electric Lighting Company having given notice to the Town Commissioners that they intended to apply for a provisional order for the electric lighting of Helensburgh, the Commissioners have resolved to oppose the application.

Tenders for Woking.—The Local Board invite by the 18th inst. tenders for the lighting of the Woking Station and Maybury Ward. A draft of the proposed contract can be inspected at the office of Mr. Robert Mossop, clerk, Bank-chambers, Woking. Tenders are to be sent to the clerk.

Eastern Extension, Australasia, and China Telegraph Company.—The interest on this Company's 4 per cent. mortgage debenture stock for the half-year ended 31st inst. will be paid by warrant on August 1. The stock register will be closed from 27th to 31st inst., both days inclusive.

Bowness.—The Local Board have received notice of the intention of the Troutbeck Company to apply to Parliament for powers enabling them to lay down plant for the supply of electric light within the Board's area. The clerk has been instructed to enquire into and report to the Board on the matter.

Stroud.—The Local Board of Health have received a letter from the captain of the Stroud Volunteer Fire Brigade (Mr. P. Ford), informing the Board that the brigade contemplated carrying out a system of electrical communication between the police station and the residences of their members at a cost of £31.

Direct United States Cable Company.—The directors recommend a final dividend of 2s. per share, free of income tax, making, with the interim dividends already paid, 2½ per cent. for the year ending June 30. The sum of £6,000 has been placed to the reserve fund account, and a balance of £1,032 has been carried forward.

Leeds Tramways.—The report to be drawn up on the system of haulage best adapted for the city, and to which we referred last week, has not yet been completed, the committee being still busy making enquiries. It is probable that some of the members will pay further visits to towns where different systems of haulage are in operation before the report is prepared. A trip to Douglas has been mentioned.

Morecambe.—The charges for the electric lighting service at Morecambe, as furnished by the Morecambe Electric Light and Power Company, Limited, have been increased as follows: for an 8-candle lamp, from 10s. to 12s. per annum; for a 16 candle lamp, from 20s. to 24s. per annum; and for a 32-candle lamp, from 40s. to 48s. per annum.

Barnet.—Messrs. Joel and Co. have written to the Local Board that they were about to apply during the session 1894-5 for a provisional order for the Barnet District Electric Supply Company to light the town of Barnet with electric light, and they forwarded the usual notices. The matter was referred to the Electric Lighting Committee.

Bradford.—The Bradford Bowling Green Club, Limited, have fitted up their bowling green with the electric light. The plant consists of a 4-h.p. gas-engine, and a Preece dynamo capable of lighting 60 incandescent lamps inside the club and four 1,000-c.p. arc lamps on the bowling green. Messrs. Andrews and Preece, of Bradford, laid down the plant.

Ambleside.—At a meeting of the Local Board, two letters were read, one from the Troutbeck Bridge Electric Works, and another from the Halloway Works, to give notice that they intend applying to the Board of Trade for a provisional order for electric lighting. It was decided to inform each company that the Local Board could not see their way to sanction it.

Chiswick.—The Works Committee of the Local Board have further considered the plans and elevations of the building at the pumping station for the electric lighting of the district, and instructions have been given to Messrs. Bourne and Grant to push on with the work as soon as possible.

Tenders for Watlington (Oxon.).—The Lighting Inspectors invite tenders for lighting streets, roads, and other places comprised in the parish either with oil or with gas, or any other illuminant. Tenders should be sent forthwith in a sealed letter, addressed to the Inspectors, Market-place, Watlington, of whom full particulars may be obtained.

Grange.—At a meeting of the Local Board a communication was read from the Windermere and District Electric Supply Company, Limited, giving the Board formal notice of its intention to apply to the Board of Trade for the supply of electricity for public and private purposes in this district. It was decided to refer the matter to the committee.

Shoreditch.—The Shoreditch Vestry have decided to memorialise the Board of Trade in favour of an extension of time within which to complete the electric lighting scheme. The appointment of an electrical engineer has been deferred to a future meeting. In connection with this matter it has been resolved to make application for sanction to borrow £12,300 for 60 years.

Water-Tube Boiler.—The Sanitary Works Committee of the Warrington Corporation invite tenders for the supply of a water-tube boiler. Specifications may be seen and further information obtained from Mr. James Deas, Longford Depôt, Warrington. Tenders to be sent to Mr. Deas by 23rd inst., addressed to the chairman of the Sanitary Works Committee.

The Clyde.—The Sub-Committee on Hydraulic Installation Building at Cessnock Dock recently approved of the plans as altered, and agreed that the buildings should be erected to these plans, at a probable cost of £11,600 for the whole buildings, which includes space for workshop, store, and electric lighting plant. The Clyde Navigation Trust have now approved this minute.

Scarborough.—The Scarborough Electric Supply Company, Limited, which has only been in operation about nine months, have already the equivalent of over 9,000 8-c.p. lamps connected to their mains. The directors, in order to meet further additions, have ordered from Messrs. C. A. Parsons and Co. another turbo-alternator to give 75 kilowatts, complete with condenser.

Tenders for Rugeley (Staffs.).—The Local Board desire by August 1 tenders for the lighting of the street lamps for the winter season, commencing September 1, 1894, and ending April 30, 1895. Particulars may be obtained of the chairman of the Lighting Committee, Local Board, Rugeley, to whom tenders should be sent. Mr. Robert Landor is the clerk to the Board.

Thames Ditton.—The members of the London Association of Foremen Engineers and Draughtsmen recently paid a visit to the works of Messrs. Willans and Robinson, at Thames Ditton, and were received by Mr. Mark Robinson and Captain Sankey. The members were split up into groups, each under the charge of a member of the firm's staff, and conducted round the various departments of the works.

Country-House Lighting.—Elveden Hall, in Suffolk, which has recently become the property of Lord Iveagh, is being fitted by its new owner with the electric light. About 500 incandescent lamps will be installed. The plant comprises two steam-engines and dynamos and accumulators. The work is being carried out by Messrs. Edmundsons, Limited, under the superintendence of Mr. A. A. C. Swinton, who, as consulting engineer, has arranged the installation.

Agency for Steam Accessories.—Messrs. Crosier, Mills, and Co., of Newcastle-on-Tyne and Sunderland, have been appointed agents on the north-east coast for Messrs. Holden and Brooke, Limited, of Salford, and are making a special display of injectors and other steam specialities at 58, Collingwood-street, Newcastle-on-Tyne, where they invite inspection of the Meldrum patent furnace, Richards's side planer, the Morse valve-reseating machine, and other labour and money saving devices.

Edmonton.—The Local Board have further considered the application of the Tottenham and Edmonton Electric Light and Power Company for sanction to apply to the Board of Trade for power to light part of Edmonton, from Tottenham boundary to Silver-street, with electric light and energy. The engineer and secretary of the company attended before the Board for the purpose of explaining its objects. The clerk was instructed to apply for the names of the gentlemen forming the company.

Tenders for Carshalton.—The Local Board invite by the 18th inst. tenders for the lighting of their district (consisting of the entire area of the parish of Carshalton) with gas, oil, or other illuminant, at per lamp, exclusive of the cost of columns, frames, and lanterns, for 12 months from 31st inst. Tenders, marked "Public Lighting," and addressed to the chairman of the Board, must be delivered at the Board Offices, High-street, by the date mentioned. Mr. Chas. P. Lovelock is the clerk to the Board.

Telegraphy to Singapore.—The chairman of the British North Borneo Company mentioned, at a meeting of the Company on Tuesday, that cable communication had been successfully established between Singapore and Labuan, and the directors had arranged with the Eastern Extension Telegraph Company, in consideration of this, to continue a land line across to Sandakan. They believed communication could be established for about £5,000, but, of course, this would only mean a rough track across country.

Paddington.—The Vestry have accepted the tender of Messrs. Dawson, Hammond, and Co., of John-street, Edgware-road, for

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fixing private telephone wires (metallic circuit) and three sets of instruments connecting the Vestry Hall, Bridge House Wharf, and 11, 12, and 13, wharves. The Electric Lighting Committee of the Vestry have been instructed to ascertain from the Metropolitan Electric Supply and other companies if they are prepared to enter into an agreement to light the streets with electricity, and at what cost.

Birkenhead.—At a meeting of the Town Council, a letter was read from Mr. Robert Walker, Sandford-street, stating that the ratepayers of the borough were going to be called upon to provide a large sum of money for electric lighting. The cost of this could be largely avoided by obtaining from the Mersey Tunnel Company the 100,000 tons of water daily lost in being pumped into the Mersey. This force could easily be diverted into another course, and would thus drive the machinery and light up the whole town. The letter was allowed to lie on the table.

Lighting of the City.—The returns of the City of London Electric Lighting Company for the June quarter show that the revenue from the sale of current for public lighting amounted to £3,162, as compared with £2,838 for the corresponding period of last year, and the revenue in respect of private lighting was £7,153, as against £3,074. The total revenue is £10,315, being an increase of £4,401 over the same quarter of last year. The number of 8-c.p. lamps or their equivalent now connected is 99,140, as compared with 45,562 in June of last year.

National Telephone Company.—The directors have resolved to recommend the following dividend, less tax, for the eight months ending June 30 at the rate of 6 per cent. per annum on the amount paid up on the first and second preference shares, 5 per cent. per annum on the amount paid up on the third preference shares, and 5 per cent. per annum on the amount paid up on the ordinary shares, making, with the interim dividend already paid, 5 per cent. per annum for the 14 months ending with June. The balance left is about £67,000.

Eastbourne.—At a meeting of the Town Council, Councillor Martin asked the chairman of the Lighting Committee if he would consider the advisability of erecting an extra electric lamp opposite the top of Victoria-place, which he said was one of the darkest spots along the front. There were two or three small lamps that might be done away with, so that there would be no extra cost. A powerful electric light would enable visitors to inspect the beautiful carpet beds at night-time. Alderman Homewood, in reply, said the committee would, of course, gladly consider the suggestion.

Bromsgrove.—The Local Board on Wednesday received an application by letter from Messrs. Hemming and Co., electrical engineers, Birmingham, for the consent of the Board to the laying down electric lighting plant in Bromsgrove, so that they might apply to the Board of Trade for a license. Mr. Giles said he believed the applicants intended to lay down the greater part of their plant at Bromsgrove. As some members of the Board thought it was necessary that enquiry should be made before the matter was decided, he gave notice that he would bring it before the next meeting.

The City Polytechnic.—The foundation-stone of the third and last building of the City Polytechnic was laid on Monday by Mr. Charles Dorman. The City Polytechnic consists of the Birkbeck Institute, the City of London College, and the Northampton Institute, and a member of one institute enjoys the advantages of all three. The last named is being erected in St. John's-street-road, Clerkenwell. When completed there will be workshops for instruction in carpentry, turning, smith's work, clockmaking, plumbing, bookbinding, dressmaking, cooking, wood-carving, and the manufacture of electrical apparatus.

Provisional Orders.—The Committee of the House of Commons on Unopposed Bills have passed and ordered to be reported for third reading the Electric Lighting Provisional Orders (No. 3) Bill, confirming certain orders relating to Oswestry and Shrewsbury, and the Electric Lighting Provisional Orders (No. 4) Bill, confirming an order relating to Birmingham. These Bills have already passed the Upper House. The Bills passed by Mr. Mellor have included Bills to confirm provisional orders made by the Board of Trade under the Electric Lighting Acts, relating to Aberdeen, Chelmsford, Guildford, and elsewhere.

Brechin.—The clerk has reported to the Police Commissioners that on the instructions of the Lighting Committee he has written to the Northern Electric Light Supply Company, Aberdeen, who had intimated their intention to apply for a provisional order authorising the company to make an electric light installation in Brechin, putting several questions on the point. He also stated that he had received another notice from the House-to-House Electric Light Company, Glasgow, intimating their intention also to apply to the Board of Trade for a provisional order for supplying Brechin with electricity. The Commissioners decided to leave the matter in the hands of the Lighting Committee to consider and report.

Wolverhampton.—The Town Council have decided to renew the contract with the gas company for the supply of gas to the public lamps, etc., for 12 months, on the same terms as those contained in the previous contract, but subject to any variation rendered necessary by the laying down of the electric plant by the Corporation. Mr. Stevenson asked that the Council should enforce the fair-contract resolution passed by them in respect of the contractor who was erecting the electric lighting station in Commercial-road, and who, he said, had violated it by sub-letting a portion of the work. Alderman Jackson said that he knew nothing of the matter, and the town clerk stated that the Mayor would make enquiries and report upon it.

Monmouth.—There is some difficulty regarding the obtaining of a site for the drainage and electric lighting works. Messrs. Bramwell and Harris have written to the Town Council that the suggested buildings for the electric light station have all had to be rearranged. With regard to the provisional order, a letter was read from the Corporation's parliamentary agents in the matter (Messrs. Burchell and Co.) stating that the provisional order was read three times in the House of Commons and three times in the House of Lords, when it was referred back again in order that the compulsory and other areas should be certified. The borough surveyor was instructed to give the required certificate.

Sale of Plant.—Messrs. Wheatley Kirk, Price, and Goulty will sell by public auction, on Tuesday, Wednesday, and Thursday next, the contents of the works situate at St. Neots, Hunts, hitherto carried on by Mr. George Bower. The machinery includes lathes, drilling machines, planing machines, light and heavy plate-bending machines, punching and shearing machines, screwing, shaping, grinding, and other machines, cupolas, cranes, shafting, etc. The stock includes new horizontal steam-engines, exhausters, liquor pumps, new steel, bar iron, piping, etc. Catalogues may be obtained of Mr. Alfred Good, 57, Moorgate-street, London, E.C.; Mr. C. R. Wade-Gery, solicitor, St. Neots, Hunts; or of Messrs. Wheatley Kirk, Price, and Goulty, 49, Queen Victoria-street, E.C.

Hastings.—At a meeting of the Town Council, the Roads Committee reported that they were informed by the borough surveyor that the manager to the Hastings and St Leonards Electric Light Company, Limited, told him it would be very inconvenient to alter the site of the circuit-chamber proposed to be constructed under the public pavement opposite Messrs. Amoore and Son's premises at Robertson-street, the plan for which was, on the committee's recommendation, formally disapproved by the Council at the last monthly meeting. Under the circumstances, the committee now recommended that the plan for the chamber in the position indicated be approved, subject to the company undertaking not to remove the upper surface or cover of the chamber except between the hours of 10 p.m. and 9 a.m., unless in case of actual emergency. This was carried.

Church-Lighting.—The Castle-gate Congregational Church, Nottingham, was on Sunday evening experimentally lighted by electricity. The church was connected by electric cables with Messrs. Perry's factory in Stanford-street, and the installation was entrusted to Messrs. Danks and Co., Thurland-street, whose representative, Mr. Greenall, superintended the arrangements. The church was effectively illuminated by a large number of delicately-tinted lamps in various colours. A committee, specially appointed for the purpose, with the minister—the Rev. R. B. Brindley—at its head, carefully considered several modes of arranging the lamps. Mr. W. Longdon (Messrs. Danks's electrician) had charge of the installation. In the event of the scheme being adopted, it is proposed to make a permanent installation during the cleansing and redecoration of the church.

West African Telegraph Company.—The Company's revenue for the 12 months amounted to £61,847. 1s. 5d., against which £18,828. 19s. 1d. is charged for ordinary expenses, and £20,492. 5s. 11d. for expenditure relating to repairs to cables, etc. After providing £1,026. 6s. 1d. for income tax and £214. 8s. 3d. due to revaluation currency balances at stations, there remains a balance of £21,285. 2s. 1d., to which is added £2,410. 9s. 10d. brought forward from the preceding year, making a total balance of £23,695. 11s. 11d. From this balance there is deducted £12,495. 11s. 11d. for interest on debentures, and £11,200 for sinking fund. The total expenses attending repairs and renewals of cables, etc., amounted to £31,233. 17s. 6d., but the directors have decided to apply from the general reserve fund the sum of £10,741. 11s. 7d. to meet the deficit which would otherwise have appeared.

Halifax.—Upon the minutes of the Gasworks Committee coming up for confirmation at a meeting of the Town Council last week, Alderman Whitaker drew attention to the fact that they were introducing the electric light, and said that if the latter took well and became widely used the consumption of gas might decrease. He therefore counselled that in the interests of the ratepayers expenditure on capital account at the gasworks needed to be very carefully watched, and no more expenses ought to be decided upon. Applications for the electric light in Halifax continue to advance apace, and it is now pretty clear that considerably before the installation is completed the whole of the current will be taken up. The Masonic Hall Management Committee have decided to light their place throughout, and have entrusted the work to Messrs. Walter Emmott and Co., of Thomas-street, Halifax.

Ayr.—At a meeting of the Ayr Town Council on Monday night tenders for the introduction of the electric light, numbering in all 49, were submitted. The work was offered for in eight sections. The lowest offer amounted to £10,138, and the highest to £16,991. The lowest offer by one firm was £12 760—namely, Messrs. Siemens. Mr. James Smith, the convener of the Lighting Committee, stated that the offers had been submitted to Mr. Hammond, engineer for the work, and under his advice the committee had agreed to accept offers amounting provisionally to £11,834, which was somewhat under the original estimate. He pointed out that the aggregate of the lowest offers was £10,138. 0s. 6d. It was eventually agreed to remit to the Lighting Committee with powers to accept the offers referred to subject to certain adjustments, on the understanding that the aggregate would not exceed £12,000.

Brasyer v. Harness.—The action brought by Colonel Brasyer, C.B., against Mr. C. B. Harness and Dr. McCully, to recover money alleged to have been obtained by false pretences, and in

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which the defendants counterclaimed for damages for malicious prosecution, was concluded on Tuesday before Mr. Justice Charles and a special jury in the Queen's Bench Division of the High Court. The jury said they could not agree whether Harness had been guilty of obtaining money by false representation, but they were agreed that Dr. McCully was not guilty; with regard to the charge of negligence and unskilful treatment, they were agreed that both defendants were not guilty. In reference to the cross-action the jury could not agree, and said they were evenly divided. Mr. Justice Charles gave judgment in favour of Dr. McCully in the action, with costs, and reserved the other questions for further consideration if desired.

Annual Excursion.—The employés of Messrs. Rashleigh Phipps and Co. held their annual excursion on Saturday last. Proceeding by an early train to Brighton, a pleasant morning was passed in and upon the water, after which the company, numbering the whole of the available staff of the firm, sat down to dinner, at which the usual toasts were proposed. In the afternoon the party proceeded in brakes and carriages to the village of Southwick, where the annual cricket match between carpenters and wiremen was played on the village green. The weather was all that could be desired, and the whole affair passed off with the most perfect success. We may mention that this firm is at the present time particularly busy with the electric lighting of a large number of private houses, principally in the London district, and notwithstanding the slackness usually prevailing at the present time in the electrical trade, the number of employés who attended the annual excursion exceeded last year's number by nearly 50 per cent.

Eastern Telegraph Company.—The report of the directors for the half-year ended March 31 last states that the revenue for the period amounted to £389,314, from which are deducted £102,218 for the ordinary expenses, and £49,660 for expenditure relating to repairs and renewals of cables, etc., during the half-year. There remains a balance of £233,813, to which is added £86,252 brought from the preceding half-year, making a total available balance of £320,066. From this balance there have been paid interest on debentures and debenture stock, dividend on preference shares, and an interim dividend of 2s. 6d. per share on the ordinary shares, leaving a balance of £222,001, from which £110,000 has been carried to general reserve fund. The directors now recommend the declaration of a final dividend for the year ended March 31, 1894, of 2s. 6d. per share and a bonus of 3s. per share, free of income tax, making a total distribution of 13s. per share, or 6½ per cent. for the year on the ordinary shares. The receipts for the month of June were £53,752, as against £62,564 for the corresponding period of 1893.

Bristol.—The Executive Committee for the restoration of Bristol Cathedral have generally agreed that the choir should be lighted by electricity and not by gas, but the precise method, whether by pendants or otherwise, has been postponed for future consideration. The Electrical Committee of the Bristol Town Council have been informed that the Local Government Board have sanctioned the borrowing of £24,650 additional capital for the purposes of the installation This sum will enable the committee to clear off existing liabilities and to make a few extensions. For example, the proposal to light the Cathedral and St. Mary Redcliff by electricity will be made possible by extending the mains in those directions. It is hoped, also, that sufficient money will be available for further extensions in order to promote private lighting in Clifton, whence the committee expect a profitable return in due course. Over £9,000 of the loan will be necessary for paying off the extra expense of the central depôt, which, on account of the unexpected piling and the additional accommodation provided, cost that amount more than was originally estimated.

Salisbury.—At a meeting of the Town Council the Town Clerk stated that he had received notice of the application of the Salisbury Electric Light and Supply Company, Limited, to the Board of Trade under the Electric Lighting Acts, 1882 and 1888, for a license. He had also received the following letter on the subject from Mr. Gramshaw: "1, Shorter's-court, London, July 4, 1894. Dear Sir,—I beg to enclose for the use of the Corporation six copies of the license as applied for to the Board of Trade. The kind way in which I have been met by the Council prompts me to ask for an early consideration of the same, as the company is anxious to proceed at once with its various arrangements.—Yours truly, W. H. Gramshaw." The Mayor remarked that whilst they warmly welcomed the electric light company to the city, there were certain interests which they as a Council had to safeguard. He did not know whether or not they might think it desirable that they should engage an electrical expert to advise them on any point which might arise affecting their interests. He had already received several applications for the appointment. After some discussion, it was resolved that the question should be referred to the General Purposes Committee, with instructions to appoint an expert at a cost not exceeding £50.

The Birkbeck Building Society.—The forty-third annual meeting of the Birkbeck Building Society was held last week at the offices, 29 and 30, Southampton-buildings, Chancery-lane. The report adopted states that the receipts during the year which ended March 31 last reached £10,014,003, making a total from the commencement of the society of more than 173 millions (£173,311,217). The deposits received were £9,102,698, and the subscriptions £218,366. The gross profits amounted to £220,833. The surplus funds have been augmented by £176,146, and now stand at £5,903,479, of which £1,732,248 is invested in consols and other securities guaranteed by the British Government, and the cash in the hands of the bankers is £449,814. A further sum of £25,000 has been added to the permanent guarantee fund, thus bringing up the amount to £175,000, and the balance £155,439, making together £330,439 in excess of the liabilities. The whole amount is invested in consols. The subscriptions and deposits withdrawable on demand amount to £6,053,681. The fourteenth triennial bonus on investing shares has been allotted, and the amount placed to the credit of all shares in existence at the close of the forty-third year is £52,237. The surplus funds (which are invested in convertible securities) are sufficient to pay the depositors 111¾ per cent. on the amount of their deposits.

Cardiff.—The Corporation Property and Markets Committee have decided to appoint the chairman and deputy-chairman of the committee to act with the chairman and deputy-chairman of the Lighting Committee, and the Mayor is to make arrangements for lighting the Town Hall, market, and other public buildings by electricity. The preparations for the lighting of Cardiff by electricity are progressing apace, and, as far as the street work is concerned, the pipes are all laid and most of the cables have been drawn in. Only two or three lamp pillars for street illumination remain to be erected, as their precise positions have not yet been decided upon. The building of the electric lighting station has been completed, and nearly the whole of the machinery has been delivered, and is now being fixed. The district to be lighted is that comprised in the compulsory area, and includes Queen-street, Castle-street, Duke-street, St. Mary-street, Custom House-street, Bute-street, from Custom House-street to the Hayes Bridge, the Hayes, Working-street, Wharton-street, and Church street. Mr. W. Harpur, the borough engineer, has stated that he thought everything would be ready for a start on September 1. They would supply private consumers at 6d. per Board of Trade unit, which was an exceedingly moderate price (being 2d. below the maximum allowed), and they hoped to get a large number of customers. The streets would be lit by 48 arc lamps. Private consumers would be supplied with the low-tension current for incandescent light and high tension for arc lights.

Rochdale.—A question was asked by Councillor Diggle at a meeting of the Town Council last week, whether the committee, in deciding to purchase two new boilers, had considered the advisability of the General Purposes Committee working with them with the view of making the new boilers generate power for supplying the electric light to the public buildings in the town? He moved as an amendment that boilers of 120lb. pressure be obtained, and that the committee be requested to use the additional power for lighting the public buildings of the Corporation by electricity. Councillor Turner, learning that the amendment was not seconded, said that he would move instead that the boilers obtained be boilers of the dimensions stated, but that they be made for 120lb. pressure, instead of 80lb. The time of day was passed for 80lb. pressure in boilers; the pressures generally worked were from 100lb. to 150lb. Whatever was the outcome of the electric lighting scheme, the Health Committee ought to provide themselves with high-pressure boilers. Councillor Diggle said he would second Councillor Turner's amendment. Councillor Turner's amendment, which was carried, was read by the deputy town clerk as follows: "That the minutes of the proceedings and resolutions of the Health Committee be approved with the exception of the minute referring to the purchase of two Lancashire boilers, and that such be referred back to the committee with the recommendation that any boilers purchased should be capable of working at 120lb. pressure at the least."

Belfast.—The new buildings to be erected from the designs of Messrs. Young and Mackenzie for the Young Men's Christian Association are to be lighted by electricity. Mr. Peach, of London, the architect for the new central lighting station in Chapel-lane, was in Belfast the other day, and visited the site and works. The adoption of the report of the Electric Committee, which recommended the payment of sundry accounts, was moved on Monday by Alderman Pirrie at a meeting of the Corporation, and was seconded by Councillor Andrews. Councillor Harrison asked if the chairman of the committee could give any information as to the time when they might expect to see the electric light in operation. Alderman Pirrie said that everything was going on remarkably well. The laying of the wires in the streets was proceeding in accordance with the contract, and was up to time, and the building of the central station was progressing very rapidly. He had no doubt but that by September he would be able to mention the date when the electric light would be on. Councillor Harrison said he would like to know if any information could be given as to the relative cost of the two systems of lighting. Some information should be given on this subject in order that people might know what they would have to pay for the electric light. Mr. Meyer said the committee had fixed 7d. per unit, subject to a discount as the price. Councillor Harrison said that did not answer his question. Mr. Meyer said electrical engineers were at variance as to the comparative cost, and, therefore, a layman could not give an answer. After further discussion the report was passed.

Whitehaven.—The chairman of the Town and Harbour Trust at a meeting last week referred to an application to the Local Government Board for increased borrowing powers on electric light account. He said they would remember that the original application to the Local Government Board for powers to carry out the electric lighting order was for £14,000. At the enquiry that was held, Dr. Hopkinson presented a supplementary estimate, which involved a large increase of the works, more especially with regard to the mains; and his estimate for the extra work was £7,000. An application was made at the enquiry that the amount of loan to be sanctioned should be £21,000 instead of £14,000. However, the Local Government Board gave their sanction to the £14,000 only, as required by Dr. Hopkinson's original estimate.

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The work that was included in Dr. Hopkinson's original estimate had all been carried out, at an expense of £12,294. 14s., which was some £1,700 under the original estimate of £14,000. But in carrying out this work from time to time there had been certain additional works sanctioned by this Board, especially the extension of the mains to Arrowthwaite, and the extension to Hensingham-road. These two outlying places were not included in Dr. Hopkinson's original scheme. Then there had been also a great number of lamps added at places not previously lighted by gas, where it was found highly desirable lamps should be placed; and there had been altogether 43 lamps more erected for public lighting than was specified in the original contract. The result was that the extras over and above the original contract amounted to £3,199. 19s. 2d., and the proposal of the Electric Lighting Committee was that this Board should ask the Local Government Board now to sanction the borrowing of £4,000. This motion was adopted.

Taunton.—Since the works of the electric light company have been acquired by the Town Council a number of important alterations and extensions have been made with a special view to increased efficiency and economy. The alterations have been carried out on the advice of Dr. Fleming, the electrical adviser of the Council. Iron guards have been provided to protect the belting and other exposed dangerous parts of the machinery. The boiler plant, which was previous incomplete, has been supplemented by an "Economic" boiler, made by Messrs. Davey, Paxman, and Co., and capable of evaporating 4,400lb. of water per hour, or about 105 nominal horse-power. The old cast-iron steam-pipes have been taken down and a new system of steel drums and wrought-iron pipes fixed. The additions to the engine and dynamo plant consist of a 50-h.p. Bumsted and Chandler engine, driving a 30-unit Thomson-Houston alternator at a speed of 1,500 revolutions per minute, by means of belt gearing. The engine runs at 380 revolutions per minute. The new underground conductors are laid on the "transformer sub-station" system, where the high-tension current is led direct to large transformers in some convenient building, close to the area of supply, from whence low-tension cables distribute energy to consumers on the "three-wire system." No. 1 sub-station, which is now completed, is under the Municipal Buildings. A high-tension, concentric armoured cable, made by the Fowler-Waring Company, composed of 19 strands of No. 18 S.W.G. wire, runs from the works to the sub-station. Here it is led by means of suitable switching gear to two 30-kilowatt transformers, which supply current at 200 volts pressure to three feeders which convey it to the consumers' houses. Mains are laid around the Parade, and along sections of High-street, East-street, and North-street, making a 220 yards radius from the Municipal Buildings. The Town Council on Friday considered a favourable report by Dr. Fleming on the electric lighting works recently acquired by the Town Council. The lights in use last October numbered 1,055 of 16 c.p., whereas now it is 1,674.

Montrose.—The question of introducing the electric light into the town was again under consideration at a meeting of the Police Commission on Tuesday, when Mr. Whiteman, convener of the Lighting Committee, moved that the Commissioners apply to the Board of Trade for a provisional order. He thought that such an order should be asked for. Seeing that two companies were already in the field proposing to supply the light, it stood to reason that those companies had good prospects of deriving a profit from their speculation, or else they would not have applied for permission. When an order had been obtained they could then proceed to get all the information necessary as to the probable expense, and they might decide to arrange with some company to supply the lighting, when the fact that they had obtained such an order would enable them to make better terms with competing companies. The Chairman, in seconding Mr. Whiteman's motion, stated that in terms of the Act they could not settle anything at that day's meeting, seeing that one clause of the Act specially provided that no application for a license could be made by any local authority unless a resolution was first passed at a special meeting of the local authority, of which at least a month's notice had been given. His special reason, however, for seconding Mr. Whiteman's motion was that he thought it was very undesirable in the public interests that they should be thrown into the hands of any private company. Mr. Strachan moved that, instead of applying for an order for themselves, they should entertain the application of the House-to-House Electric Supply Company. He was satisfied that the carrying out of an installation could not be accomplished on more favourable terms than those offered by that company. Mr. Strachan failed to find a seconder to his motion. On the suggestion of the Provost, Mr. Whiteman agreed to alter his motion to the effect that as the Board did not consider it expedient to accept the offer of any private company, a special meeting of the Commission should be called for the purpose of taking into consideration the present state of affairs, and the expediency of applying for an order for themselves. After further discussion, this motion was adopted.

Walsall.—The Corporation of Walsall having applied to the Local Government Board for the necessary sanction to the borrowing of £22,000 for the purpose of electric lighting, an enquiry took place at the Town Council Chamber on Friday morning last week before General Henry Darley Crozier, R.E., inspector. There were present the Mayor (Councillor T. P. Brownhill, J.P.), Councillor Marshall, Councillor Noake, Mr. Tindall (gas engineer), Mr. R. H. Middleton (borough surveyor), Councillor William Smith, Alderman Lindop, Alderman Newman, the town clerk (Mr. Cooper). The Town Clerk (Mr. J. R. Cooper) stated that the population of Walsall stood at 75,000 according to the most recent estimate, and was rapidly going up. The estimated value was £151,210. Regarding the scheme, the area of supply was the whole of the borough. The borough was of a very scattered character, the total length being about seven miles, and an average breadth of about three miles. Over 60 miles of public highways were possessed. There had been no application by any person or company within the area to provide electric lighting. The attention of the Council had been engaged some time on the subject, and Mr. Frederick Brown was called in by them as adviser. It was upon his advice, and after having inspected some of the best electric lighting stations in London and the provincial towns that they concluded that the high-pressure system was best adapted to the town of Walsall. Mr. Cooper, continuing, said they wanted a system capable of meeting the full requirements. Lying to the north of the borough there was practically another town containing about 12,000 people; he referred to Bloxwich. In all probability there would be a demand made upon them to supply that part of the borough. The scheme had been submitted to and approved by the Board of Trade. As to the site of the works, the Corporation proposed to appropriate part of the site of the Wolverhampton-street gasworks. Up to the present time the town had been supplied with two gasworks, both belonging to the Corporation—one at Wolverhampton-street, which was an old works established some 40 or 60 years ago, and the other a modern works at The Pleck about 20 years old. This year the Corporation were abandoning the Wolverhampton-street works for the purpose of the manufacture of gas, but would still use them as a storing station. It was proposed to appropriate 2,370 square yards as a site for the station. It abutted on the canal and was conveniently situated for the purposes of a generating station. Mr. Brown then rose and explained the working of the scheme in some detail.

Gas and Electricity at Blackpool.—In our issues of June 22 and 29, we gave an abstract of the paper read by Mr. William Chew before the Incorporated Gas Institute on the "Gas and Electricity Supply of Blackpool." Some correspondence on the subject has since been published in a Blackpool paper, and in this connection Mr. J. Hesketh, the borough electrical engineer, replies as follow: "My natural antipathy to appearing in a public controversy has been my excuse for letting previous criticism connected with the electricity works pass unchallenged. But when from the utterances of the assistant gas engineer are drawn distorted conclusions acting against this department, I must beg your indulgence if I intrude myself. Mr. Chew's paper contains much interesting information. That with reference to the gas department he has every reason to be confidently proud upon. That with reference to the electrical department, I think, would have been better held over until at least a year's working had given more reliable averages than can be obtained from the midsummer results. A word as to the results up to March 25, 1894. The charges in the totals given by Mr. Chew included all charges, such as preliminary trials of machinery, tests, etc. This point should not be lost sight of. It makes a large proportion of the total cost. By far the most important point, however, is the one which is raised: that at an output of 4,000 units a week, can we hope to produce electricity at a paying cost? Mr. Chew's deductions are admirable so far as they go. The only regret I feel is that he has not investigated the possibility of this output being reached and placed it before your readers. The unfortunate impression is given that it is Utopian to expect this demand. Let us see whether or no we can hope for it. We have installed in Blackpool at the present moment over 2,500 16-c.p. lamps. These absorb 160 units every hour they are used. Mr. Chew's experience enables him to give four hours as the average time an ordinary lamp is used daily. Then 160 units by four hours per day gives 3,840 units per week, neglecting Sunday. But this does not include the arc lamp consumption, which is at the rate of 40 units per hour. As arc lamps in Blackpool are used only till midnight, we can only take an annual consumption of, say, 1,500 hours per lamp—this is a low estimate. Therefore, 60,000 units are to be used annually in this service alone, or, say for simplicity's sake, 1,000 per week. That with the incandescent lighting, brings up the output average to 4,840 units weekly. I am aware that this glaring conflict of facts arrived at by legitimate deduction with those deduced from Mr. Chew's appears at first sight rather strange, and I may therefore be allowed to point out where I imagine the error has crept in. Mr. Chew says 'the plant has reached its maximum capacity,' and one argues therefrom to a rather false conclusion. True, the plant has reached its maximum capacity at any one moment. But it requires no demonstration on my part to show that the maximum demand being reached for a brief moment or two at the turn of a summer night, is no measure whatever of the earning capacity of that plant when the nights lengthen. It is the omission of this 'time factor' (if I may be permitted to use an almost technical term) which falsified the almost necessary deductions from Mr. Chew's paper. I would emphasise that these calculations are on our present connections. We have in view many more. I may perhaps now be allowed to extend the point raised by the gas engineer, and draw attention to the output on which electricity works have paid and will pay. Newcastle in 1891 paid on an average delivery to consumers of slightly under 5,000 units weekly, in 1892 of 6,000, and 1893 of 6,500 (roughly). Dublin has an average of 6,500 weekly, Brighton of 5,000, and Bradford of 9,000. These are not large figures, and if I might venture a pertinent question, I would ask what gasworks on an output of the equivalent to 4,000 units weekly—that is, an output of 400,000 cubic feet of gas—would venture to sell at less than 5s. per thousand? This puts the cases on the same level. The gasworks

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produced during the year ending March 25, 1894, 242 million cubic feet, or an average of slightly over 4,650,000 cubic feet weekly. This is equal to 46,500 units of electricity, or rather more than 10 times the amount on which we are asked to show profits approaching those of the gasworks. With a demand approaching 5,000 units weekly these works will pay, and until it is seen whether the average weekly output will reach this amount I think judgment should be deferred. As the demand increases, and the nights lengthen, the cost will be reduced, and I trust that then even the most anxious to cavil will have no opportunity. I am sorry that there still seems some doubt as to the system on which we are working. I think that an extract from Mr. Chew's paper might have given the idea he wished to convey, and at the same time strengthened the public knowledge if it had been worded somewhat thus: 'One result of the rapid development of these new electricity works has been that the expensive system of separate transformers in separate houses has, in view of the large demand at the end of six months, been advanced to that of distribution from half-a-dozen transformers placed in the streets.' This will naturally in the development of the business have to be still further extended to several more, as the demand increases, forming what are known to gas engineers as town governor-houses. I am not anxious to question the reasonableness of expecting any works during their first year's working to do more than strengthen that which they hold. I trust only that in endeavouring to vindicate the claims we have laid to public confidence I do not betray that of our Corporation in giving figures which to the present date at least can only be experimental, and until the time when they can be officially presented to the ratepayers are only known under the head of "Private and Confidential.'"

PROVISIONAL PATENTS, 1894.

JULY 2.

12767. **Improvements relating to electric incandescent lamps.** William Henry Willatt, 22, Jalland-street, Holderness-road, Hull.

12817. **Improvements in electric incandescent lamps.** Albert Zobel and Fritz Buchmüller, 18, Buckingham-street, Strand, London.

JULY 3.

12861. **New or improved electrical fishing apparatus.** Edward Poppowitsch and Herman Wüstenfeld, 34, Southampton-buildings, Chancery-lane, London. (Complete specification.)

12870. **Improvements in electric switches.** Claud Hamilton, 70, Wellington-street, Glasgow.

12875. **Improved alternating-current meter and method of measuring alternating currents.** John Forrest Kelly and William Stanley, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

12877. **Improvements relating to the operation and control of steam machinery or other mechanism by means of electricity, and in apparatus therefor.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (John Dunlap Williamson, jun., United States.) (Complete specification.)

JULY 4.

12928. **Improvements in or in connection with the commutator brushes of dynamos.** John Alfred Edmondson, 2, East-parade, Leeds.

12946. **Improvements in arc electric lamps.** Samuel Sealy-Allin and William Henry Wood, 52, Woodstock-road, Bedford Park, London.

12965. **An improved contrivance for automatically switching on and off electric currents suitable for many purposes.** George Bett Blanchard and Arthur Ballance, 8, Quality-court, Chancery-lane, London.

12972. **Improvements in electric arc lamps and current regulators therefor.** Stefan Doubrava and Josef Donát, 6, Bank-street, Manchester. (Complete specification.)

12982. **Improvements in electric arc lamps.** James Brockie, 28, Southampton-buildings, Chancery-lane, London.

12991. **An automatic cut-out for electrical heating and cooking appliances.** John Alexander Macmeikan, 97, Newgate-street, London.

12993. **Improvements in the electrolytic separation of gold from ores.** Alexander Cruickshank, 40, Chancery-lane, London.

JULY 5.

13018. **Improvements in electrical firing keys.** Herbert Vivian Keeson, 40, Loudoun-road, St. John's Wood, London.

13042. **An improved contrivance for automatically switching on and off electric currents, also suitable for many purposes.** George Bett Blanchard and Arthur Ballance, 8, Quality-court, Chancery-lane, London.

13063. **Indicating lamp failures in electric lighting circuits and apparatus therefor.** George John Tom Jelley Parfitt, 4, South-street, Finsbury, London.

JULY 6.

13078. **An electric resistance switch improvement for lowering incandescent lamps.** Edward Russell Cummins, 38, Gracechurch-street, London.

13082. **A method of and apparatus for fixing or erecting telephonic, telegraphic, or other wires.** Charles Shore, 2, Old Market-chambers, Yorkshire-street, Rochdale.

13115. **Improvements in telephonic transmitters.** Guillaume Arnaud Nussbaum, 29, Ludgate-hill, London.

13136. **Improvements in or appertaining to submarine telegraph and like cables.** Herbert Arnaud Taylor and Joseph Arthur Lovel Dearlove, 124, Chancery-lane, London.

13148. **Improvements in electrical measuring and recording instruments.** Haydn Thies Harrison, 46, Lincoln's-inn-fields, London.

13157. **Improvements in means for insulating electric cables.** Georg Eduard Heyl, 37, Chancery-lane, London.

13158. **Improvements in electric fuses.** Georg Eduard Heyl, 37, Chancery-lane, London.

13160. **Improvements in the manufacture of electric cables.** George Gatton Melhuish Hardingham, 191, Fleet-street, London. (The firm of Felten and Guilleaume, Germany.)

JULY 7.

13182. **Improvements in electric light ceiling roses.** Charles Richardson and Edward Herbert, Cornbrook Park-road, Manchester.

13208. **Improvements in field magnets for continuous-current dynamos.** William Henry Allen, Richard William Allen, and Charles Cæsar Hawkins, York-street Works, Lambeth, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1893.

16028. **Compensating variations of lead at electrical stations.** Siemens Bros. and Co., Limited. (Siemens and Halske.)

16175. **Electrical fittings.** Lundberg.

1894.

5796. **Underground conduit systems for electric railways.** Petersen.

6046. **Effecting electrolysis of saline solutions.** L. A. P. and H. E. A. Lienard.

7645. **Underground conduits for electric railways.** Brand and Franklyn.

7879. **Reflectors for electric arc lamps.** Coerper.

8273. **Shade tilt for electric light pendants.** Claremont.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	5	5¼-5⅜
Bournemouth Electric Company	—	—
Brighton and Hove Company Original	100	210-215
—— "A" Ordinary	—	162-166
Brush Company, Ordinary	3	2⅞-3
—— Nom. Cum., 6 per cent. Pref.	2	2⅛-2⅜
—— 4½ Debenture Stock	100	109-112
Charing Cross and Strand	5	4½-5¼
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	12½-13
—— 6 per cent. Cumulative Pref.	10	14-14½
—— 5 per cent. Debenture Stock	115	127-130
City and South London Railway, Consolidated Ordinary	100	36-38
—— Debenture Stock	100	119-121
—— 5 per cent. Pref. Shares	10	12½-13
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2⅞-3
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	95-100
Elmore's French Company	2	⅛-¼
Electric Construction, Limited	2	⅛-¼
—— 7 per cent. Cumulative Pref.	2	1⅛-1⅜
Elmore's Copper Depositing	2	1⅛-1⅜
Electricity Supply Company for Spain	5	—
Elmore's Wire Company	2	¼-1⅛
Fowler-Waring Cables	5	¼-1⅛
W. T. Henley's Telegraph Works, Ordinary	10	6⅞-7⅛
House-to-House Company	5	1-1⅛
India Rubber and Gutta Percha Works	10	23½-24½
—— 4½ per cent. Debentures	100	103-105
International Okonite, Ordinary	10	1-2
Kensington and Knightsbridge	5	4½-5½
Liverpool Electric Supply, Ordinary	5	6½-6⅝
—— Pref.	—	—
Liverpool Overhead Railway	10	8½-8¾
—— Pref.	10	12⅞-13¼
—— 4 per cent. Mortgage Debentures of £100	100	110-112
London Electric	5	¾-1⅛
Metropolitan Electric Supply	10	8¾-9
—— 5 per cent. Reg. Debentures, 1-10,000 in Bonds of £10, £20, and £40	—	109-112
National Telephone, Ordinary	5	4⅝-4¾
—— 6 per cent. Cum. First Pref.	10	14½-15½
—— 6 per cent. Cum. Second Pref.	10	14-15
—— 5 per cent. Nom. Cum. Third Pref.	5	5¼-5½
—— 4½ per cent. Deb. Stock	—	109-112
Notting Hill Company	10	4¼-5¼
Oriental and Electric Company, £1 shares	1	⅛-¼
—— £5 Shares	—	5⅛-6⅛
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7-7½
—— 7 per cent. Pref.	5	8¼-9
Swan United	—	—
Telegraph Construction and Maintenance	12	40-42
—— 5 per cent. Bonds	100	102-105
Westminster Electric Supply, Ordinary	5	6⅛-6⅜
Yorkshire House-to-House	4½	4¼-4⅜

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NOTES.

Electric Lighting in Berlin.—The Berlin Electricity Works intend to extend their mains.

Matabeleland.—Telegraphic communication between the Cape and Buluwayo has been opened.

Telegraphy in China.—It is stated that Pekin will shortly be connected direct with St. Petersburg.

Blackpool Electric Tramway.—The electric cars on this line have, we are glad to say, now been again set in operation.

Flensburg.—The new town theatre is to be supplied with an electric light installation by the General Electricity Company of Berlin.

Electric Lighting at Frankfort-on-the-Maine.—A large new church, the Peterskirche, is being built here, and will be lighted electrically.

Electric Lighting at Biarritz.—The central station is expected to be completed in September. The Grand Hotel is putting up an independent installation.

Society of Chemical Industry.—This society held its annual general meeting in Edinburgh on Wednesday, Mr. Stanford, the president, occupying the chair.

Atmospheric Electricity.—A discharge of atmospheric electricity has destroyed the telephonic system in the Spanish Cortes and frightened some of the members.

Treguier.—In the electric lighting of this small town, situated on the Cotes-du-Nord, a Davey-Paxman semi-fixed engine and two Rechniewski dynamos are to be laid down.

Aix.—The inhabitants of Aix-en-Provence are urging the Municipal Council to establish electricity works so as to remove the burden imposed upon them by the local gas company.

Electric Lighting at Hengersberg.—An electric light installation has been started in this Bavarian town by Mr. Steininger in his mills. There are two dynamos driven by means of turbines.

Marseilles.—The local gas company, which also supplies electric light, has made experiments in street-lighting with arc lamps at the request of the Town Council, and now an extension is being made.

Freiberg (Saxony).—An industrial exhibition has been opened here, and will be kept open till the middle of August. The various buildings are connected by an electric mining tramway.

Electric Lighting at Weissenfels.—The Municipality have decided to build a central electric light station. The work will be carried out by the German Electricity Works of Aix-la-Chapelle.

Electricity at Zittau.—The Municipality propose to erect a central electricity station here. Circulars have been issued in order to ascertain the probable demand for current for light and power purposes.

The Latest from the States.—The American papers state that an electric light is to be placed in the Fire Island lighthouse, off New York, the candle-power of which is estimated to be 450,000,000 candles.

Traction in Paris.—It appears that the promoters of electric traction in Paris have not been very successful, since the Compagnie Générale des Omnibus is laying down the Mekarski compressed-air system.

Traction in Switzerland.—The construction of the electric tramway at Champel-Petit-Saeonnex, Geneva, which is being carried out for the Compagnie des Tramways Suisses, is being rapidly pushed forward.

Thurgau.—A movement is on foot in Switzerland for the establishment of telephonic communication between Kreuzlingen and Frauenfeld, with a further extension between Kreuzlingen, Schaffhausen, and Basle.

Electric Lighting at Gebweiler.—A syndicate has been formed to introduce the electric light at Gebweiler. It is proposed to use the water power of the Lauch for this purpose, a head of about 1,300ft. being available.

Poitiers.—Extensions which are being made in the electric lighting of this town include a Weyher and Richemond steam-engine, and a Brown alternator giving 2,400 volts at a frequency of 80 periods per second.

Morez.—This industrial town in the watch manufacturing district of Jura is to be lighted by electricity. Power is to be obtained from the Grandvaux lake, so as to supply 6,000 lamps and electric motors of 300 h.p.

Messrs. Naglo Bros., Berlin.—This firm of manufacturers of telegraph and telephone plant and electric machinery have erected new works at Treptow, near Berlin. All the machinery is run by means of electromotors.

Electric Lighting at Wynau.—Dr. Budde, of the firm of Messrs. Siemens and Halske, has been visiting Wynau, in Switzerland, in connection with the erection of a central electric light station there. Work is to be commenced shortly.

Telegraph Subsidy.—The *Indian Engineer* states that the European telegraph companies which work together with the Chinese Telegraph Administration, derive a yearly subsidy from Russia in connection with the Siberian lines.

Personal.—Dr. Kaiser, of Hanover, has been called upon to succeed Prof. Henri Hertz in the chair of instruction in physics at the Bonor University. Prof. F. Kohlrausch, of Strassburg, has gone to Berlin as the successor to the late Prof. Kundt.

Pressburg Electric Traction.—The Ministry of Commerce has approved of the agreement of the Pressburg Municipality with Messrs. Werner, Ganz, and Co. for the construction of an electric tramway, but has laid down as a condition that the plant must be made in Hungary.

Incandescent Lamp Action.—The appeal of M. Augé against the judgment delivered in favour of the Compagnie des Lampes Incandescentes Edison-Swan, who had proceeded against him for infringement of lamp patents, has been dismissed by the Paris Court of Appeal.

Association of Municipal Engineers.—We understand that a large party of the Incorporated Association of Municipal and County Engineers will pay a visit to Belgium next month, and that the electric tramway and central station in Brussels and the Antwerp Exhibition will be inspected.

French Electro-Metallurgical Companies.—According to a French contemporary, it is stated that an agreement has been come to between the Compagnie Française des Métaux and the French Elmore Company whereby vexatious competition between the two concerns will be avoided.

Electrical Workmen.—It is noteworthy that the Chambre Syndicale des Ouvriers Electriciens (Chamber of Electrical Workmen), of 13, Rue Aumaire, Paris, has established a sitting every evening from 8.30 to 10 p.m., where managers of electricity works can find men capable of doing all kinds of work.

Electric Traction in Austria.—The Austrian Minister of Commerce has authorised the construction of the following local railways, on which possibly electric

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traction will be adopted: between Stag and Golling, between Gosaumühle and Gohausen, between Obertraun and Lahn, and between Golling and Bluntau.

Amsterdam.—The new town theatre is being fitted with the electric light by the Hamburg agency of the General Electricity Company of Berlin. The installation will comprise 2,000 incandescent lamps, 12 arc lamps, and four electromotors. There are two horizontal compound engines each of 60 h.p. It is also proposed to light the town hall by electricity.

Electric Lighting at Borkum.—The Dorf and Strand Hotels, both of which belong to the same proprietors, and which are about three-quarters of a mile apart, are being electrically lighted by the Bremen agents of Messrs. Schuckert and Co. The generating station is close to the latter of the two hotels, and the three-wire system is being employed.

A Telephone Action.—The Liège Court of Appeal has given judgment in the action brought against the Société des Téléphones by the Compagnie Continentale Edison. In the first instance the Namur tribunal nonsuited the Edison Company. The Liège court has, however, nullified this judgment, and concluded that if the use of the induction coil has become public property, the plate in the Blake apparatus constitutes an improvement, and cannot be employed in the Edison apparatus without a previous understanding with the company owning the latter.

Obituary.—The death is announced of M. M. P. Lemonnier, one of the founders of our French contemporary *L'Industrie Electrique*. The deceased, who was formerly connected with the firm of Sautter-Lemonnier, which on his retirement became Sautter, Harlé, and Co., was president of the Société Internationale des Electriciens in 1888. We also have to record the decease of M. Edmond Julien, whose type of accumulator is well known; of M. Pierre Houry, wire and cable maker; and of Prof. A. Kundt, who succeeded Prof. Helmholtz at the Berlin Physical Institute.

Illuminating Power of Search-Lights.—Mr. F. Nerz treats in the *Elektrotechnische Zeitschrift* of July 5 of the illuminating power of search-lights, with special reference to the large projectors made by the Schuckert Company. The author examines various criticisms made by Prof. Silvanus P. Thompson, Mr. Carl Hering, and M. Blondel, and concludes by stating that the efforts made by that company in the direction of getting introduced an accurate system of determining the lighting powers of search-lights should receive the attention and support of all interested in this branch.

Telephony in Nottingham.—The commencement of operations in the building of the new post office in Queen-street has rendered it necessary for the National Telephone Company to remove their wires, which run directly over the site. Pending their removal and for future service a cable is being laid underground from the central office to Ilkeston-road, where it will be connected with a distributing pole, which will supply the wants of the subscribers of the neighbourhood. It is expected that the work, which is being carried out under the superintendence of Mr. R. C. Bennett, district manager, will be completed in October.

Appointment of City Inspector.—The City Commission of Sewers on Tuesday elected an electrical inspector at a salary of £250 per annum. There were 88 candidates, and this number was reduced to three, whose names were Mr. T. A. B. Carver, 26; Mr. O. C. Gerhardi, jun., 25; and Mr. A. A. Voysey, 30. Each of these candidates had been approved by Mr. W. H. Preece, the electrical adviser of the Commission. Mr. Voysey, who gained 32 votes against 22 by Mr. Carver, was elected. Mr. Voysey, in thanking the Court, promised he would serve the Commission faithfully and well. A grant of 10 guineas each was made to the two unsuccessful applicants.

Production of Chromium.—It is stated that M. Moissan has succeeded with his electrical furnace in preparing for the first time chromium in a pure state. On Monday, before the Academy of Sciences, he was able to show, according to a Paris correspondent, the relatively large quantity of 40lb. of this rare metal. It is entirely free from carbon, does not scratch glass, can be filed easily, and is whiter than iron. It is untarnishable, and acids have no action on it. M. Moissan purifies it in his electric furnace in presence of a double oxide of calcium and chromium. M. Moissan exhibited to the Academy new alloys of chromium with aluminium and copper which are tough, malleable, and untarnishable.

Large Armature Stars.—A pair of probably the largest armature stars or carriers in the world has recently been made for the Siemens and Halske Electric Company, of America, who will put them down for street railway service at Toronto, Ontario. The machines when completed will weigh about 60 tons each, and have a nominal capacity of 1,200 kilowatts, or 1,600 e.h.p. each, under 50 volts pressure, and will be over-compounded for 12 per cent. drop in the lines. They are to be directly connected to a pair of horizontal cross compound condensing engines making 80 turns per minute. The armature stars are 13ft. in diameter, and weigh something over 10 tons each. The brush carriers will be about 14ft. 6in. in diameter.

Telegraphy with the Far East.—As we mentioned in a note in our issue of 6th inst., the commemoration of the twenty-fifth anniversary of the establishment of submarine cable communication with the Far East is to be celebrated at the Imperial Institute this evening. The Prince of Wales and the Duke of Cambridge will be present. A distinctive feature of the proceedings will be the arrangements made for entering into direct communication with different parts of Europe, Asia, and Australasia, Africa, and America. The apparatus for effecting this will be grouped on the four corners of a large table placed in the centre of a room, and from the different instruments messages will be despatched and answers received while the Prince of Wales remains in the room. Among other communications, the Prince of Wales will send a message to the Viceroy of India. It is anticipated that Lord Elgin's reply from India will be handed to his Royal Highness within 150 seconds of the despatch of the message from the room.

Large Electric Motor.—At a recent meeting of the Société Internationale des Electriciens, M. J. Rey presented a communication on the efficiency of a 720-h.p. motor. This motor, which has been constructed by MM. Sautter, Harlé, and Co., is intended for driving the submarine boat, the "Gustave Zédé." It is of the six-pole type, and has two equal armatures coupled in quantity and arranged on a common shaft. The measurement of the commercial efficiency of this motor has been carried out according to the Hopkinson method, suitably modified, and which consists in connecting rigidly the two armatures opposed to each other, one working as a motor and the other as a generator. M. Rey gave details of the tests and the calculations made therefrom, and from which it appeared that the commercial efficiency was equal to 92·44 per cent. The efficiency calculated before the motor was constructed was 92·15 per cent. The author concluded by stating that it is possible to construct powerful direct-current motors which will only vary by 1 per cent.

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from the estimated efficiency and that obtained when the machines are built.

Electricity at the Antwerp Exhibition.—Before the Société Internationale des Electriciens on the 4th inst., M. L. Brunswick presented a communication on a visit to the Antwerp Exhibition. He stated that the exhibition only comprises direct-current machines which have interesting constructive features, among others mentioned being the Manchester type of the Compagnie Internationale d'Electricité de Liège. Only one German firm, that of Schuckert and Co., makes a display, the company being the suppliers of search-lights to the Belgian Government. The lighting of the exhibition is effected by 220 arc lamps and 1,500 incandescents, the work having been carried out by MM. Dulait and Pieper. The electric motors in operation during the day drive ventilators, pumps, and mining plant. The navigable balloon is not yet at work. Among the steam-engines mentioned by M. Brunswick as being shown are those of the Corliss, Sulzer, Willans, and Brown types.

Cost of Working an Electric Elevator.—Mr. Morgan I. M. Williams, A.M.I.C.E., gives the following statement as to the cost of working an electric elevator. The elevator in question was erected under his supervision for Mr. E. D. Stern, at 4, Carlton House-terrace, at the commencement of the present year; the contractors for the work being the Otis Elevator Company. The elevator itself is fitted with a 600lb. car, having a rise of 40ft., and designed to work at the rate of 60ft. per minute, and is fitted with all the latest improvements in regard to self-acting safety appliances. It is operated from within by a simple regulating switch, which can be worked quite well by a woman or child; and everything has so far given great satisfaction. The current is supplied from the mains of the local supply company, whose invoice for the last quarter shows that the cost of current for working during the last three months amounts to the sum of 9s. 2d., during which time the lift has been in regular use, the number of trips being probably about 400, the cost of an average journey amounting to from one farthing to one-third of a penny, according to the load.

Indicating the Position of Vessels.—Before the Royal United Service Institution recently, Lieutenant Charles W. Sleeman, R.N., described an invention claimed to be applicable to any vessel designed to be run and directed without human agency actually present in the vessel itself—*i.e.*, by means of an electric cable "paid out" from the vessel as she proceeded ahead. Its purpose was to indicate the point of the compass on which such a vessel was heading at any moment during its run, this being notified to the person at the distant station who is directing the vessel or torpedo. The invention, which Lieutenant Sleeman explained by means of models and drawings, consists of an ordinary ship compass electrically combined with a specially devised reversible "step-by-step" instrument, and a small battery. These are placed in the vessel, and a recording key instrument, a galvanometer, and another small battery are required at the station from which the vessel is directed. When the vessel or torpedo is in the water ready for running, and with all the wires connected, the operator, the lecturer stated, can ascertain in what direction the vessel is pointing by moving his key until the galvanometer is deflected. Subsequently the operator has only to watch the galvanometer, and by moving his key he is enabled to regulate the course at will to any point of the compass. The steering of the vessel, or torpedo, as the lecturer explained, was a function of control altogether apart from and independent of his "compass-steering invention." He claimed that by his invention "a controllable vessel" of any kind could be steered on a compass course, even when entirely invisible to the operator, and quite as readily as though the operator were actually on board, instead of at a considerable distance. The "compass-steering" invention was originally worked out with the object of applying it to controllable torpedoes, in order to avoid the use of the masts or floats attached to these weapons in such manner as to be visible to the operator.

Tic Douloureux and Electricity.—In reference to the note on this subject in our last issue, Mr. W. S. Hedley, M.D., writes to the *Lancet* as follows: "The letter of Dr. Althaus lends support to the contention that in cases of trigeminal neuralgia surgical interference ought, as a rule, to be withheld until electrical treatment has been duly tried. The long-continued application of very weak continuous currents, as advocated by Dr. Althaus, is a proceeding of recognised value, and had the more rapid expedient failed, it would doubtless have been proper in the case quoted to persevere in the use of other and slower methods. By a sublime effort of faith and patience the application of the fractional part of a milliampere of continuous current for an hour a day during a period of three successive weeks might even have been carried out. It is, however, to avoid such a necessity that I venture to suggest a trial of this quicker procedure when the current in question is available, and the medical man knows how to handle it. In gauging the relative merits of various methods, it is not to be forgotten that a course of treatment extending over a period of three weeks allows to come into play so many other possible factors in the process of cure that it becomes proportionately difficult to distinguish the exact relationship of cause and effect. This can scarcely be mistaken in the case referred to. It is cited as an instance in which the results of a single electrisation are certainly not less striking, and possibly not less permanent, than those claimed for one of the most difficult operations known to surgery."

Detecting the Presence of Electric Oscillations. Prof. Elihu Thomson, in the New York *Electrical Engineer* of July 4, mentions the following curious and rather amusing illustration of the principle upon which the beautiful instrument for detecting the presence of electric oscillations devised by Dr. Lodge, and called by him the "coherer," is based: "It was reported to me when in Philadelphia that a certain electroplater had found that he could not pursue his silver-plating operations during thunderstorms, and that if he left his plating over night and a thunderstorm came up the work was invariably ruined. I was disposed to be thoroughly sceptical, and expressed my disbelief in any such effect. Being urged, however, I went to the silver-plater's shop, which was a small one, and questioned the silver plater himself concerning the circumstance which had been reported. While it was evident that he was not a man who had informed himself electrically, I could not doubt that, after conversing with him, he had indeed been stating what was perfectly true—namely, that when his operations of plating were going on and a thunderstorm arose, his batteries, which were Smee cells, acted as though they were short-circuited, and the deposit of metal was made at too rapid a rate. The secret came out on an inspection of his connections. The connections of his batteries to his baths were made through a number of bad contacts, which could not fail to be of high resistance under ordinary conditions. I could readily see that virtually he was working through a considerable resistance and that he had an excess of battery power for the work. Under these circumstances a flash of lightning would cause coherence of his badly contacting surfaces, and would improve the conductivity so as to cause an excessive flow of current,

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give a too rapid deposit, and—as he put it—'make the batteries boil.' The incident suggests the use of Dr. Lodge's ingenious instrument in the study of the waves which are propagated during thunderstorms, of which waves we have practically little or no information."

Village-Lighting.—An excellent example of village illumination is to be found at Auffay, which has a population of 1,500 persons distributed over an area of about a square mile. About 800 metres from the centre of the town there was a fall of water actuating an ancient type of waterwheel capable of giving a maximum of 7 h.p. This wheel has been replaced by a Hercules turbine of 12 h.p., running at 145 revolutions a minute, whilst a steam-engine of equal power has been put down as reserve. Having thus provided a regular power, the company established in adjoining buildings wood-working machines, and leased them to a carpenter on condition that he superintended the working of the dynamo serving to light the village. The distribution is effected at 110 volts notwithstanding the rather considerable extent of the service; a feeder is carried 800 metres, and the most distant lamp from the end of the feeder is about 800 metres. The loss provided for in the feeder is 15 volts, and the loss from the arrival point of the feeder to the lamps is from two to three volts. The weight of copper in the mains, which are arranged for 250 lamps, is about six tons, and of the 250 lamps 120 are already connected to the network. The generating station contains a single dynamo of the Postel-Vinay type, giving 80 amperes at 120 volts, and space is available for a second machine. The pressure at the end of the feeder is kept constant by an automatic rheostat, and as the dynamo runs without displacement of the brushes and without sparking, it is only necessary to start the dynamo at dusk and leave it to work at its own sweet will. The turbine and steam-engine generally work simultaneously during the daytime, but at night, when the carpenter has finished work, the steam-engine is stopped and the turbine alone remains in operation. The public illumination is effected by means of 32 16-c.p. lamps and one of 32 c.p. It is stated that notwithstanding the small number of lamps in use (120) the working results during 1893-94 allowed of a distribution of a remunerative dividend on the total capital expenditure.

The Proposed Pacific Cable.—A "Civil and Electrical Engineer," writing in the *Sydney Daily Telegraph* (New South Wales) with reference to the Eastern Extension Telegraph Company's offer to construct and lay down the projected Pacific cable for the British Government if supported by English money, says that this information is not surprising to persons who have seen the obstacles placed in the way of this great undertaking by the above-named "octopus" company. Canada, he states, has from the first taken the lead in this business, leaving Australia to play seconds. What the English Government will do is unknown, but he does not think they will interefere with cable construction, as they have always very properly left that to private enterprise. He is of opinion that this Pacific line of communication would have been completed long ago but for the hostility of Sir John Pender and Co. They put forth various reports in the Press to the effect that the proposed speaking distances on the new line would be too great for any electric signals to be understood; also that the ever active volcanic eruptions would soon destroy any cable if laid down in that part of our spheroid. This the writer, a practical electrical engineer, denies *in toto*. He points out that this company have the whole of the Australian lines of cable communication in their hands already, which accounts for their most liberal and strategic offer to the home Government, knowing, as they do, that the colonies have had quite enough of their monopoly, and that their grasping proposal would not for a moment be entertained in Australia. Of course, there are other extensive works in London which are quite as capable of carrying out the scheme as Sir John Pender and Co. But why not, he asks, erect works and manufacture the cable out here, submerge and work by an electrical staff appointed by the colonies? A cable factory is very much wanted in Australia for the manufacture of electric lighting, telegraph, and insulated wire, wire cables for tramways, etc., and the writer would be pleased to see a new company formed to carry out these ideas.

Important Agreement between German Firms. The agreement which has for some years existed between the Allgemeine Elektricitäts Gesellschaft (General Electricity Company of Berlin) and Messrs. Siemens and Halske has now been terminated. By the determination of this understanding the limitations imposed upon the former in the direction of constructing machinery and in carrying out installations have been removed. With a view to give effect to this important change, the Allgemeine Company propose to considerably enlarge their works and to lay themselves out for the building of the largest types of machines for central-station work. Special attention is to be paid to the electrical transmission of power, and in this connection it is interesting to note that the rotary-current system worked out by the company, and which formed the basis of the Lauffen transmission plant, will be largely applied. The extent of the company's works will be readily understood when it is mentioned that no less than 3,500 workpeople are engaged in them. Simultaneously with the termination of the above-mentioned agreement, a new arrangement was arrived at, which is continue for 10 years commencing with 1887. The details of the new agreement show that the construction and working of central stations, both in Germany and abroad, will be carried out by the two companies co-operatively, that the restriction of each dealing with isolated installations will be removed, and the considerable sacrifices made by both firms having established works for the construction of incandescent lamps, and which led to ruinous competition in prices between them, will be brought to an end by a mutual convention. Coupled with this agreement is a condition that the undertaking shall be independent of foreign Edison companies, and for this purpose Messrs. Siemens and Halske have purchased the rights of the Paris Compagnie Continentale Edison for £40,450, of which £13,500 is taken up by that firm, and £17,500 by those firms taking up new shares in the Allgemeine Company. A fresh arrangement has, moreover, been arrived at concerning the supply of cables.

Electrical Affairs in Spain.—A Madrid correspondent of *L'Electricien* states that it is very difficult to obtain information in Spain so as to prepare statistics concerning the electricity works in operation. Everybody refuses, he says, either to give details, or furnishes incorrect information so as to prevent the actual conditions of the works from reaching the ears of the members of the financial administration. Thus a station in which there are two 50-h.p. machines will state that it has two of 20 h.p., because the taxes amounts to 20 pesetas per horse-power per annum. Moreover, as the taxes on manufactures are very high, everybody endeavours to carefully conceal figures which could be utilised by the fiscal agents. The correspondent says that the General Gas Company of Madrid has just purchased at 100 per cent. premium the whole of the shares of the Madrid Electricity Company which were held by the General Electricity Company of

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Berlin. There are in Madrid two large companies and three small central stations, whilst another is about to be constructed. The two important companies are the Compañia Madrilena de Electricidad, which supplies 70,000 lamps to 3,000 subscribers, and the Electricity Supply Company for Spain, which furnishes about the same number of lamps. Of the small stations mentioned, one which was originally built for the lighting of the Princesa Theatre has a capacity of 6,000 lamps; the second, for the illumination of the Lara Theatre, supplies 1,500 lamps in the neighbourhood; the third station has an output of 200 amperes. About 600 lamps are energised from a station situated at Carabanchel, a small village 3¾ miles out of Madrid, and the owners have asked for permission to erect a large station in the Barrio Salamanca in Madrid. All the companies, the correspondent continues, are doing a good business and making money, but the one which has prospered the most is the Compañia Madrilena, which has just paid a dividend of 11 per cent. By the purchase of the shares hitherto held by the General Electricity Company of Berlin, as mentioned above, the undertaking has passed entirely into the possession of the Madrid Gas Company.

The Caen Electricity Works.—The central electric light station of the Société Régionale d'Electricité (Normandy district) at Caen was set in operation on the 9th ult. The system adopted is the alternating-current method at 2,400 volts; the cables are laid underground, and transformers placed at suitable intervals reduce the current from 2,400 to 110 volts. The current thus transformed, according to an article in *L'Electricien* of the 14th inst., is then distributed to consumers by means of an overhead three-wire system, which is supplied by feeders connected to the groups of transformers arranged with two secondary circuits in series. The difference of potential between the two outer conductors is 220 volts. Concentric cables of the Fowler type are used; they are placed in wooden conduits covered with tar at a depth of about 20in. below the ground level. In order to eliminate weak points from the mains no splicing has been carried out, the cables being in one piece between each group of transformers. The low-pressure distributing system consists of bare copper conductors of high conductivity supplied by the Maison Geoffroy-Delore, and carried on porcelain insulators arranged on struts. At each crossing the neutral wires are connected together, as are also the wires of each bridge. The generating station has been erected on the Promenade du Fort on the banks of the Grand-Odon, the water from which is used for feeding the boilers and for condensing purposes. Provision has been made in the engine-room for three groups of Willans-Ferranti combinations, but only one set is now at work. It comprises a Willans compound engine, running normally at 380 revolutions a minute, and coupled direct to a Ferranti alternator of a capacity of 55 amperes at 2,400 volts; the exciter, which is arranged on the alternator shaft, gives 60 amperes at 110 volts. A second group has been ordered, and will soon be laid down. Steam is supplied by two Babcock and Wilcox boilers, and a third is shortly to be erected. There are six banks of transformers in the town; they are of the Labour type, are all connected in shunt to the high-pressure circuit, and their secondaries are placed two in series. They are arranged for 80 periods, and to convert the current from 2,400 to 110 volts. Being connected two in series on the secondary, a neutral point is produced at the junction of the circuits of the two transformers, and a difference of potential of 220 volts between the extreme terminals. The station has already 4,000 lamps connected to the mains. It has been carried out according to the designs of Mr. Ferranti and M. Leroy, the latter of whom is engineer-in-chief to the Compagnie Nationale d'Electricité. M. Lecornu, who was for some time at the Troyes station, has been appointed engineer-in-charge.

Awards Offered for Electrical Papers. — The Société Industrielle de Mulhouse has recently issued the programme of prizes to be awarded in 1895 for papers and designs which are to be addressed to the president of the Société by February 15, 1895. Among the prizes offered the following may be cited: A silver medal for any application of electricity in the printing industry; and a similar medal for a registering pyrometer which will determine the temperature of gaseous products of combustion of coal in steam-boilers. The apparatus desired is one capable of indicating with an approximation of at least 5 per cent. the temperature of a gaseous current in the flue of a steam-boiler between the limits of 300deg. and 800deg. As the apparatus will be plunged into the gas, the indicator of the temperature must be placed outside the mass of the furnace in order to render readings easy of being taken. The prize will only be awarded to an apparatus which has for at least some months been applied to a steam-boiler working in Upper Alsace. A medal of honour is offered for a practical installation carried out in an industrial establishment in Upper Alsace, with a view to the distribution of motive power to various machines or apparatus by means of electricity obtained from either a public or private generating station. The installation must have been in practical operation for a year, and must have the advantages of showing an appreciable economy over the method of distribution hitherto employed. A medal of honour will be awarded for an electric motor capable of developing power and a variable speed at will. The power of the motor is to be 10 h.p. or less. Either a silver or bronze medal of honour or a sum of money is offered for a simple and practical method of connecting armature coils to the commutator segments of dynamos. This new system must allow of one easily changing, and in a relatively short space of time, the commutators of dynamos. It must ensure a good contact of the coils with the commutator segments and must not cause damage to the wires, as happens with binding screws. Commutators with air insulation between the segments are out of the question. The paper describing this method must enumerate the advantages and the inconveniences of the systems already in use, and compare them with the new method. A comparison between electric and gas illumination is desired, and for this a medal of honour is to be presented. The paper is to deal with the comparative expenditure of an electrical installation and of a gasworks having to serve in each case a population of 30,000. The comparison is to specially treat the following points: (1) costs of installation of the central station and of the gasworks, of the electrical distribution, and mains from the generators to the houses; (2) cost of coal required for producing power in the generating station and gas in the gasworks; and (3) the working expenses and maintenance in each case. A special chapter is to be devoted to a detailed estimate of the expenses and receipts resulting in the case of the gasworks of the value of the by-products of distillation. Another chapter is to treat of the photometric value of gas jets for a given consumption, and of the number of electric lamps which would be substituted for them. It will be convenient, in fact, in the comparison to keep account of the fact that the substitution of the electric light for that of gas permits generally of an increase in the illuminating power.

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REACTANCE.*

BY CHARLES PROTEUS STEINMETZ AND FREDERICK BEDELL.

The term "reactance," which has been used and advocated by the writers and others, and which has been officially adopted at our suggestion by the American Institute of Electrical Engineers at its Philadelphia meeting, is one which assumes particular importance now that the term "inductance" is defined as synonymous with the "coefficient of self-induction," usually symbolised by the letter "L." Reactance is a quantity similar in many respects to resistance, but the E.M.F. in overcoming reactance consumes no power, for it is at right angles to the current.

The impressed E.M.F. in an alternating-current circuit may be divided into two components: first, the power E.M.F. in the direction of the current; and second, the reactive E.M.F. in quadrature with the current to overcome the reactance. The reactive E.M.F. is the product of the current and the reactance. The reactance is accordingly equal to the component of the impressed E.M.F. at right angles to the current divided by the current. Reactance is measured in ohms.

The reactive E.M.F. in the circuit may be due to self or mutual induction, to capacity or to some outside counter E.M.F. produced by a motor or other device. In general, in any alternating-current circuit,

$$\text{Impressed E.M.F.} = \sqrt{\text{Power E.M.F.}^2 + \text{Reactive E.M.F.}^2};$$

that is, the impressed E.M.F. is the vector sum of the E.M.F. which transmits power and the reactive E.M.F.

Reactance tends to cause a phase difference between current and E.M.F. If θ represents this angle of phase, we have the relation,

$$\tan\theta = -\frac{\text{reactance}}{\text{resistance}}.$$

When θ is negative, the current lags behind the E.M.F.; when θ is positive, the current is in advance of the E.M.F. The expression for the instantaneous value of the current may be written

$$i = I \sin(\omega t + \theta),$$

or

$$i = \frac{\text{Impressed E.M.F.}}{\text{Impedance}} \sin\left\{\omega t - \text{arc tan}\frac{\text{reactance}}{\text{resistance}}\right\}.$$

A few illustrations of particular cases will make the use of the term reactance more clear.

Circuits Containing Resistance and Inductance.—In a simple circuit containing resistance and inductance, the reactance is equal to $L\omega$—that is, it is 2π times the product of the inductance and frequency. The impedance being the vector sum of the resistance and reactance, is

$$\text{Impedance} = \sqrt{R^2 + L^2\omega^2},$$

where $\omega = 2\pi \times$ frequency. In this case all the power is used in overcoming resistance, and the power E.M.F. is equal to the ohmic E.M.F. RI. The reactive E.M.F. is equal to the inductive E.M.F., $L\omega I$; hence

$$\text{Impressed E.M.F} = \sqrt{\text{Power E.M.F.}^2 + \text{Reactive E.M.F.}^2},$$

or

$$\text{Impressed E.M.F.} = \sqrt{\text{Ohmic E.M.F.}^2 + \text{Inductive E.M.F.}^2}.$$

The impressed E.M.F. in this case is the vector sum of the E.M.F.'s necessary to overcome resistance and inductance.

A consideration of Figs. 1 and 2 (in which positive direction is counter clockwise) will show that the reactance and reactive E.M.F. are positive in the case of a circuit containing inductance. The impressed E.M.F., which is the sum of the two, is therefore in advance of the current, which is in the same direction as the power or ohmic E.M.F. The current is indicated by a closed arrow in the figures. The same, however, may be otherwise expressed if we take the impressed E.M.F. as our direction of reference, by saying that the current lags behind the E.M.F. by the angle θ, which angle is negative, therefore, for circuits with inductance according to the relation

$$\tan\theta = -\frac{\text{reactance}}{\text{resistance}} = -\frac{L\omega}{R}.$$

* A paper presented at the Philadelphia meeting of the American Institute of Electrical Engineers.

The value of the current at any instant is given by the equation

$$i = \frac{E}{\sqrt{R^2 + L^2\omega^2}} \sin\left(\omega t - \text{arc tan}\frac{L\omega}{R}\right).$$

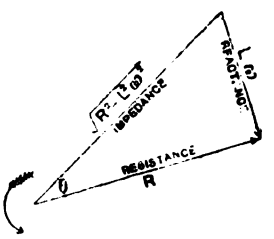

FIG. 1.

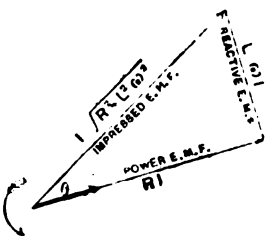

FIG. 2.

Circuits Containing Resistance and Capacity.—In such circuits the reactance is equal to $-\frac{1}{C\omega}$, where C, capacity, and $\omega = 2n \times$ frequency—that is, it is negative. The reactive E.M.F. is also negative, being equal to $-\frac{I}{C\omega}$. This negative reactance gives a positive value to the angle θ, and the current is accordingly in advance of the E.M.F. We have then

$$\text{Impedance} = \sqrt{R^2 + \frac{1}{C^2\omega^2}},$$

and

$$\tan\theta = -\frac{\text{reactance}}{\text{resistance}} = +\frac{1}{CR\omega},$$

similar to the corresponding equations above. The instantaneous value of the current is given by the equation

$$i = \frac{E}{\sqrt{R^2 + \frac{1}{C^2\omega^2}}} \sin\left(\omega t + \text{arc tan}\frac{1}{CR\omega}\right).$$

These relations are shown in Figs. 3 and 4.

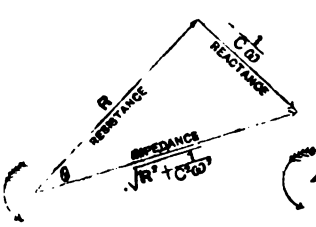

FIG. 3.

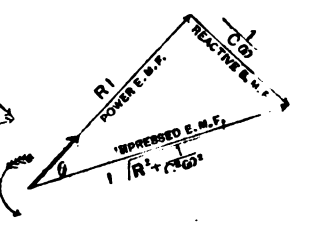

FIG. 4.

Circuits Containing Resistance, Inductance, and Capacity.—In a circuit containing inductance and capacity the reactive E.M.F. is the sum of the inductive E.M.F. and the condenser E.M.F.—that is, $L\omega I - \frac{I}{C\omega}$. The reactance is similarly the sum of two terms, $L\omega - \frac{1}{C\omega}$; thus, the reactance is positive or negative according to whether the inductive E.M.F. is greater or less than the condenser E.M.F. Whether the current is behind or ahead of the impressed E.M.F. depends upon the same condition, for

$$\tan\theta = -\frac{\text{reactance}}{\text{resistance}} = \frac{1}{CR\omega} - \frac{L\omega}{R}.$$

The value of the current at any instant is

$$i = \frac{E}{\sqrt{R^2 + \left(L\omega - \frac{1}{C\omega}\right)^2}} \sin \left\{\omega t + \text{arc tan}\left(\frac{1}{CR\omega} - \frac{L\omega}{R}\right)\right\}$$

The diagrams in Figs. 5 and 6 illustrate the case of a single circuit containing resistance, inductance, and capacity. In the case here represented, the condenser E.M.F. is

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greater than the inductive E.M.F., and the current is therefore in advance.

Circuits Containing Mutual Induction. — To further exemplify the use of the term reactance, let us consider a circuit containing a transformer. Besides the E.M.F.'s already discussed, we must consider the back E.M.F. due to the influence of the secondary upon the primary circuit. This may be resolved into two components—one in the same direction as the current, and the other in quadrature with it, which will form part of the power E.M.F. and reactive E.M.F. respectively. The E.M.F. introduced by a motor is treated in the same way.

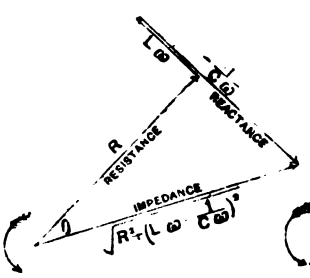

FIG. 5.

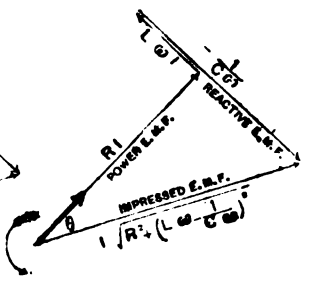

FIG. 6.

These illustrations will suffice to show the method by which any E.M.F. in a circuit is resolved into two components—one in the direction of the current, which therefore transmits power, and the other at right angles to the current, which represents no power, but simply overcomes the reactance.

It is to be borne in mind that the terms here given may be used in all alternating-current circuits, whether the current is harmonic or not; for when the current is not strictly harmonic we may consider it equivalent to an harmonic current. The equivalent harmonic current and equivalent harmonic E.M.F. have the same square root of mean square values as the actual current and E.M.F., and have such relative phase positions that the same power is transmitted.

PRACTICAL NOTES ON DYNAMO CALCULATION.*

VI.

BY ALFRED E. WIENER.

14. *Weight of Armature Winding.*—A copper wire of one circular mil $\left(= \frac{1}{1{,}000{,}000} \times \frac{\pi}{4} \text{ square inch}\right)$ area weighs ·00000303lb. per foot of length; our armature conductor of δ^2_a circular mils sectional area, therefore, has a weight per foot of ·00000303 × δ^2_a pound. And the total L_t feet of it used in winding the armature will weigh:

$$\text{lb.}_a = \cdot00000303 \times \delta^2_a \times L_t \quad . \quad . \quad . \quad . \quad (28)$$

lb._a = weight of bare armature winding, in pounds;
δ^2_a = sectional area of armature conductor in circular mils, from formula (4);
L_t = total length of armature conductor, in feet, formulæ (19) to (27) respectively.

In case of round gauge wires, the product ·00000303 × δ^2_a is contained in the gauge table under the heading "lbs. per foot," and consequently the bare weight of the winding is found by simply multiplying the respective table value by the total length, L_t, and eventually by the number of wires, p, stranded in parallel.

If, in case of heavy rectangular or wedge-shaped armature bars, the cross-section, δ^2_a, is given in square inches, the numerical constant in the above formula (28) should be replaced by 3·858, this being the weight per foot of a copper bar of one square inch sectional area.

When standard gauge wire is to be employed in winding the armature, it is desirable to know the weight of the winding, including its covering, particularly in the case when insulated wire, such as is obtainable from wire manufacturers, is to be used. This covered weight of the winding can be expressed as a multiple of the bare weight by the equation:

$$\text{lb.}_a = k_5 \times \text{lb.}_a = \cdot00000303 \times k_5 \times \delta^2_a \times L_t \quad (29)$$

in which k_5 is a constant depending upon the ratio of the bare diameter of the wire to the thickness of its insulation. In the following Table XXI. these ratios and the corresponding values of k_5 are given for all standard gauge wires likely to be used for winding armatures, for single and for double cotton covering:

TABLE XXI.—Weight of Insulation on Round Copper Wire.

Gauge of wire. B.W.G.	Gauge of wire. B. & S.	Diameter of wire (bare inches).	Single cotton insulation. Thickness of insulation, inches.	Ratio of bare diameter to thickness of insulation	Weight of insulation in per cent. of covered wire.	Weight of covered wire in per pound of bare k_5.	Double cotton insulation. Thickness of insulation, inches.	Ratio of bare diameter to thickness of insulation.	Weight of insulation in per cent. of covered wire.	Weight of covered wire in per pound of bare k_5.
1	—	·300	—	—	—	—	·020	15	2·28	1·0228
—	1	·289	—	—	—	—	·020	14·45	2·32	1·0232
2	—	·284	—	—	—	—	·020	14·2	2·33	1·0233
3	—	·259	—	—	—	—	·020	12·95	2·40	1·024
—	2	·258	—	—	—	—	·020	12·9	2·40	1·024
4	—	238	—	—	—	—	·020	11·9	2·50	1·025
—	3	·229	—	—	—	—	·020	11·45	2·55	1·0255
5	—	·220	—	—	—	—	·020	11	2·65	1·0265
—	4	·204	·012	17	2·20	1·022	·020	10·2	2·85	1·0285
6	—	·203	·012	16·9	2·20	1·022	·020	10·15	2·86	1·0286
—	5	·182	·012	15·15	2·27	1·0227	·018	10·1	2·87	1·0287
7	—	·180	·012	15	2·28	1,0228	·018	10	2·90	1·029
8	—	·165	·012	13·75	2·33	1·0233	·018	9·17	3·20	1·032
—	6	·162	·010	16 2	2·24	1·0224	·018	9	3·25	1·0325
9	—	·148	·010	14·8	2 30	1·023	·016	9·25	3·15	1·0315
—	7	·144	·010	14·4	2·32	1·0232	·016	9	3·25	1·0325
10	—	·134	·010	13·4	2·36	1·0236	·016	8·4	3·55	1·0355
—	8	·1285	·010	12·85	2·40	1·024	·016	8	3·75	1·0375
11	—	·120	·010	12	2·50	1·025	·016	7·5	4·10	1·041
—	9	·1144	·010	11·4	2·55	1·0255	·016	7·1	4·35	1·0435
12	—	·109	·010	10·9	2·66	1·0266	·016	6 8	4·60	1·046
—	10	·102	.010	10·2	2·85	1·0285	·016	6·4	5·00	1·05
13	—	·095	·010	9·5	3·10	1·031	·016	5·9	5·55	1·0555
—	11	·091	·010	9·1	3·25	1·0325	·016	5·7	5·85	1·0585
14	—	·083	·007	12	2·50	1·025	·016	5·2	6·60	1·066
—	12	·081	·007	11·6	2·54	1·0254	·016	5·1	6·80	1·068
15	13	·072	·007	10·3	2·80	1·028	·016	4·5	7·80	1·078
16	—	·065	·007	9·3	3·15	1·0315	·016	4·1	8·60	1·086
—	14	·064	·007	9·1	3·25	1·0325	·016	4	8·80	1·088
17	—	·058	·007	8·3	3·60	1·036	·014	4·1	8·60	1·086
—	15	·057	·007	8·1	3·70	1·037	·014	4·1	8·60	1·086
—	16	·051	·007	7·3	4·20	1·042	·014	3·6	9·60	1 096
18	—	·049	·007	7	4·40	1·044	·014	3·5	9·80	1·098
—	17	·045	·005	9	3·25	1·0325	·012	3·75	9·30	1·093
19	—	·042	·005	8 4	3·55	1·0355	·012	3·5	9·80	1·098
—	18	·040	·005	8	3·75	1·0375	·012	3·33	10·10	1·101
—	19	·036	·005	7·2	4·30	1·043	·005*	7 2	5·60	1·056
20	—	·035	·005	7	4·40	1·044	·005*	7	6·00	1·06
21	20	·032	·005	6·4	5·00	1·05	·005*	6·4	6·60	1·066
22	21	·028	·005	5·6	6·00	1·06	·004*	7	6·00	1·06
23	22	·025	·005	5	7·00	1·07	·004*	6·25	7·00	1·07
24	23	·022	·005	4·4	8·00	1·08	·004*	5·5	8·00	1·08
25	24	·020	·005	4	8·80	1·088	·004*	5	8·80	1·088
26	25	·018	·005	3·6	9·60	1·096	·004*	4·5	9·60	1·096
27	26	·016	·005	3·2	10·40	1·104	·004*	4	10·40	1·104
28	27	·014	·005	2·8	11·25	1·1125	·004*	3·5	11·25	1·1125
29	28	·013	·005	2·6	11·65	1·1165	·004*	3·25	11·65	1·1165
30	—	·012	·005	2·4	12·05	1·1205	·004*	3	12·05	1·1205
—	29	·011	·005	2·2	12·45	1·1245	.004*	2·75	12·45	1·1245

* Double silk: 1 mil of silk insulation taken equal in weight to 1·25 mil of cotton covering.

15. *Armature Resistance.*—The electrical resistance of the armature winding can be determined by the total length of wire wound on the armature, and from the sectional area of the conductor. If R denotes the total resistance of the armature wire, all in one continuous length, and if the machine has P pairs of magnet poles, and therefore 2 P electrically parallel armature portions, then the armature forms the combination of 2 P parallel branches of $\frac{R}{2P}$ ohms resistance each (see Fig. 13). The joint resistance of these 2 P circuits—that is, the actual armature resistance—will consequently be

$$r_a = \frac{R}{(2P)^2} = \frac{R}{4 \times P^2},$$

* From the *Electrical World* (New York).

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The total resistance, R, of all the armature wire in series can be calculated from the total length, L_t, and the sectional area, δ^2_a, of the conductor by the formula

$$R = L_t \times \frac{10{\cdot}5}{\delta^2_a},$$

where 10·5 is the resistance, in ohms, at 15·5deg. C. (=60deg. Fahr.), of a copper wire of one circular mil sectional area and 1ft. length, and of a conductivity of about 98 per cent. of that of pure copper. The quotient $\frac{10{\cdot}5}{\delta^2_a}$, for commercial copper, or $\frac{10{\cdot}32}{\delta^2_a}$ for chemically pure copper, represents the resistance per foot of the armature conductor, and can, for every standard size of wire, be taken from the wire gauge table.

Introducing the value of R into the above equation, we obtain the following formula for the resistance at 15·5deg. C. of any armature having a single conductor:

$$r_a = \frac{1}{4 \times P^2} \times L_t \times \left(\frac{10{\cdot}5}{\delta^2_{a_1}}\right) \quad . \quad . \quad (30)$$

r_a = resistance of armature winding at 15·5deg. C., in ohms;
P = number of pairs of magnet poles, eventually half the number of parallel armature portions;
L_t = total length of armature conductor, in feet, formulæ (19) to (27) respectively;
$\delta^2_{a_1}$ = sectional area of armature conductor, in circular mils, formula (4).

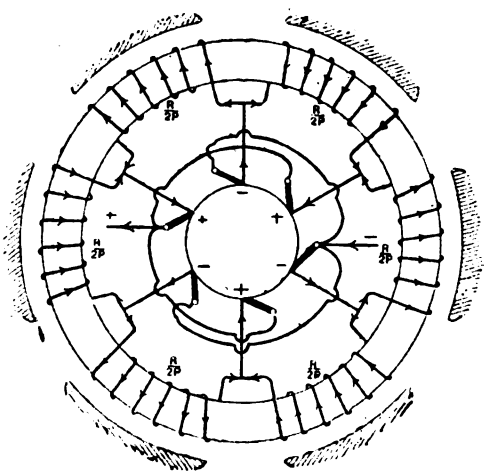

Fig. 13.

In an armature each conductor of which consists of p parallel strands of wire of $\delta^2_{a_1}$ circular mils sectional area, there are 2 P parallel circuits of p wires each, or altogether $2 \times P \times p$ parallel circuits of $\frac{R}{2 \times P \times p}$ ohms resistance each; the joint resistance therefore is

$$r_a = \frac{R}{4 \times P^2 \times p^2},$$

and since in this case the total resistance of the whole armature wire in series is

$$R = L_t \times p \times \left(\frac{10{\cdot}5}{\delta^2_{a_1}}\right),$$

we obtain for the resistance at 15·5deg. C. of any armature winding consisting of p strands of wire of $\delta^2_{a_1}$ circular mils sectional area, the formula

$$a = \frac{1}{4 \times P^2 \times p^2} \times L_t \times p \times \left(\frac{10{\cdot}5}{\delta^2_{a_1}}\right)$$

$$= \frac{1}{4 \times p \times P^2} \times L_t \times \left(\frac{10{\cdot}5}{\delta^2_{a_1}}\right) \quad . \quad (31)$$

In formulæ (30) and (31) the number of pairs of poles, P, is to be replaced by half the number of parallel armature portions if these two numbers differ from each other.

In order to obtain the armature resistance at any other temperature higher than 15·5deg. C., add 1 per cent. for every 3deg. C. over 15·5deg. C. The resistance, r_a, at 15·5deg. C. being known, the armature resistance at t deg. C. consequently will be

$$(r_a)_{t\,\text{deg.}} = r_a + \frac{1}{100} \times r_a \left(\frac{t\,\text{deg.} - 15{\cdot}5\text{deg.}}{3}\right)$$

$$= r_a \times \left(1 + \frac{t\,\text{deg} - 15{\cdot}5\text{deg.}}{300}\right) \quad . \quad (32)$$

16. *Energy Losses in Armature.*—There are three sources of energy dissipation in the armature which are transformed into heat: (1) overcoming of electrical resistance of armature winding; (2) overcoming of magnetic resistance of iron; and (3) generation of electric currents in the armature core.

a. Energy Dissipated in Armature Winding.—The energy required to pass an electric current through any resistance is given, in watts, by the product of the square of the current intensity, in amperes, into the resistance, in ohms. The energy absorbed by the armature winding, therefore, is:

$$w_a = C^2 \times r'_a \quad . \quad . \quad . \quad . \quad . \quad (33)$$

where w_a = energy dissipated in armature winding, in watts;
C = total current generated in armature in amperes;
r'_a = resistance of armature winding, hot, in ohms; see formulæ (30), (31), and (32).

The total current, C, in series-wound dynamos is identical with the current output, c; in shunt and compound wound dynamos, however, C consists of the sum of the external current, c, and the current necessary to excite the shunt magnet winding. The amount of current passing through the shunt winding is the quotient of the potential difference, e, at the terminals of the machine, by the resistances of the shunt circuit, r_m—that is, the sum of the resistance of the shunt winding and of the regulating rheostat, in series with the shunt winding.

For the resistance, r_a, of the armature winding, when hot—in order to be on the safe side in determining the armature losses—that at about 75deg. C. should be taken, or, according to formula (32), the resistance, r_a, at 15·5deg. C. multiplied by $\left(+1\frac{75\text{deg.} - 15{\cdot}5\text{deg.}}{300}\right) = 1{\cdot}2$.

The energy dissipated in overcoming the resistance of the armature winding consequently can be obtained from the formula:

$$w_a = 1{\cdot}2 \times \left(c + \frac{e}{r_m}\right)^2 \times r_a \quad . \quad . \quad . \quad (34)$$

If w_a is to be computed before the field calculations are made—that is to say, before r_m is known—it is sufficiently accurate for practical purposes to express from experience the total armature current, C, as a multiple of the current output, c, and, therefore, we have approximately

$$w_a = 1{\cdot}2 \times (k_6 \times c)^2 \times ra \quad . \quad . \quad . \quad . \quad (35)$$

and in this the coefficient k_6 can be taken from the following table:

Table XXII.—Total Armature Current in Shunt and Compound Wound Dynamos.

Capacity in kilowatts.	Shunt current in per cent. of current output.	Total current as multiple of current output. k_6.
·1	15%	1·15
·25	12	1·12
·5	10	1·10
1	8	1·08
2·5	7	1·07
5	6	1·06
10	5	1·05
20	4	1·04
30	3·5	1 035
50	3	1·03
100	2·75	1·0275
200	2·5	1·025
300	2·25	1·0225
500	2	1·02
1000	1·75	1·0175
2000	1·5	1·015

(To be continued.)

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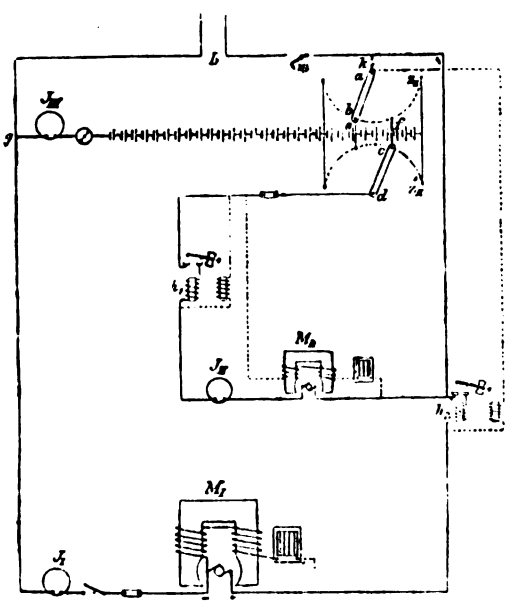
THE ZURICH-HIRSLANDEN ELECTRIC TRAMWAY.

A NOVEL DEPARTURE.

A novel departure in electric tramway working has been made in the case of the Zürich-Hirslanden tramway, which was set in operation on March 8 last. This deviation from the practice hitherto followed consists in the employment of accumulators installed in the power station in conjunction with the generating dynamos, so as to meet the varying conditions of the load on the line. The Oerlikon Engineering Works, at the suggestion of the Hagen Accumulator Works, decided to introduce this system for general traction work, they having experienced good results with an experimental line laid down at the Oerlikon factory.

As will be seen from the diagram of connections, which, together with the accompanying description, is abstracted from the *Elektrotechnische Zeitschrift*, the principal shunt dynamo, M_1, is directly connected with the line, L, with which the battery of accumulators is united in parallel. If a large quantity of current is being consumed on the line, the battery assists the dynamo in supplying current; but when the demand for current is small, the accumulators are charged so that the dynamo delivers a constant current, and the steam-engine is equally loaded continuously, and works most economically. The discharging switch, *a b*, of



the double-cell regulator, z_1 z_2, is arranged automatically, and is therefore always automatically set to the requisite pressure. The dynamo, M_1, charges, as will be observed, only the cells between *e* and *g*. In order, however, to be able to charge the cells between both cell switches, *a b* and *c d*, and also between *e* and *f*, a smaller shunt dynamo, M_{11}, is inserted between the two switches mentioned. The magnet coils of the dynamo also lie between both these points, so that if the lever, *a b*, changes its position on account of its automaticity, the magnetic field, influenced by the cells more or less connected, is likewise more or less excited, so that the charging current strength of the regulator cells remains as much as possible constant. In the conductor of this machine is inserted an automator switch, h_1, which, as soon as the pressure of the regulating cells for any reason becomes higher than that of the dynamo, automatically disconnects the conductor of the machine, and also re establishes the connection when the pressure of the dynamo becomes greater than that of the regulating cells. A similar automatic switch is placed in the conductor of the main dynamo. The battery is provided with a lead safety fuse, and the trolley line with an automatic cut-out switch, which disconnects the line on a short-circuit taking place. The current strength of the dynamos, M_1 and M_{11}, and of the battery may be ascertained at any time by the ammeters, J_1, J_{11}, and J_{111}.

The length of the tramway is 2½ miles, and the gradients are heavy. Each car will accommodate 24 passengers. The generating station is at Hirslanden. It contains two Galloway boilers, provided by Messrs. Escher, Wyss, and Co., of Zurich, two 90-h.p. steam-engines and one of 5 h.p., two shunt dynamos, giving each 100 amperes at from 450 to 550 volts, and a shunt dynamo yielding 30 amperes at 100 volts. The battery, which was supplied by the Hagen Accumulator Company, comprises 300 cells, having a capacity of 245 ampere-hours. Practical experience shows that the use of accumulators in this direction is of considerable advantage.

NOTES ON ELECTRIC TRAMWAYS IN THE UNITED STATES AND CANADA.*

BY H. D. WILKINSON, MEMBER.

During the period of the Chicago Exposition last year I had opportunities of looking into systems of street traction in that city, and of discussing points of immediate interest with engineers from different cities whom it was my privilege to meet.

For several weeks previous to the opening of the exposition the scene for miles round was one of the greatest activity in the construction of street tramways, centring from all districts on the south side, and forming connections from the city main cable car lines. The continuation of the elevated steam road to the exposition along Sixty-fourth-street was also a smart piece of work, including the erection of six stations and a pin-connected truss bridge across the Illinois Central Railroad track without obstructing traffic. Immediately this line was finished trolley wires were strung underneath the girders, and the previous horse car lines, which had grown totally inadequate to the traffic, were converted into electric lines. The motor cars were rarely without trailers, and in the busiest times of the day two, and sometimes three, fully-loaded passenger cars were hauled. The term "fully loaded," when applied to cars in America, must be understood in its most literal sense. Besides all standing and sitting room being taken up inside, the drivers' and conductors' platforms are closely packed, and people cling to the outsides wherever there is the smallest foothold. More than this, I have seen cars on busy days with people sitting on the window-ledges and climbing on the roof, and the back end of the car framework weighted out of shape and scraping the ground. After seeing one motor car hauling two or three trailers, with 250 people, at the rate of 10 miles an hour, on roads with no drainage, and covered with mud, I was convinced that the practice of putting two 25-h.p. or 30-h.p. motors on one car—which would otherwise seem a waste of material and power—was not unreasonable. The full power is, of course, not always wanted, and can be regulated by the controller to suit the traffic; but it is most important to have motors that will stand extra heavy work when required and need no attention. During the year the number of passengers on all lines in Chicago was about 288 millions, or an increase of 55 millions over the previous year.

The general type of construction in wide thoroughfares is with poles planted in the centre of the road between the double track, carrying iron brackets for the support of trolley and feeder wires, and the general appearance is far from unsightly. This is specially the case when every other post supports an arc lamp or cluster of incandescents and the brackets are ornamental. Span wires are only necessary at curves and in narrow thoroughfares. The entire track construction, including rails and wires, costs about £1,400 per mile, and the car bodies, with motor trucks complete, cost about £800 per car. For a line, say, of five miles of track, with 15 cars, the power station, including building and machinery, would cost about £5,000, and real estate and car barns about £3,000—bringing the total cost of equipment to £27,000. The revenue per car mile was from 20 to 30 cents, and the total running expenses 14 to 16 cents, or on the average about 60 per cent. of revenue.

The very energetic body of the American Street Railway Association is thoroughly representative, and its members, who are all engaged in tramway work, think nothing of travelling 1,000 miles to be present at their annual conventions. At these gatherings, which occupy three or four days, original papers and reports of investigations consigned to committees at the previous meeting are read and discussed. An exhibition of manufacturers' supplies is also held at the same time, and new electric cars of all kinds are put on the town lines and run on regular service. Members practically own the town during their stay; the largest hotels are full, rooms being taken by representatives of different concerns as temporary offices. The various companies and firms in the town send in invitations to visit power-houses and works, books of tram tickets are distributed gratis, and the telephone companies place their lines at the disposal of members. Time will not allow me to do more than refer to the very pleasant participa-

* This paper, which will be discussed before the Institution of Electrical Engineers, is taken from the *Journal* of the Institution

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tion I enjoyed in the last convention at Milwaukee, Wisconsin, The papers read have appeared in our own technical Press, and are consequently well known. The supplies comprise car bodies, trucks, motors, controllers, fuses and heaters, track scrapers and sprinklers, steel rails, points and crossings, compressed mica, and overhead line gear of all descriptions; everything that could be put in motion being supplied with electric current. Each member received a small choice souvenir of his visit, the gift of the newly-elected president, Mr. Henry Paine.

I now pass on to some of the questions which are absorbing attention, and to describe what I saw of the working of different systems. The directions in which improvements are sought comprise chiefly: (1) better construction of road beds and tracks; (2) better provision for the return circuit; (3) more uniform distribution of potential along the route. Further, in the power-house, the chief questions are in the driving, governing, and safety devices, the best proportion of power between engine and generator, and the problem of flywheel inertia. Beyond these there are the questions of practical and economic systems of delivering energy to cars in cities and crowded portions of towns, such as by the storage battery or underground conduit; and for long-distance transit the use of synchronous or of two or three phase motors with transmission of current by underground feeders at high tension.

Some of these questions have given rise to much discussion in America, and most of them have more or less a bearing upon the development of electric traction in our own country. It appeared to me, therefore, that I could in some measure further the progress of the industry in this country by making such observations and enquiries on the present working of tramways in the States and Canada as affected the immediate future; and I looked forward on my return to the duty, as well as the pleasure, of bringing the results of these investigations before the members of this Institution. During the summer of last year I visited the cities of Detroit and Milwaukee, and in November—on the completion of my official duties at the exposition—the cities of Toronto, Montreal, Buffalo, Cleveland, Cincinnati, Pittsburg, Washington, and Philadelphia; making also a complete examination of the electric railroad recently erected on the Canadian side of the Falls. From the officials of the various companies whose lines and plant I investigated I met with the greatest courtesy and cordiality, and the expressed wish, not only on the occasion of my visit, but at any future time, to furnish such information as might be desired.

With regard to road bed and track construction there is not much to be said, as the general conditions in America differ considerably from those in our own country. In many cities, and especially in the suburbs of large western cities, the rails are allowed to project above the road bed one or two inches, making very rough travel for other vehicles. In fact, the iron road is counted of the first importance in inducing people to live further out of town and build on the prairie, while the road for the use of ordinary vechicles is of only secondary consideration. After a few years, as property goes up in the district, a better foundation is put in, and the roads are levelled up to the metals by paving blocks or glazed bricks. Whole suburbs spring into existence in the wake of the electric tramway. Enterprise in promoting schemes is chiefly due to estate holders seeking to raise the value of their property, and it is remarkable that municipal corporations have given away important concessions for very trifling sums. These concessions after a few years generally become very valuable, and bring a good return to those who have sunk capital and taken risk; but it is now becoming more usual for corporations to look ahead and put in clauses that shall let some percentage of the profits come in for the improvement of the streets.

Practice in the western cities of Amercia is chiefly with T, flat, or step rails, spiked down to wooden cross-ties or sleepers; but on the best lines and in most eastern cities the channelled girder rail as used in England has been adopted, on account of smoother travel. less noise, and a flush road surface. The English construction of concrete foundation has been followed on some lines, using a 9in. or 10in. girder rail. The tendency now in the States is to put in very heavy girder rails (90lb. or 100lb.), spiked to wooden sleepers, placed at about 2ft. centres, which allows a good deal of spring in the track, and tends to loosen the bond contacts. Some 72lb. channel girder rails I saw in progress of laying had grooves 1⅛in. wide by 1in. deep. The height and base both measured 6in. There was first an 8in. foundation of concrete, upon which the sleepers (6in. by 8in.) were laid at 2ft. 3in. centres, and then grouted in. Sand was then tamped round the base of the rails to the depth of 2in., upon which the paving blocks were laid. The points and special work were of cast steel.

The question of returning the current direct to the power-house with as little leakage and loss in voltage as possible, is one of the most important in street railway problems. Excluding for the moment insulated returns, the paths open for the return current from the cars to the power-house are (1) by the rails and return feeders; (2) by supplementary wires; (3) by the earth; (4) by metallic pipes and cables laid in earth. The return feeders include not only those cables connecting the nearest point on the rails to the generators in the power-house, but cables brought in from more distant points of the line, as the configuration of the same and the load may require. In this matter everything depends on the position of the power-house with regard to the route of the line. The primary object in their use is to lessen the voltage losses at the distant portions of the line; but in some districts their use has been largely extended, in order to prevent electrolytic effects on gas and water pipes. The remedy for the latter is clearly to provide a metallic return of ample conductivity, and while on modern lines improved bonding has done much to effect this, the addition of return feeders has had the desired effect in older and badly-bonded lines. In Cleveland, Ohio, for instance, I found a very extended use of return feeders, and I was informed by Mr. Charles W. Wason, vice-president and electrical engineer of the East Cleveland Railway Company, that he had resorted to their use entirely on account of electrolytic troubles with the water-pipes of the city, with the result that the action ceased, and in addition about 25 per cent. of the voltage was saved. Some idea of the advantage of a saving in volts, apart from the consideration of speed in cars, can be gained from the fact that the current reached 3,000 amperes, and that for, say, 50 volts lost on the line every 1,000 amperes means a continuous loss of 70 h.p. The return feeders in this city are carried overhead, and are connected by riveted joints to the rails at about every 500ft. In Buffalo, also, I observed an extensive use of return feeders, carried underground with the outgoing feeders within the city limits, but overhead further out.

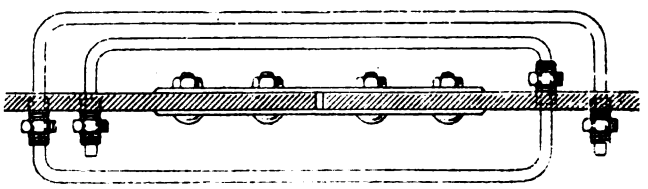

FIG. 1.—Bonding Nipple.

Coming now to bonding, I have seen many different specimens of this work, and have some samples here to-night for the members' examination. One form of bond joint, Fig. 1, consists of a steel nipple bored to fit the bond wire, and tapered and slotted at one end. This screws into the rail, and the nut, screwed up, tightens the wire in the nipple,

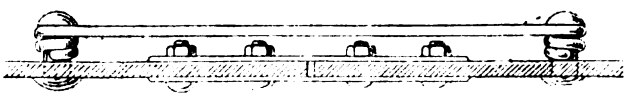

FIG. 2.—Rivet and Soldered Bond Wire.

and the nipple in the rail. This was introduced by Messrs. Stern and Silverman, of Philadelphia, and is used on the lines of the electric traction company of that city, the bond wires being passed two or three times through the rail outside the fishplates to obtain the necessary conductivity. There are still many very imperfect bonds in use, such, for instance, as that with copper or iron rivets and soldered bond wire, Fig. 2, of which I have a specimen here. In heading the rivet

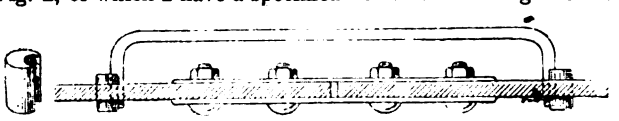

FIG. 3.—Channel Pin.

the soldered joint is frequently loosened and the bond rendered useless. The channel-pin bond, Fig. 3, of which I have a specimen here, is in very extensive use; but a great defect in this device is that it cannot be riveted or made to completely fill the hole, and corrosion takes place in the interstice. The channel pin is used for the double bonds on the Lynn and

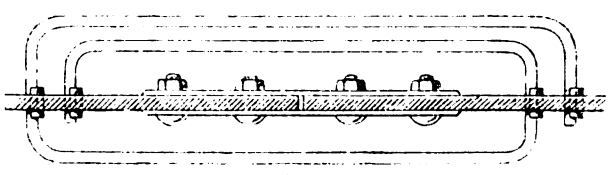

FIG. 4.

Boston line, as shown in the illustration, Fig. 4. Another bond is taper spring steel cap, Fig. 5, which is fitted on the end of the wire and driven into a hole in the web of the rail slightly less than its own external diameter. A similar bush joint, but formed as a sleeve or socket, has been in use some time on double bonds, as in illustration, and promises well, Fig. 6. A considerable improvement consists in making the bond wire in one piece, with shoulders for riveting formed at

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each end on the wire itself. This device (shown in Fig. 7) is due to Mr. McTighe, of New York, and has been very largely used. The advantages of this plan are that clean, watertight, and airtight solid metallic joints are obtained, and that the bonds can be made of any size wire. Mr. McTighe prefers to use these in short lengths of 12in. inside the fishplates, instead of the usual length of 30in., thus saving 40 to 50 per cent. in bond resistance. The short bond cannot be fixed to the web of the rail on account of the fishplates, but is either attached to the tread or the base, the latter being the better point of attachment, as the bonds are soon worn away when on the tread. This bond, however, sooner or later becomes loose, owing to the difference in the coefficient of expansion of copper and steel, and this being followed by galvanic action, the resistance, which at first is slight, rapidly increases at the joint. Some provision by which solder could be run in might add to the certainty of this joint, the ductility of the solder taking up the unequal expansion and contraction.

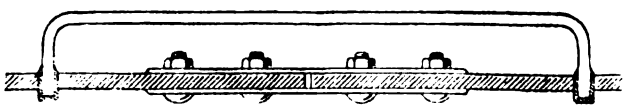

FIG. 5.—Taper Spring Cap.

Some of the older lines in the States, laid before the value of good bonding was appreciated, show an enormous loss of voltage from this cause. I was informed that on an old line in Richmond, Virginia, the bonding was done by No. 6 iron wires, and the same bonds used for a recent extension of 2½ miles, with the result that of 500 volts put into the line not more than 210 appeared at the distant end. The matter was investigated in consequence of bad working, and good copper bonds substituted for the iron wire, with the result that the loss was reduced to 5 per cent.

Bond wires are subject to corrosion by electrolytic action, especially in alkali soils. The wires consequently become thinner and conduct badly, and some of the current is shunted round the joint to earth, thus increasing the corrosion. Again, when the wires get very thin they become heated, and fuse, thus throwing extra load on other feeders. I was informed that the action was prevented by painting the wires, or coating them with shellac and asphaltum. The section or number of bond wires has, of course, to be increased nearer the power station.

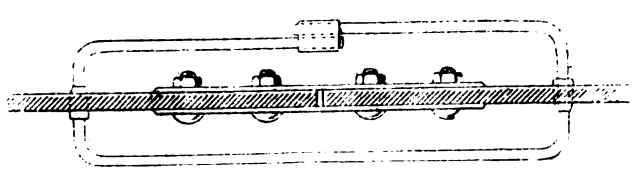

FIG. 6.—Split Steel Sleeve Bond.

The conductivity of the return circuit has been increased on some lines by the use of a supplementary wire, which is usually of bare copper §in. or ½in. diameter, laid along the centre of the track. Cross-connections from all bond joints are made by copper wire twisted and soldered to the supplementary wire, and on double tracks the supplementary wires of each track are connected every 30 yards. I saw new lines being laid with these wires in Chicago and Detroit, but I have also seen lines freshly opened up where the supplementary wires were considerably corroded, and was informed that their life was about two years. There were so many joints in the system, the wires used were so small, and were of such poor conductivity in comparison with a well-bonded rail, that the expedient appeared to me to be temporary and unreliable. In fact, I gathered that one of the chief uses of the wire was that its presence allayed to some extent the anxiety of the city authorities, otherwise harassed by water and gas pipe corrosion.

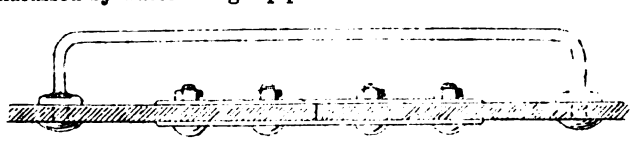

FIG. 7.—Bond Wire with Shoulder Riveted in one piece.

I next come to the earth as a return. I found that earth connections were made on most lines at their lowest points and at the power-house. Such connections were made by sinking old car wheels or driving rails or pipes in moist earth, and making as good a connection therefrom to the rails as possible; but, from all I could learn, not much reliance was placed on such returns. The extremes of weather no doubt have something to do with it, as hard dry earth is a bad conductor. Even wet mud in comparison to the rails is a poor conductor, as is evidenced by the brilliant arcing at the wheels of cars running on a muddy rail. In the *Street Railway Journal* for last December, some tests by Mr. James D. Rostron, chief engineer of the Union Railway Company, of Chester, Pa., bearing upon the conductivity of the earth as a return were published. Mr. Rostron obtained an average of 285·5 amperes through the track and supplementary wires, 12·8 amperes through the city water-mains, and only 0·51 through the earth-plates sunk in creeks. If this is confirmed by further tests, it shows that the conductivity of the earth as a return is not high, but depends upon the presence of metallic conducting matter within it. While in Chicago I made some tests to ascertain the approximate conductivity of the earth, and the difference of potential required to force current through pipes not metallically connected to a circuit. I laid some lead and iron pipes in earth, and at 1½in. distance above them I placed two iron plates as electrode, 6ft. apart. Each plate offered 20 square inches of surface, and the current passed partly through the 6ft. of earth from plate to plate through clay,

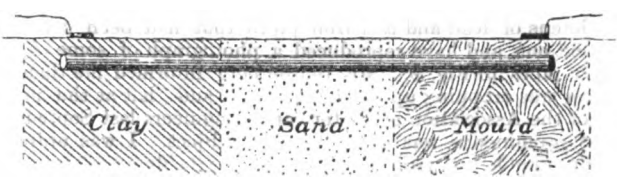

FIG. 8.

sand, and mould, and partly through 1½in. of earth at either end (clay and mould), and along the pipes, Fig. 8. I expected the resistance of the latter part would be almost nil, and, as I had 120 volts at disposal, I first put a resistance in series of four 105-volt lamps in parallel. I found, however, that the earth resistance was far more than I anticipated, and I removed three lamps with very slight increase of volts on the remaining one. The current was then half an ampere, and the earth absorbed 20 volts. A few days after, I obtained current from a 200-volt circuit, and put the four lamps on again. I then had 2½ amperes, with 100 volts absorbed by the earth. After keeping the current on for two weeks, the pipes were taken out, and were found to have a pitting of white scale in places at the negative ends. The scale was in white lumps, which, upon being scraped off, revealed the starting of little holes about $\frac{3}{32}$in. diameter. This proved that some of the current, if not almost all, had passed by the pipes through the 3in. of clay and mould. While I attribute this high earth resistance to the clay, which had set hard, I am still of opinion that the earth has more resistance than is generally imagined, and that to attract current in anything but very minute amounts from a well-bonded rail to earth requires special conditions—such as deeply sunk plates, metallic connection to pipes, the ground saturated with moisture, or an excessive density of current in the bonds. I was informed by Mr. C. H.

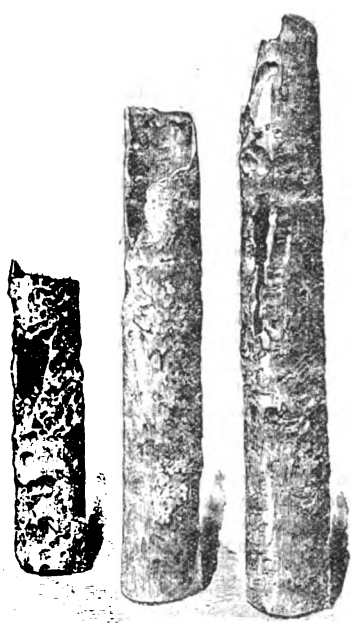

FIG. 9

Morse, the city electrical engineer of Cambridge, Mass., that in some tests he made at Saginaw, Mich., for the gas company there, he was surprised to find that pipes were eaten away in two or three months under a return current which did not exceed 500 amperes. The soil was, however, very moist clay, and the rails were connected to earth-plates.

This leads me to the question of the use of city water-mains and gas-pipes as return conductors. At Milwaukee, Wisconsin, where this was first brought under my observation, I was informed by the city engineer, Mr. G. H. Benzenberg, that considerable difficulty had been experienced. City water-mains and service pipes had become corroded in from two to three

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years, the action being most marked near the power stations. An attempt was made by the passing of an ordinance to stop the tramway companies connecting their rails to any pipes whatever; but the matter had gone too far, and the benefit to the latter companies in reducing volt losses by so doing was so marked that the practice was still carried on in spite of this ordinance. The matter was at length remedied by obliging the companies to make good connections to the water-mains at the nearest points to the power-house where the current left the pipes, such connections being taken right on to the switchboard return. The point proved was that pipes were affected at points where the current left them, like anodes in an electrolyte, and that protection could be afforded by putting a conductor instead of the electrolyte to earth. In this way pipes in an affected district could be thoroughly protected, but at considerable expense. It was evidently better to put such conductors to the rails direct, and not connect to pipes at all. I saw several specimens of lead and cast-iron pipes that had been corroded and cut out, and have reproduced a photograph of some of the larger pipes in Fig. 9. Mr. Benzenberg informed me that the matter was cropping up in several cities, and that at the meeting of the Association of Waterworks Engineers last September great prominence was given to this subject. I was unfortunately unable to visit Boston and Cambridge and see the extensive electric tramway systems and the enormous power-houses there, but partly by communications with Mr. Morse, and partly from Boston engineers who visited the exposition, I was informed of some of the experience gained on these points in those cities.

The amount of return current to deal with can be imagined when it it is known that the West End Railroad Company have an output of 12,000 h.p. This is distributed from three stations, of which the one at East Cambridge alone has an output of 6,000 amperes. Considering, also, that of 270 miles of track more than half is of 56lb. and 70lb. rails, laid years ago, and either bonded indifferently or not at all, it is not surprising that pipes and cables which were metallically connected to the rails in places should be affected. The information I have from authentic sources is that the water and gas mains and lead-armoured telephone cables suffered to a very great extent. The Bell Telephone Company tried earthing their cables by connecting them to lead plates buried in manholes, but this afforded no protection from the very heavy currents passing.

A curious experience was gone through in this city in reversing the direction of current. The supplementary wires resorted to as a means of increasing the conductivity of the track became corroded to such an extent that when a car passed an affected section a difference of potential was set up between rails and earth sufficient to cause shocks to people and horses. This effect was so great towards the end of the year 1891 that the West End Railroad Company reversed their current, making the rails positive and the trolley wires negative. The current then left the station by the earth connections, including all piping in the station, and the condenser pipes were attacked. Other troubles arose at fresh points where the current left the city pipes to get on to the rails, and to obviate these the current was again reversed, making the trolley wires positive again. The action was then noticed in places near the power house where the current left the pipes, and this was overcome by making heavy copper connections to the pipes in these places, and carrying the same to the negative poles of the generators in the power-house. It was also found that gas-pipes had to be treated in the same manner, and soldered connections were made between gas and water pipes in all large buildings and in places in the streets. Where the return currents reached 12,000 to 15,000 amperes the ground along the track was found to be heated, and return feeders from heavily loaded points had to be used. These were tapped down near the station to underground pipes as it was found that if this was not done the pipes entering the station were at a difference of potential sometimes as much as five volts—sufficient to heat an iron wire between them, with consequent danger of fire.

Mr. Morse, in a comprehensive paper on this question before the New England Waterworks Association at Boston, Mass., in January, 1893, describes having tried covering pipes with cracked stone, and in muddy places bedding them in cement as a protection; but this was costly, and of no use unless done completely over the whole pipe system. The trouble with electrolysis in this city I take to be due to the exceptionally large outputs and indifferently bonded rails. The city has purchased experience at heavy cost, but which has been of benefit to others. The adoption of return feeders and good bonding on later lines, with freedom from these troubles, has been one result. At the same time the congested condition of current-density has raised the question of some other means of distributing current to cars. One method about to be tried in Boston and Cambridge is the three-wire, or zone system. The rail or earth return would then be the neutral wire, and the sections of trolley wire would be alternately positive and negative. The section of the trolley and feed wires within a circle of, say, one mile of the power station would be at 500 volts positive potential, and the outer sections 500 volts negative. Further, this section might be again divided into half or quarter mile zones, or further subdivided, thus practically preventing any flow of current in the earth. By this means the potential and volume of current would be distributed more evenly over the circuit, and there would be less concentration of current at power-houses. The current would return by the insulated feeders. On the other hand, there would be a current flowing through the rails or earth from the cars on one section to cars on another; but this would supply power to twice as many cars as on the two-wire system. On rare occasions, if all cars happened to be banked on one section or a set of sections at one potential, the action would be like a two-wire system, and the current return by rails and earth to the station. The spark, on passing an insulated junction between trolley wires of opposite potential, could easily be deadened by a small high-resistance shunt across the break. The general advantage of such a system cannot be pronounced upon until it has been tried; but as far as the return current is concerned, it appears to offer considerable relief. I should mention here that in Boston the experiment was tried of welding the fishplates to the rails, thus making a permanent and reliable electrical joint. The Johnson Company, after obtaining good results on 3,000ft. of experimental track, were empowered to weld 16 miles for the West End Street Railway Company, and during two years the rails have shown no tendency to buckle. During this winter, however, I learn that the rails have broken into sections of a few hundred feet, due to contraction, the fractures always occurring near the weld. I believe, however, that this is the right method, and may still be modified to give successful results. The bond should be made outside the fishplates, allowing a loop for contraction, and the poles of the welder should be arranged to distribute the heat gradually from the weld, and so prevent abnormal strain of the metal. The absence of dissimilar metals in the joint ensures its permanency as long as the rails itself lasts, both as regards local action and expansion.

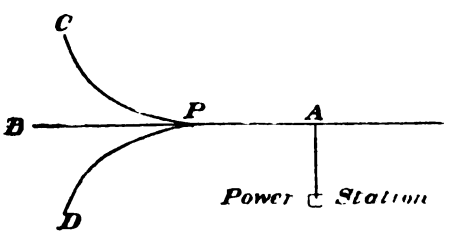

FIG. 10.

Reviewing the circumstances attending electrolytic action, as far as I have been able to gain information on the spot, I find that these troubles have chiefly been traced to insufficient conductivity at the rail joints, and to the want of proper return conductivity in the shape of feeders. When traffic on the lines increases, or extensions take place, and the increased power is drawn from the same supply station, either the bonds must be increased in sectional area (if they have not been put in at first of sufficient size for ultimate demands), or return feeders must be run to relieve the bonds, otherwise the consequence will be that the current will be crowded out of the rails into the earth. This is what has actually taken place on some systems in the States, and the current has been allowed to take its own course until the heating of rail joints and bonds has drawn attention to the want of conductivity. This crowding out occurs on the main or trunk lines, into which several branch lines converge. On simple lines, or those from which no branch lines radiate, it is less liable to occur, as even with an excessive volt loss per mile the density of current is well within the capacity of ordinary single bonds. Take, for instance, a line of three miles of double track between A and B, Fig. 10, and consider it first with no branch lines. Say we have a three-minute service of cars, and the average speed, allowing for stoppages, is 7½ miles per hour. The cars will then be three-eighths of a mile apart, and there will be eight cars on each track. With two motors per car the current will be about 25 amperes at maximum speed; but some cars will be starting, and using 100 amperes, and we may take a time average right through of 50 amperes per car. The maximum current returning to the power station from A will then be 800, and the maximum at B 100 amperes. The resistance of copper bonds varies according to method of bonding, length and size of bond wire, and whether it is double or single. Per mile run of rails the bonds may be from one-sixth to twice or three times the resistance of the rail. Taking a 70lb. rail with low-resistance bonds, say, of No. 000 gauge, 12in. long, and fixed double, we shall have the resistances per mile of rail 0·0344 ohm, of bonds (176 to the mile) 0·0056 ohm—total, 0·04 ohm, or 0·01 ohm for the double track. The voltage loss will therefore be one volt per mile per 100 amperes. Working this out for the varying strength of current on different portions of the return, we have a loss of 10 volts on 1½ miles from A to P, and four volts on an equal distance from P to B—total, 14 volts. Suppose now a branch line is laid from P to C, also of 1½ miles, with cars at same speed and same rate

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of service. This will then absorb four volts, but the loss between P and A on the trunk line will be increased to 19 volts; and if another similar branch, P to D, is added, the loss on the trunk line becomes 28 volts, or a total of 32 volts on the whole. When it is considered that with a theoretical continuous rail without bonds this loss is only reduced by five volts, it will be seen that to prevent waste of energy, quite apart from reducing current-density, we must connect return feeders to the rails on the trunk line. Now, considering the current-density, we have in the trunk line, when the two branches are in operation, a current of 1,300 amperes at P and 2,400 amperes at A. The maximum current per rail is therefore 600 amperes, and this on seven square inches gives a density of 86 amperes per square inch of rail (equivalent to 510 amperes per square inch of copper). This could be increased four or five times before any sensible rise of temperature would take place in the rail; but, considering the bonds, whose sectional area per rail is 0·262 square inch, we find we have a density of 2,290 amperes per square inch. It would probably take very little increase of current beyond this to cause heating of the bonds and crowding out of current into the earth; and yet the bonds on many lines in the States have less sectional area than the one cited, and the currents are from twice to four or five times as great, producing far higher densities in the bonds than they can carry. I am convinced that this is the cause of most of the electrolytic troubles in the States. Trunk lines into which a number of branch suburban lines feed are frequently of considerable length, and cars necessarily move slower in consequence of their accumulation on one line. Not only on account of the number of cars, but also because of their slower speed and frequent restarting, the current put on to the rails is very much increased, and the density in the bonds becomes far more than they can carry. We have seen that it is not a question of resistance or conductivity of the bond, as the voltage loss beyond that on a perfectly continuous rail is only increased by about one-sixth of that lost on the rail, and therefore the increasing of the conductivity confers no appreciable benefit so far as reducing voltage is concerned. The question is one of sectional area of bond with reference to the ultimate maximum current it is expected to carry, and this, I think, should not exceed 2,000 amperes per square inch. The sectional area of the bond refers as much to those portions in contact with the rail at the joint or joints, as to that of the single or double bond wire itself. I cannot leave this portion of my paper without a tribute to the pioneer work and enterprise of our transatlantic cousins. They meet every difficulty squarely in the face, and in spite of all obstacles "get there all the same." Our designs must necessarily comply with more conditions than are exacted in America, but when our difficulties have been the same our friends have generously been ever ready to impart their experience.

I will only touch upon one of the Board of Trade regulations—viz., rule 7—similar to which is rule 9 of the draft regulations for underground electric railways. In its draft form rule 7 exacted that the original or recorded resistance of the return should be maintained constant, with a maximum allowable increase of 15 per cent. In its amended form the same idea is carried out, but the element of current strength is included—namely, the product of resistance with current—that is, the difference of potential between extreme ends of the line—and this must not exceed seven volts. The framing of the rule, I take it, was aimed at securing a low density of current in the rail, thus preventing the crowding out of which I have spoken, and placing the pipes of gas and water companies beyond all harm. It seems to me that this end is not altogether accomplished, because with a given difference of potential, however low, it is possible to have a very high density in the bonds, with a very low one in the rail. In other words, under complete compliance with the rule the bonds may be carrying far too high a density and shedding their current into the earth. Referring for a moment to the example considered above, a heavier rail might be laid with bonds of less sectional area and still not alter the difference of potential at the ends of the uninsulated return. A 90lb. rail would have 0·0268 ohm per mile—that is, 0·0076 less than the 70lb. rail—and this difference could be made up of smaller bonds of less carrying capacity. By using single bonds of No. 00 gauge (0·104 square inch section) instead of double of No. 000 (0·131 square inch section), this is obtained very closely, and we have the resistance per mile of rail 0·0268 ohm, of bonds 0·0142—total, 0·0410, or 0·01 ohm, for the double track, as before. The difference of potential at the ends of the uninsulated return for the same currents is therefore unchanged, but the densities are very different. That in the rail is reduced to 66 amperes per square inch (equivalent to 400 amperes per square inch of copper), while that in the bonds is increased to 5,760 amperes per square inch—nearly three times more than the limit I alluded to. Some of this density is relieved, of course, by the conductivity of the fishplates, but this is of such a variable and unreliable nature that it should not be reckoned upon. Density, of course, can and should be relieved by return feeders, and these would be necessary on most lines of any extent to keep the volt loss within the required limit; but even with return feeders and low density in the rails I have shown that there might still be too great a density in the bonds if these were not of sufficient section. Further, it appears to me that a limit of volts per mile would be equally effectual and more workable than a certain limit for lines of all lengths and traffic.

Having endeavoured to put before you the results of my observations, I may say that I am convinced that bonds should be of sectional area proportioned to load, which will materially lessen cost of return feeders; and secondly, at points on the rails chosen with regard to load, return feeders should be connected of such section as to relieve the density of current in the rail. By return feeders I do not mean supplementary wires or connections to water-pipes, but metallic conductors either above or below ground, not necessarily insulated, but connected direct from the rails to the power station. Supplementary wires are of no use unless increased in section as the current increases, so as to keep an approximately constant density, and this I have never seen done; while making connections to water-pipes is a makeshift at best, and one that shows a want of good design. I believe that by designing the return circuit of electric tramways in the manner I have indicated we shall keep clear of electrolytic troubles upon gas and water pipes, and ensure an unhandicapped career for electric traction in this country.

I now come to systems in which the return is insulated from earth—namely, those using the overhead double trolley and the underground conduit. I was much interested in the double-trolley system working in the city of Cincinnati, Ohio, and wished to ascertain whether the insulation from earth was well maintained, and of sufficient benefit to warrant the use of such a system. I received the greatest courtesy during my stay in that city from Mr. George Hornung, civil engineer; Mr. H. P. Bradford, of the Cincinnati Inclined Plane Railway Company (using single trolley); Mr. Kilgour, of the Consolidated Street Railway Company (using double trolley); and Mr. Wm. J. Clark, of the General Electric Company, with whom I visited the power-houses and inspected the lines. I shall not easily forget my first impressions of double-trolley working, as I passed through Fourth-street to Fountain-square, in the busiest part of this city, on the morning after my arrival: cable cars, double and single trolley cars, and horse cars followed each other in rapid succession, often on the same track; but the most startling thing was the immense amount of trolley and span wires suspended over the roadways, with all the necessary adjuncts of insulators, guard wires, frogs, and separators. I watched several of the double-trolley cars rounding curves, and observed that the trolleys frequently jumped off the wires, and that the conductor on the car had to keep his eyes on the trolleys and steer them with the cord on passing curves. A good deal of extra complication was due to the presence of single-trolley wires along double-trolley tracks, and the necessary use of span wires in the narrow streets of the city. Out in the suburbs, however, the double-trolley construction was seen to better advantage, as the wide roads allowed for centre-pole construction. The rumour prevailed in other cities that the double-trolley system was on its last legs; but, so far from that being the case, I found that the Board of Affairs of the city had just granted the company powers to lay 50 additional miles of double-trolley track, the mileage then in operation being about the same in extent. No doub the rumour arose from the fact that this was the only city in the States (with the exception, I believe, of a small line at Rochester) that employed the system, and the history of its rise in Cincinnati was remarkable. The first to be put down was a single-trolley line, which was opposed by the telephone company on the ground of interference. Litigation resulted in favour of the latter company; but the tramway company appealed on two or three judgments to higher courts, and eventually got a verdict in their favour.

(To be continued.)

THE CITY ELECTRICAL INSPECTOR.

Mr. A. A. Voysey, who on Tuesday was appointed electrical inspector to the City Commission of Sewers, is 30 years of age. He learned mechanical engineering at the Barrow Steelworks, and studied under the late Prof. Lant Carpenter at the School of Electrical Engineering, Hanover-square, where he passed all his examinations at the head of the list. Leaving there, Mr. Voysey became connected with Messrs. Siemens Bros., where he was engaged under Mr. Jacob, the chief electrician. Subsequently he joined the firm of Callender's Bitumen Company, and for them he laid down the important low-tension distributing systems in Liverpool and Birmingham, and also carried out similar work in London and in Denmark for the same company. The largest work was, however, executed at Liverpool and Birmingham.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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Vol. XII. of new series of "THE ELECTRICAL ENGINEER" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

GISBERT KAPP.

It is an interesting custom with Englishmen to "speed the parting guest." In connection with this custom, a few of the friends of Gisbert Kapp will appear at a function to be held at the Whitehall Club in a day or two, consisting of a dinner and a presentation to the gentleman who is leaving us, whom, indeed, till recently we had not looked upon as a guest, but as one of ourselves. It may be said at once that the one great reason for Mr. Kapp's decision to leave this country has no connection with business at all. It is with great reluctance that he breaks away from friends who have grown up around him contemporaneously with the growth of the industry to which he is so bright an ornament, and to the progress of which he has so largely contributed. From almost the earliest days of the modern electrical engineering development Mr. Kapp has been connected with it. We well remember a remark of Mr. Crompton's, with whose firm Mr. Kapp was then connected. "He is a first-rate engineer," said Mr. Crompton, "but knows very little about the electrical part of engineering. It will be our business to introduce him to that, and he will soon pick it up." The foresight of Mr. Crompton has been completely justified by the lapse of time. Not only did Mr. Kapp soon pick up all that was then known about electrical engineering, but he soon pushed ahead into fresh fields and pastures, and from that early period has stood in the fore-front of all those whose work and investigations have reduced electrical engineering to an acknowledged industry, and separated and defined it as a distinct branch of engineering. At the time Mr. Kapp took up the practical work of electrical engineering the rule of thumb was prevalent—indeed, it was the only rule that reigned supreme. It was largely his work that enabled us to write a specification — to indicate and foretell the results a definite piece of apparatus should give. Gradually order was evolved from chaos, and we contend that much of the order is due to the work, the energy, and the ability of Kapp. The papers he has read and written are the classics of the subject. They are probably consulted by practical men more than all other papers and books combined. Others may have written more, but the writings mostly savour of pure scholasticism, and are practically useless. Mr. Kapp, with one or two others, has been, and is, the guide, philosopher, and friend of the practical man. And this is the man his friends meet and delight to honour, though it is to bid him farewell. We lose a man who had largely imbibed English thought, whose brainwork was quickened by contact with our best, whose labours have been among us and of us, and to whom we pointed with some national pride as a growth of England's possibilities. The incentive to his work was from England, and the results we claim for England. In the heyday of his experience, he is to give the whole of his unsurpassed powers to his native-speaking race. Our loss is their gain; and though we as a nation are somewhat uncouth and uncommunicative, we are sure that before Mr. Kapp leaves these shores which he has so long called home

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he will find that there is a depth of feeling among us, and a sincere admiration for all that is good and noble and honest, that he will, like many before and many who will come after, realise that only under exceptional circumstances can the depth of England's regard be duly gauged. Many of us will be unable to meet Mr. Kapp at the function to which we have referred, but we can assure him that the gentlemen who do meet him will all inadequately express the regret that is so general at his leaving us. The regret is the keener in that we know the cause to be chiefly due to the health of his helpmate, and we shall all unite not only in heartily wishing him every success in his new sphere, but that the change will bring brighter sunshine into his home and into his daily life. .

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

"OUR REVIEW OF REVIEWS."

SIR,—Sam suggested, you will remember, that I should make it hot for sheet lightning, and now I will fulfil my promise to do so. Before, however, making it very warm, I will refer to It of July 5. Of course "Gas Meter" occupies the first pages of this rag. Opening with the Tower Bridge, "Gas Meter" fully justifies his pseudonym by puffing in a reprint of a circular issued broadcast the gas lighting of the bridge as carried out by a firm of gas engineers. A firm of wine agents then receives attention. Perhaps "Gas Meter" is going to make electrical experiments with the wine—give it age, for instance. Well, I guess he can give it age—and body, too. Then he writes something about gas, of which, having such a lot himself, he tries to inflict a little upon others.

But who is Mr. Ohen? What will Mr. Chew, of Blackpool, think of this mutilation of his name? But, of course, he is not likely to look at It.

Chestnut, jun., discourses in the financial padding from the daily papers on the Wellsbach (*sic*) lighting. Is it not time that he learned how to spell? Surely Frenchmen who have lived in England for some years should understand a leetle Engleesh. I once knew a Frenchman who resided here for 12 years, and yet he did not know a well's back light from a duck's back. Chestnut, jun., then laments that the House-to-House Company does not pay a half-yearly dividend on its preference shares. Surely Chestnut, jun., who was, and I believe still is connected with the company, knows perfectly well the reason why it does not, and also why no dividend is forthcoming on the ordinary shares. But is it not rather nasty on his part to say to his brothers that "this is a very poor financial operation on the part of its Board?" Chestnut then hears for the first time, what you published about two months ago, about the conversion into a limited company of a firm of ventilating engineers.

In "Our Review of Reviews" "Faddist" actually says of its little schoolboy sister, the *Cable Gazette*, that it has "the usual sneer at parochial management." And this, too, after having loved her so well! Poor little baby; dear, sympathetic "Faddist"! Its idea of wit, It says, is to leave out the nots. "Lamplighter" will have to go to school again, too; poor little boy, talking about electrical energy at so much per 1,000, as if it was gas. But can you expect a "Lamplighter" to know of anything other than gas?

I found a copy of It in the train bearing the date of July 12. Don't know whether this was an advertising dodge—if so, it was not so good as that practised by the *Cable Gazette* on the *Financial Times*, which you recently exposed—or whether somebody had seen through It and become disgusted. When I reached Sam's house he said, "What a lark. 'Gas Meter's' been stung by a bee." "I don't know so much about it," I replied. "It looks as if he had been hugged by a bear." Sam could not see it for a moment, then he exclaimed: "Why, you mean the lightning express railway service which 'Gas Meter' now hears of for the first time." Then we both laughed. "Gas Meter" next quotes something from the *Cable Gazette* about electric heating and cooking, and says "this sort of things provokes laughter." Of course it does. Ha, ha, ha! Poor little sister, in for it again. Ha, ha, ha! Next he remembers in his "student days an electric foot-warmer being brought into the works to be tested." Evidently he has not yet ceased attending school. Ha, ha, ha! I really cannot help laughing. Fancy an electric foot-warmer in "Gas Meter's" student days of any time ago! Ha, ha, ha! This reminds me of a remark made by one man to another when passing down Bishopsgate-street the other day. He said: "Blessed if these lamps are burning right." "No, they ain't," replied the other. "You should 'ave seen the electric lamps here in '49; they was stunners." "Gas Meter," it seems, finds every week greater difficulty in padding out the space in this little sheet. He manages this week to fill up with such irrelevant items as the speed of torpedo boats, a cutting from a daily paper about the twenty-fifth anniversary of the Broad-street cable clique, and two columns about matters *only one hundred years old!* "Gas Meter" winds up by discovering for the first time that there are such motors as oil-engines.

"Faddist," in "Our Review of Reviews," desires to be once more friendly with the *Cable Gazette*. Isn't he a turncoat? He kisses his little baby sister, and says, "Be friends, ciss—won't you?" Then he tries to launch forth at the *Electrical Review*, which criticised Mr. Hammond's paper on electric traction. The *Electrical Review* was quite correct in its statements on the subject, and "Faddist" does not like it. But had "Faddist" anything whatever to do with it? Of course not.

I feel quite flattered by "Faddist's" reference to myself. He actually takes without acknowledgement a block from the *Electrical World* of the 2nd June to illustrate his own qualities, demonstrating that there is a close connection between lightning and a donkey. Good old "Faddist." It is suggested that I suggested there was an understanding on the part of It and preceding occupants of Its offices. I would never dream of believing It had any understanding. Chestnut, jun., and "Lamplighter" manage to pad out the remaining columns with a lot of stale matter that you have previously published.—Yours, etc.,

JOHNNY.

Timbuctoo, July 18.

GAS v. STEAM FOR CENTRAL STATIONS.

SIR,—My attention has just been called to the article in your issue of the 6th inst., and as you are good enough to invite discussion on the subject to which it refers, I beg to offer the following remarks:

Preliminary Installation.—An ordinary set of gas plant for 160 i.h.p. should not cost more than £500 erected, including builder's work.

If the estimates you give refer to the place I believe they do, the £732 for gas plant is due to the fact that the engineer included a much larger gasholder than usual—viz., 20ft. diameter by 10ft. deep, as part of the provision for additional power when required. Clearly it would be wrong to compare this with steam plant, which includes no such provision.

A six ton traveller for the gas plant is put at £300, and a similar one for the steam plant at only £200.

The buildings are put at £2,000 in each case, but with the gas plant there would be no costly chimney shaft.

The above items affect the 10 per cent. for contingencies and the interest on capital outlay.

Complete Installation.—If this plant is for the place I suppose it is, the engineer for reasons of his own made it include *three* gasholders, each 20ft. diameter by 10ft. deep, and *nine* generators and *nine* sets of scrubbers, etc. In the usual way, one holder of the above size and five generators, etc., would be amply sufficient. For some years past Messrs. Crossley have used one generator to serve about

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300 i.h.p., and other examples of large powers could be given.

The effect of having three separate gasholders not only increases the initial outlay for plant, but adds materially to the ground space and builder's work.

Working Expenses.—The estimates for gas power are based on anthracite at 24s. a ton, whereas gas coke can be used, and the local price of this is probably under 10s. a ton. There are several gas plants working well in the North with coke, and it is hardly fair to gas power to take its fuel at 24s. against 6s. for steam.

If anthracite is used, the consumption should be taken at 1lb., not 1½lb., per indicated horse-power per hour, in engines of the size selected.

The cost for water for gas power is wrongly stated, as 500,000 gallons at 7d., per 1,000 = under £15, not £150.

The repairs and maintenance are taken as higher for the gas power than for steam power, whereas the contrary is guaranteed.

No mention whatever is made of the fact that the stand-by loss in gas generators is much less than in boilers. The loss in one generator of 300 i.h.p., when standing several hours with a fire in it, is under 8lb. per hour.

As these erroneous estimates have been published without explanation, I venture to suggest that it will be only fair to the engineer that his report should be published also, as in this he may have given some explanations which it would be well for your readers to know of.—Yours, etc.,

J. EMERSON DOWSON.

SIR,—In your issue of the 6th inst. we notice on page 10 tables giving the estimated comparative costs of an electrical plant driven by steam or gas engines. Some of the figures in connection with the expenses of the gas-engines seems to us to require revision.

In the first place, you will find that the figures bracketed together as being the cost of the Dowson plant, gas-engines, dynamos, water-tanks, and overhead traveller, amount to £3,042, instead of £3,092, as printed. In comparing the figures, it seems strange to us that the cost of a six-ton overhead traveller in connection with a gas-engine should be £300, whereas the same article when used in connection with a steam-engine can be bought £100 cheaper. Assuming the cranes to be the same, it seems a little hard that in the case of a gas-engine such an invidious distinction should be made!

The price of the two Crossley gas-engines of 35 nominal horse-power is also rather high, as we consider that engines of this size could be delivered and fixed under ordinary circumstances for £1,000. We also note that £100 is put down for water-tanks, piping, and connections, which would be included in the £1,000 above mentioned. The cost of the Dowson gas plant also seems to us rather high for this power; but leaving this figure alone, our estimated capital of the gas plant would be as follows:

One Dowson gas plant, including one gas-tank, two generators, scrubbers, etc., fixed, taking your figure	£732
Two Crossley gas-engines, each of 35 nominal horse-power, delivered and fixed	1,000
Two Siemens dynamos, as per your figure	710
One six-ton traveller	200
Electrical instruments, etc., as per your figure	1,700
Distribution service, etc., as per your figure	1,200
Central-station buildings, as per your figure	2,000
Contingencies, etc., 10 per cent.	754
	8,296
Add for land, etc., as per your estimate	1,000
Total	£9,296

This brings the cost of the plant worked by gas-engines to £64 less than the estimated cost of the steam-engine and plant.

Then again, in the third and fourth tables giving the working expenses for the two plants, you give the consumption of anthracite in our engine as 1½lb. per indicated horse-power per hour. This is 50 per cent. higher than it need be, as in making gas on such a large scale you will be quite safe in allowing a consumption of 1lb. per indicated horse-power per hour. This would considerably modify your figures, and would bring down the total of Table No. 3 from £1,116 to £1,102. This you will see is also less than the corresponding figures giving the estimated cost of working the steam plant. By making the same reduction in the amount of fuel used in Table 4, you will arrive at a total of £4,240 instead of £4,440.

We think, therefore, that when all these alterations are made, the gas-engine-driven plant will, on the whole, be found to be the cheaper of the two.

Another very important item which appears to have been left out in Table 1 in the case of the steam-engine plant is the cost of a chimney; and we see that for central-station buildings £2,000 is allowed both for the gas-engine plant and also for the steam plant. If the £2,000 is supposed to cover the cost of the boiler chimney in connection with the steam-engine plant, then the buildings for the gas-engine plant would be considerably less than £2,000, as no chimney stack is required.—Yours, etc.,

CROSSLEY BROS., LIMITED.

Manchester, July 13, 1894. (D. H. Irwin, Director).

SIR,—I have been very much interested in noticing your article on "Gas *v.* Steam for Central Stations," but I do not consider that the comparison between the two is at all fair so far as the cost of fuel is concerned.

In the first place, there are very few parts of England where coal can be obtained at 6s. per ton, and there are very few parts of England also where anthracite coal cannot be obtained at considerably less than 24s. per ton, so that in both these cases the advantage would be considerably in favour of producer gas. In the neighbourhood of London, for instance, steam coal cannot be obtained under 14s. to 15s. per ton, and anthracite coal can be obtained at from 17s. to 18s. per ton. On the above calculation, instead of the balance being against producer gas, there would be a balance of about £100 in favour of it.

I also notice that you put down the cost of an overhead traveller for six tons at £200 in one case and £300 in another. I am erecting a six-ton overhead traveller at the present moment with 36ft. span for less than £100.—Yours, etc., HENRY ROGERS, M.I.M.E.

The Engineering Works, Watford, July 13.

REVIEWS.

The Electric Central Stations at Cologne and Amsterdam. By CARL COERPER. Translated from the German by CLARENCE P. FELDMANN. The International Electric Company, 55, Red Cross-street, Barbican, E.C.

We have received from the International Electric Company a copy of what they are pleased to term a ponderous work, but which we should be more inclined to call a magnificent work. It is perfectly certain that there is no other electrical work possessing, in a certain way, more value than this. A great many thoughtless people incline to the opinion that English people are great readers. No doubt that opinion is formed from the casual paragraphs which appear in ordinary newspapers to the effect that so many thousands or scores of thousands of readers have visited a free library, or that so many thousands of books have been lent therefrom. When, however, we come to analyse the reading of this reading fraternity, we find that it is mostly directed towards pleasure than profit. In other words, the majority of these readers are readers in name and not students. The class of reader which we should like to see extended is the student class. Unfortunately, this class is comparatively small in numbers, but in every department of life we find the men who make their mark are those who keep themselves well abreast with all that goes on in their respective industries. The electrical engineer cannot have had a long experience nor a varied one, so far as he is personally concerned, and he can only extend his experience by carefully considering

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the experience of his colleagues, and he must learn both from their successes and their failures the steps which he ought to take in his own practice to lead him to succeed. Such a work, then, as we have named above ought to be of immense value, in that it not only describes two very fine central stations, but it also illustrates upon a very large scale, and in an excellent manner, the whole of the details of these stations. This will readily be seen when we give as the dimensions of many of the illustrations a size of 24in. by 18in. or 19in. There are 33 large engravings of this kind, in addition to some 60 smaller illustrations interspersed with the descriptive text.

We have at various times referred to these installations in our pages, but it is evident that our references have been too meagre, and that the work of these stations ought to be, even by English electrical engineers, more carefully examined. We hope to be permitted to do this from time to time. Take, for example, the tabular statement which takes the distribution of energy delivered to customers. This tells us not only that there are a certain number of customers at Cologne, but the class of customers, the energy delivered to the various classes, the number of lamps both of arc and incandescent, giving the equivalent of these lamps and 16 c.p. lamps—which, by the bye, we prefer to the English system stating equivalents in 8-c.p. lamps—concluding with a column showing the mean annual hours with mean annual number of lamps. We find in this last column that 122 is the smallest number of hours, and stands against private houses there; 585 is the largest number of hours standing against factories, workshops, and warehouses, thus leaving out the number of hours at the station itself, which is not usually a figure required in calculations. The next largest item is 550 hours for the restaurants, hotels, etc., banks and offices reading 420 hours, and shops 413 hours. The financial results of the working at Cologne are stated to be 141,354 marks, distributed as interest, redemption, and fund for renewals; while Amsterdam has earned 82,646 florins, half of which have been distributed as interest on the bonds.

These few remarks will suffice for the moment to call attention to this magnificent work, and we must leave for the future any other remarks we may feel inclined to make.

The author of this book is the managing director of the Helios Company, and he describes herein work that has been carried out under the company.

SOME STORAGE BATTERY PHENOMENA*.

BY W. W. GRISCOM.

(Concluded from page 48.)

This fall of temperature on discharge was first brought to my attention in 1887, when some of the cells of the Julien cars on Fourth-avenue, New York, were reported to heat unduly, and the explanation offered was that they were called on for increased currents on certain grades with unfavourable conditions of the tracks. As some of the cells did not heat, I was not satisfied with the explanation, especially as the resistance of the cells, about ·002 ohm, would only account for about 1¼ heat units even on 100 amperes discharge. I then investigated the question and found that the temperature actually fell even with heavy current, when the cells were in good order.

The potential of a cell is partly due to the degree of charge of the positive and partly to that of the negative and partly to the electrolyte. If a negative plate taken from a fully-charged cell indicating, say, 2·65 volts on the normal charging current, is coupled with a positive from a partly-discharged cell, indicating, say, 1·9 volts on its normal discharge current, the E.M.F. of the combination will lie between the two. If the couple be removed to a stronger or weaker electrolyte, the E.M.F. will rise or fall accordingly. So that a measurement of the potential difference at the terminals of the cell is not an infallible indication of its condition of charge. If both plates are equally charged the indication is most useful, but when, as frequently happens in actual service, one plate is further discharged than the other, the potential difference is deceptive.

The variations of specific gravity of the electrolyte are practically proportional to the ampere-hours of useful charge or discharge—barring local action, short-circuiting, change of temperature, and a gradual sulphating of discharged positives when idle.

The variations of the internal resistance of a cell afford a valuable indication of the condition of its active material, and therefore of its degree of charge. These variations have been attributed to the varying porosity of the active material—the electrolyte becoming more and more excluded as the pores become clogged. But this explanation does not account for the odd but invariable nature of the characteristic curves of the internal resistance. If this were the true explanation, why does the curve fall rapidly in the early part of the discharge instead of rising? Why should it remain constant for the greater part of the useful discharge? Why should it suddenly rise to a great degree, and then fall in the middle of a prolonged charge? Why is the internal resistance less instead of more on a higher rate of discharge? These facts are not easily reconcilable with the clogging theory, and our knowledge of the chemical reaction is not sufficient as yet to afford a convincing explanation.

Experience shows that it adds greatly to the life of a cell and brings other advantages to stop the charge at between 2·3 and 2·45 volts, and to stop the discharge at 1·90 or 1·95 volts, while a comparison of the accompanying curves of a cell will show that these potentials are reached shortly before or during a sudden rise of the internal resistance.

A very curious misapprehension prevails among some battery people, in spite of the airing the subject has again and again received, to the effect that the negative plate has more capacity than the positive. If a cell be discharged at a high rate—to 1·88 volts, for example—the positive plate will show a much lower potential than the negative, and might therefore be deemed to be more discharged. If, then, the negative element be transferred to a freshly-charged positive element, the negative will usually show a considerable additional capacity, and this has been cited as a proof of the erroneous statement. But if the positive be similarly treated, it usually shows considerably greater capacity than the negative. This is especially the case with the Faure cell, in which the positive actually has 25 per cent. more volume of active material than the negative, and shows 45 per cent. more capacity; and is even so on a Planté negative, which has as much active material as the positive, and yet the latter has nearly 10 per cent. more capacity.

The positive plate is usually made of greater capacity than the negative in order to prevent it from ever becoming discharged, to allow for its gradual loss of active material, but there are grounds for doubting the propriety of so doing. A negative plate ought never to be discharged so far as to drop after the first 10 minutes more than 1 or 2 per cent. in voltage, yet the temptation to do so with 45 per cent. excess of capacity in the positive is very great—with the result of causing shrinkage of the negative paste and a serious loss of capacity in the cell.

There is another action which goes on in storage batteries, and presumably in other forms of electrolyte chemistry, which I have not seen explained, nor, in fact, described. When the chemical reaction in an electrolytic cell are simple, as, for example, decomposing sulphate of copper or sulphate of zinc, the amount of action is proportional to the ampere-hours. But when the possible chemical reactions are complex, as in a storage battery, the changes are governed by the potential difference, as well as by the current, probably because one of the components requires a different E.M.F. to break it up from that required by another. A curious result ensues. Perhaps the current governs the amount of chemical action and the potential the kind. Our factory department reports that if a plate pasted with red oxide of lead is opposed to a plain lead grid in a "forming" bath, the formation of peroxide proceeds evenly and uniformly in the well-known way. If it be opposed to a pasted

* Paper read at the American Institute of Electrical Engineers,

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negative, the same result follows. But if it be opposed by another positive plate a different action ensues, and the unformed plate cannot be properly converted to peroxide until the other positive has been completely reversed and converted into a negative, thus raising the potential difference of the cell. In the curve of the Faure cell it will be noted that at the time the potential of the piles suddenly rises, due to the sudden increase of the potential of the negative plate, there is at the same time a sudden increase of the internal resistance of that plate. This is, however, accompanied by a sudden and apparently sympathetic perturbation of the internal resistance of the positive plate, showing that some chemical change occurred in it, quite different from the usual action. This perturbation ceased as soon as the negative potential ceased to rise.

There are two other phenomena to which I will refer briefly in the hope that some members may be able to throw some light on their cause—viz., the sudden spontaneous discharge of a fully-charged positive, and the tendency to buckle away from the light—*i.e.*, with a concave face toward the light. Wherever the tendency to buckle is great, as in treating Planté plates in some of the more rapid methods, I have observed that when a single positive is suspended freely a great distance from a negative in the centre of a large jar, the buckling is invariably away from sunlight. The plate may be turned around, it may be moved quite close to one negative or the other, yet the buckling repeats itself invariably from the light. The plate may be straightened as you will, it may be left with a slight curve in the other direction, yet neither the natural differences of tension in the two sides of the plate nor the increase or diminution of electrolytic action on either side has any influence in buckling compared, apparently, with the action of direct sunlight.

It will be remembered that Prof. Ayrton, in one of his valuable contributions to storage battery literature, commented on the theory of Mr. Crompton regarding the effect of light on the sulphating of the negative plate, and detailed an interesting experiment which, although not conclusive, tended rather to confute this theory. Sir David Salomons remarked upon the effect of light on the glass cells causing them, he said, to crack. Altogether it would seem that storage batteries are devices which engineers would do well to keep in the dark.

The automatic discharge of the positive plate is a comparatively rare phenomenon. In my experience I have secured accurate data in only three instances. I am under the impression that Sir David Salomons, when by his courtesy I was enabled to examine his splendid private plant in 1886, mentioned this phenomenon, but I do not find it described in his book, and as it may not have recurred in his experience he may have felt some hesitancy in publishing it.

On one occasion a cell was reversed experimentally, and the reversing charge continued until 470 ampere-hours, or three times the normal capacity of the cell, had been passed through it. The potential attained 2·41 volts on a low charging rate. The positive had the healthy dark colour of electrolytic peroxide of lead and was freely gasing, showing that it was as fully charged as possible. The charging current was interrupted, and the E.M.F. fell gradually to 2·12 volts in a perfectly normal way. In 35 minutes a curious seething sound attracted my attention to the battery, and I found it in a state of violent, almost explosive, ebullition. The gas given off was pure oxygen in immense quantities. The temperature at the botttom of the cell had risen from 68deg. F. to 85deg. F., and at the top of the cell it reached 109deg. F. Fifteen minutes later the cell was quiescent, the voltage had fallen to ·84, and the specific gravity from 1·157 to 1·123—the lowest point which it had reached 470 ampere-hours before. Two or three days later the E.M.F. was zero.

During the progress of the phenomenon and afterward the cell was examined carefully with the most minute care for any defect, short-circuit, or other irregularity, and it was found to be in perfect order. A further charge of 876 ampere-hours, or about six times the normal capacity, was given at a normal rate. On this charge as well as on the first reversal charge another curious effect was observed—the voltage rose in 15 minutes from zero to 0·18; in one minute more it jumped to 2·63. It then gradually fell to 2·01 in about seven hours and thereafter gradually rose to 2·48. The discharge was normal to 148 ampere-hours and presented a peculiarity of a fully-charged cell—that is to say, the E.M.F. fell in two minutes from 2·05 on 30 amperes to 1·935, and then rose in a few minutes more to 1·94 volts, and then gradually fell the usual way.

Here, then, is the story of a complete automatic discharge of positive plates from the beginning of the preceding charge to the end of the following normal discharge. Was it because the peroxide formed only to a certain depth in a spongy lead and so densely as to exclude the electrolytes for a time, so that when the liquid at last penetrated the spongy lead a violent local action ensued? This would account for the heat, and for the fall of potential and of specific gravity, but would it account for the liberation of immense volumes of oxygen? I have frequently noticed the presence of considerable quantities of peroxide of hydrogen in electrolytes. Gladstone and Tribe have also remarked this substance, but intimate that they found it in minute quantities only. In some cases, however, I have observed it in very considerable amounts. Is it possible that this substance was present and exercised its well-known property of liberating one atom of oxygen from peroxide of lead and another atom of its own oxygen at the same time? This would account for all the phenomena, but what accounts for the peroxide of hydrogen in such an enormous amount, and why does it not always discharge oxygen from the peroxide? And finally, is it possible that the continuous evolution of oxygen on the positive plate while the cell is idle is sometimes due to the presence of peroxide of hydrogen in minute amounts, and not merely to what has been called local action? I trust some of the gentlemen present will enlighten us on this point.

Perhaps the most striking peculiarity about the modern storage battery is the diversity of opinion among professional electricians as to its utility and commercial value. Men of the highest rank as electricians and engineers are ranged on either side of the question. Men of affairs who have put them to a commercial test exhibit a like divergence of views. Men who have tried the storage battery for a year or two have written about it in the most flattering terms and have discarded it later. Men who have used accumulators ever since their introduction, when they were much less efficient machines than now, continue to use them, and would under no circumstances be induced to part with them. Unmitigated praise on the one hand and unmitigated contempt on the other. Broadly stated, the European consensus of opinion, both technical and commercial, may be said to be in favour of storage batteries. The American view until now has been mainly the opposite. What is the ground for this wide discrepancy? Why is cautious, conservative Europe so far ahead in the race? Why is America a laggard in the running?

The answer is not far to seek. Storage batteries are almost always an economical success abroad, while here they have been too often an economical failure in the past. And the reason is that the European always demands a margin for safety, while the American, with less capital and keener competition, is tempted to sail too close to the wind.

A storage battery continually worked to its commercial rating is a commercial failure. A storage battery worked sufficiently within its capacity is invariably a commercial success.

It has been said of Watt that he pursued careful and exhaustive experiments upon the power of horses for all day work, and that he ascertained that the average power which they could maintain for 10 hours was 22,000 foot-pounds per minute, but in rating his engine he added 50 per cent. and called the horse-power 33,000 foot-pounds per minute, so as to make his new pumping devices more than satisfactory substitutes for horses. Would that storage battery people had been equally wise.

The writer has had occasion to watch with the closest scrutiny a considerable number of plants, aggregating perhaps some millions of plates. These batteries were rated, like all reputable makes, well within their capacity

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in ampere-hours measured by charging the battery to about to 2·65 volts, and then discharging it until the potential difference was 1·8 volts per cell. Some batteries have been spoiled by bad management and neglect, and some by false economy or bad engineering at the very start. By eliminating these there remain a very large number which were successful or were failures for no apparent reason. The utmost care was exercised at the factory. The constituent materials were analysed as soon as purchased. Able engineers watched the processes of manufacture, but while the quality of the battery was improved until no flaw, mechanical, electrical, or chemical seemed to remain, still an occasional failure occurred in actual practice, and the cause eluded our search.

Finally, by classifying the failures and successes, the truth dawned upon us. Wherever the battery was exhausted to its full capacity daily, its life did not exceed 500 discharges, but wherever it was worked within two-thirds of its capacity, complaints were unknown.

Exhaustive tests were undertaken, and some curious phenomena heretofore unknown to the writer were disclosed, and after some hesitation he concluded that they might be of interest to this society.

It is natural to ask why the rating should not be changed so that the owner of the battery would not be tempted to work it to the danger limit. That is a commercial question. In these days of close commercial figuring it would be difficult to sell a battery which appeared *cæt ris paribus*, to cost 50 per cent. more than its competitors. The present rating is strictly accurate and has the sanction of custom the world over. It is only necessary for the engineer to remember to add 50 per cent. of the capacity as a factor of safety to his maximum load, just as he allows several hundred per cent. in calculating the strength of a bridge or axle.

This additional amount is not a dead loss in investment. It produces many countervailing advantages. It saves the necessity for regulation in most instances. It provides a very effective and safe reserve for cases where the charging apparatus breaks down and for many other cases, and it improves the actual efficiency of the battery, which arises from about 80 per cent. to nearly 90 per cent. when used with a sufficient reserve. And for cases where it is necessary to maintain a constant difference of potential, such as electric lighting, it raises the efficiency much more, because in these cases the commercial efficiency must be rated not from the average point of E.M.F. but from the lowest point to which the battery falls on discharge, and when used in this way the potential difference drops only 2½ per cent. All the E.M.F. above the lowest point must be wasted in order to secure regulation, unless the troublesome method of regulating by the introduction of extra cells is adopted.

In circuits where this regulation is of no consequence, as in motor circuits for cars, all the E.M.F. is utilised in increasing the car miles per unit of energy.

In this connection it is perhaps worth while to call the attention to a very common misapprehension on the part of engineers. A storage battery for trolley systems or other central stations for the production and utilisation of electricity has heretofore been regarded in this country as a very expensive addition to the plant. But this is not always the case. There are many opportunities for introducing storage batteries as a part of the original plant without increasing the cases, as, for example, in cases where the maximum output is two or three times greater than the average output. In the tables here given I have taken Emery's figures for a basis for the steam plant.

1,000 h.p., Direct System.

Cost of steam plant	$70,000·00
Electric plant, 750 kilowatts, at 30dol. per kilowatt	22,500·00
	$92,500·00

1,000 h.p., Storage System.

One-half steam plant	$35,000·00
One-half electric plant—375 kilowatts	11,250·00
1,500 kilowatt-hours, accumulator capacity, at 30dol. per kilowatt-hour	45,000·00
	$91,250·00

Now that batteries are made in large units and in much more compact shape than formerly, with increased facilities for handling, it is to be hoped that the engineers in this country will begin to give the subject of their introduction more attention, especially as a cell having a capacity of 24 kilowatt-hours occupies a floor space (exclusive of connections) of less than a square yard.

A battery's discharge should be stopped after its E.M.F. has fallen to two volts, or at furthest to 1·9, unless it be desirable to draw upon its reserve. It should be understood that a full discharge—that is, to 1·8 volts—is working a battery to the danger limit, and is unadvisable for the following reasons: (*a*) regulation is troublesome; (*b*) efficiency is low; (*c*) dangerous molecular changes take place, as indicated by changes of internal resistance and changes of E.M.F., as well as occasional buckling; (*d*) uneven plates discharge into one another after the circuit is interrupted; (*e*) the life of the battery is diminished.

I desire to acknowledge the aid I have received in the study of these phenomena from my very competent laboratory assistants, as well as the accurate and fatiguing work, both night and day, kindly undertaken by two of them, Hugh Lesley, aided by Norman Mellor, in making the measurements and plotting the curves herewith presented for your consideration.

TRAMWAYS IN GERMANY: A COMPARISON BETWEEN THE COST OF HORSE TRACTION AND ELECTRIC TRACTION.

In the *Foreign Abstracts* of the Institution of Civil Engineers an article on the above subject is given from the *Zeitschrift für Transportwesen und Strassenbau.* It is as follows:

The comparison is founded on many years' experience of an important German tramway company in horse traction (the situation of which, however, is not given), and by carefully obtained trial results in electric traction.

The tramway selected is 8·08 miles in length, and establishes intercourse between a large town and several suburbs. The time-table is so prepared that the trams run at 6.0, 6.30, and 7.0 a.m., and then every quarter of an hour until 9.0 p.m., after which they run at 9.30, 10.0, 10.30, and 11 p.m. The car, which is a one-horse one, carries 30 persons inclusive of driver and guard; on 20 days of the year it is necessary to double this service.

With the use of horse traction, a speed of eight to ten miles an hour is the limit, and eight cars are required for the service; 126 (2 × 63) single tours are made daily, and 1,018·08 (126 × 8·08) car miles are run, consequently 391,961 [(365 + 20) × 1,018·08] car miles are run in the year.

As the daily performance of a horse in tramway work amounts on the average to 16 miles, theoretically 63 horses are required for the usual traffic, but in practice 10 per cent. more are added to make allowances for disease and rest, so that 70 horses are kept. The 70 horses represent a capital of £3,150 (70 × £45), and a further sum of £4,250 is required for land and buildings. The following tables are then given as representing the yearly cost of horse traction.

I. Payment of Interest and Depreciation.

4 per cent. interest on £7,400 (£3,150+£4,250)	£296	0	0
15 ,, depreciation of capital value of horses	472	10	0
1½ ,, ,, ,, ,, buildings	63	15	0
Total	£832	5	0

II. Cost of Management.

Salary of manager	£90	0	0
Wages of eight drivers	360	0	0
Wages of six stable-boys	150	0	0
Provender for 70 horses	2,175	0	0
Harness and shoeing	287	10	0
Veterinary treatment	65	0	0
Repair of stables, etc.	100	0	0
Sundries	72	12	0
Total	£3,300	0	0

These two sums, amounting to £4,132. 5s. yearly for 70 horses, gives 3s. 2·8d. per horse per day. But to this sum is still to be added the hiring price of 63 horses for

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20 days at 5s. per day, which amounts to £315. Therefore the total yearly disbursement for horse traction is £4,447. 5s., the cost per car mile being 2·72d. $\left(\frac{£4,447.\ 5s.}{391,961}\right)$.

The estimate for electric traction is founded on the overhead line system of O. L. Kummer and Co., of Dresden. Each car is provided with two electromotors of 8 h.p. The capital required is estimated as follows:

Land	£150	0	0
Buildings	1,600	0	0
Boiler and engine and two dynamos, including all fittings	3,750	0	0
Length of 8·08 miles of line work, fixed complete	3,500	0	0
Electric fittings for nine cars, one of which stands in reserve	2,250	0	0
Total capital expenditure	£11,250	0	0

The following tables are then given as representing the yearly cost of electric traction:

I. Payment of Interest and Depreciation.

4 per cent.	interest on £11,250		£450	0	0
1½ ,,	depreciation on buildings account		24	0	0
7½ ,,	,,	engine, etc., account	281	5	0
5 ,,	,,	line work account	175	0	0
15 ,,	,,	electromotors account	337	10	0
Total			£1,267	15	0

II. Cost of Management.

Salary of manager	£90	0	0
Wages for three enginemen	180	0	0
Fuel	830	0	0
Carriage of cinders	10	0	0
Lubricants	125	0	0
General repairs	225	0	0
Sundries	72	5	0
Total	£1,532	5	0

These two sums, amounting to £2,800, give 1·72d. per car mile as the cost of electric traction.

The paper concludes in enumerating several advantages that electrical cars possess over the horse cars in the matter of speed, safety, and size in crowded streets, as well as in cost.

THE LONDON COUNTY COUNCIL AND METROPOLITAN SUBWAYS.

PROPOSED REGULATIONS.

The Highways Committee of the London County Council reported to that body on Tuesday that by Section 10 of the London County Council (Subways) Act, 1893, the Council is empowered to make, vary, and enforce by-laws regulating the use of all the subways vested in it at the time of the passing of the Act, and by such by-laws to fix and determine the scale of fees to be paid for the use of the subways, and the penalties for breaches of the by laws. The by-laws when made by the Council are, however, not to come into effect until they shall have been confirmed by the Board of Trade. Notice of the intention to apply for such confirmation is to be given to the Postmaster-General; and such other notices as the Board of Trade may prescribe are also to be given before the Board takes the by-laws into consideration. The committee have given consideration to the question of what restrictions and conditions should be imposed upon companies and others using the Council's subways, and have prepared a draft code of by-laws which in their opinion should be made by the Council.

These by-laws do not apply to any pipe or wire authorised to be laid or placed by any provisional order or license under the Electric Lighting Acts, 1882 and 1888, or under any special Act incorporating the said Acts or (in respect of such wires) to any company authorised to lay or place the same.

The following are the by-laws which the Council is asked to make:

1. Fourteen days at the least before the day on which any company, body, or person desires to place or bring any pipe or wire into a subway, such company, body, or person shall give notice in writing to the Council of such desire accompanied by full particulars in writing of the position and manner in which such pipe or wire is proposed to be brought into and placed in the subway; the dimensions and full particulars of any pipe or wire that is proposed to be placed or brought into the subway; and also the proposed method of supporting the same, and, in the case of a wire, particulars of the insulation and highest E M.F. for which it will be used. No company, body, or person shall place or bring any pipe or wire into a subway until the Council shall have signified its consent in writing under the hand of its engineer to the position and manner in which such pipe or wire is to be placed, and to the method by which such pipe or wire is to be brought into the subway.

2. Fourteen days at least before the day on which any company, body, or person desires to take any pipe or wire out of a subway such company, body, or person shall give notice in writing to the Council of the manner in which such pipe or wire is proposed to be taken out of the subway. No company, body, or person shall take any pipe or wire out of the subway until the Council shall have signified its consent in writing under the hand of its engineer to the manner in which such pipe or wire is to be taken out of the subway.

3. A company, body, or person desiring to repair or alter any pipe or wire in a subway shall (except in case of emergency) give three days' notice in writing to the Council of the manner in which such repair or alteration is proposed to be made, and shall not commence such repair or alteration until after obtaining the consent in writing of the Council to the same under the hand of its engineer. Should any case of emergency arise, particulars in writing of any work done shall be forthwith sent to the Council's engineer.

4. No company, body, or person shall commence the execution of any work which will involve the alteration and reconstruction of any part of a subway until the expiration of 48 hours after such company, body, or person shall have given to the owner of every pipe or wire in the subway notice in writing specifying the nature of the work and the time at which it is to be commenced.

5. No company, body, or person shall take into a subway any candle, lamp, or light other than a safety lamp of a pattern approved by the Council, or smoke, or take, strike, or use therein any match, without the consent in writing of the Council under the hand of its engineer.

6. No company, body, or person shall open or raise any grating or other means of access to a subway or enter therein (except in case of emergency) without the consent in writing of the Council under the hand of its engineer. N.B.—The keys of the subway entrances will be kept at such places, and by such officials, as may from time to time be appointed by the Council for the purpose; each company, body, or person having pipes in a subway will be supplied by the Council with a card stating the places at which and the names of the officials in whose custody the keys are kept, which card shall be produced to the official whenever application is made for access to a subway; and such officials will arrange for the opening and closing when required of the gratings or covers for persons entering or leaving a subway.

7. No company, body, or person shall allow any grating or other means of access to a subway to be opened or to remain open without providing a temporary fence or protection and leaving a watchman to guard the same.

8. No company, body, or person shall (except in case of emergency) enter or remain in a subway between the hours of 6 p.m. and 6 a.m.

9. Every company, body, or person having a pipe or wire in a subway shall within six months of the confirmation of these by-laws deposit with the Council full particulars in writing of such pipe or wire, stating name of subway; date when first placed; position, dimensions, gauge, material, and purpose for which it is used or proposed to be used; nature of supports (if any); and within a further period of six months, if so required by the engineer of the Council, shall deposit with the Council a plan, on a scale of not less than 88ft. to 1in., showing the position, with such detail drawings as the Council may require.

10. Every company, body, or person depositing the particulars and plan required by the last preceding by-law shall, once in every subsequent year, cause such particulars and plan to be duly corrected to date.

11. No company, body, or person shall store materials in a subway, or allow any rubbish to accumulate or remain therein.

12. No person shall commit any nuisance in a subway.

13. All persons working or being in a subway shall conform to all reasonable instructions of the Council's officers.

14 Every company, body, or person using a subway shall pay to the Council on the usual quarter days in each year fees and charges according to the following scale: (*a*) a charge of 5s. for each day or part of a day during which a pipe or wire is being laid in or removed from a subway; (*b*) a charge of 1s. for opening or closing a subway at any time other than that fixed for the daily visit of the Council's officers; (*c*) an annual charge for use and supervision.

15. Any company, body, or person failing to comply with, or doing anything prohibited by, any of these by-laws, or any of the provisions of the London County Council (Subways) Act, 1893, or delivering to the Council any particulars or plans or making any connections therein which to their or his knowledge are incorrect, shall be guilty of an offence against these by-laws, and shall be liable to a penalty not exceeding £5, and to a further penalty not exceeding 40s. for each day during which such offence is continued after written notice of the offence shall have been given.

The names of the subways referred to are as follows: Garrick-street, Commercial-road East, Northumberland-avenue, Shaftesbury-avenue, Charing Cross road, Southwark-street, Queen Victoria-street, and Victoria-embankment.

The Highways Committee recommended that the Council make by-laws in the above form; that a copy of the by-laws be sent to the Postmaster-General, with a notice of the Council's intention to apply to the Board of Trade for confirmation of them; and that the clerk be instructed to make the application to the Board of Trade, and to do all things necessary to give effect to any order which may be made under the Act by the Board, prescribing what notices shall be given of the intended by-laws previously to their being considered by the Board.

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THE CITY COMMISSION OF SEWERS AND TELEPHONE TUBES.

THE CITY ELECTRIC LIGHTING COMPANY'S DILEMMA.

Some lively proceedings took place on Tuesday at a meeting of the Commission of Sewers in connection with the telephone tubes put down by the City of London Electric Lighting Company.

Mr. Gordon moved the following resolution, which was referred to in our issue of the 6th inst.: "That the resolution of this Court of July 25, 1893, agreeing to a recommendation of the Streets Committee, that the Commissioners only consent to the use for telephonic purposes of certain tubes laid by the City of London Electric Lighting Company, on a guarantee being given that telephones with double wires and all the latest improvements will be supplied to the citizens at a cost not exceeding £8 per annum be rescinded, and that an offer of the said company to pay the Commissioners '10 per cent. of any annual rental, so long as such may be received for the use of any tubes for telephonic purposes, up to the sum of £10,000 per annum, and 20 per cent. on any rental in excess of £10,000' be accepted, provided the minimum amount to be received by the Commissioners be £1,000 per annum, subject to a proper agreement being entered into with the company, without prejudice in any way to the rights and privileges of the Commissioners under the contracts and provisional orders." Mr. Gordon said he wished to test the feeling of the Court, as the members of the Streets Committee were pretty evenly divided. There was no doubt in his own mind that the tubes were laid down without applying for permission in a proper manner. They were laid down surreptitiously, and the company should be punished according. In order to carry out that intention the Court adopted a resolution on July 25 last asking the company to reduce the cost of telephony. But he had since realised that the Court had no *locus standi* to do that. There was no doubt that the Court was wrong as the proposed concession affected only 3,000 subscribers or users of telephones, which were a luxury. But by the second part of his motion, on a sliding scale the whole community would be affected. And it was much better as a matter of principle that that should be so. If the Court persisted in its present action it would stultify itself. A contract had been entered into by the electric lighting company and the telephone company, whereby the latter agreed to pay the former 10 per cent. on the cost of the tubes, the cost being estimated at £100,000 That represented a minimum rent of £1,000 a year. The assessment of them would not be less than £2,500, making £3,500 per annum, which could be used in relieving the rates. He had reason to believe that within two years the rent would be increased to double, or about £20,000 a year. According to that offer, the Court could claim 20 per cent. on the second £10,000. In all, the sum of £8,000 would be available for reducing the rates.

Mr. Sayer, in seconding the resolution, said he wished to disagree with Mr. Gordon in his assertion that the electric lighting company had laid the tubes in a surreptitious manner. It was true the committee had never given its consent, but he had thought all along that the laying of the telephone tubes in the same trenches with the electric lighting tubes would be for the benefit of those carrying on business in the City. The tubes were accordingly laid and the company received the consent of the Court afterwards, and he certainly thought the Commission would receive some concession from the company in consequence Those tubes were now rotting, and under the present state of things the Commission was losing a large income. He hoped, therefore, that no further delay in securing that would be permitted.

Mr. Morton challenged the remarks made by Mr. Sayer to the effect that the tubes in question had been laid down by the consent of the Commission, and the whole thing, he said, originated in the imagination of Mr. Sayer. It was of no good for members to come to the Court with such cock-and bull stories, for it was well known that the Commission refused to give its consent to the laying of the tubes. The silence of the Court on the question could only mean that its consent was withheld. The fact was, Mr. Morton said, the directors and chairman of the company had been about the members of the Court, but he did not know how it was the latter had changed their minds. It had not affected his mind, for he remained of the same opinion. The committee had, moreover, no right to negotiate with the company, and in doing so it had gone out of its way.

Mr. Pannell had never heard a more astounding argument than that advanced by the last speaker. The proposition before the Court was that all classes of the citizens should share in any advantages that were likely to accrue under the proposed arrangement, and he was all the more surprised to find Mr Morton, who ably represented the majority and the masses, refusing to consent to the rescinding of the former resolution, by which only a comparatively few persons would benefit. He (Mr. Morton) insisted that the benefit should be shared only by the users of telephones, which were used by those persons for their own business purposes. As to the statement that the Court did not know the tubes would be laid, he contended that the Commission was from time to time kept thoroughly acquainted with the various applications that were made by the company for the laying of the tubes. The assertion that they were laid by means of a subterfuge and in concealment was therefore entirely erroneous. He appealed to the members to adopt the present resolution as one which would benefit, not a section of the citizens, but the community as a whole.

Mr. Deputy Scott observed that he was the chairman of the Commission at the time the question of the tubes was before the Court. He had no hesitation in saying that the various sections were shown, and it was stated at the time that the tubes which were to be placed therein were for telephonic purposes. It was also a matter of fact that the company might have gone to Parliament had it chosen for powers to reopen the streets again for the purpose of laying them—an eventuality, he submitted, which would have been intolerable to the citizens. The tubes were down, and, in his opinion, the Commission had no right to act like dogs in the manger and prevent the use of them, or the citizens gaining any benefit from their use.

Mr. Barham hoped the Court would not rescind the resolution it adopted 12 months ago. The electric lighting company had stolen a march upon the Commission, and, so far as he was able, he would never permit it to reap the advantage; but, on the contrary, would do all he could to force it to make concessions to the citizens. The people of London were, he said, as much entitled to secure cheap telephones as those living in Liverpool or Manchester, and yet it was proposed that the Commission should sell its birthright for a mess of pottage.

Mr. Deputy Bowring trusted that the Court would think twice before rescinding the resolution it had adopted.

Mr. Bridgman expressed his surprise at hearing assertions made to the effect that the citizens had been sold. In 1892, he said, applications were made by the company for permission to lay the tubes, and, after receiving a report from the engineer, the Streets Committee resolved on April 13, 1892, that no action should be taken. If anyone could stand up, therefore, and say the Court had been sold, then it was simply a reflection on the business acumen of the person who was prepared to say so. But the decision he had spoken of was not reported to the Court, and that was the fault of the Streets Committee.

Mr. Wallace appealed to the Court to affirm the principle advocated by Mr. Gordon.

Mr. Burmester wished to repudiate in the strongest possible way the unworthy suggestion Mr. Morton had made as to why certain commissioners should change their minds. He was willing to admit that the Court misunderstood the real drift of the question when the other resolution was agreed to, but really the laying of the tubes had nothing to do with the question. The present proposition was in the nature of a fine, which would hit the electric lighting company rather hard, and it showed that the Court was ready to punish. He considered that in the name of the ratepayers the Commission had no right to throw away an offer which would afford considerable benefit to the community at large.

Other speakers followed, and after **Mr. Gordon** had briefly replied to the debate the motion was put in two sections.

On a show of hands 22 voted for the first section and 18 against it A division was claimed, with the result that 25 voted for and 19 against. As a two-thirds majority was necessary, the section was declared to be lost. The matter then dropped.

COMPANIES' MEETINGS.

WEST AFRICAN TELEGRAPH COMPANY, LIMITED.

The ordinary general meeting was held last week at Winchester House. Sir John Pender, M.P., presided.

On moving the adoption of the report, he stated that the gross revenue for the year had been £61,847, or £924 in excess of that of 1892 There had been an increase in Cape joint-purse traffic and in certain local traffic, but in the traffic with the French and British stations and with South America there had been a decrease, so that the net increase in message receipts was £644. Although the loss on exchange was still very heavy—namely, £7,751—it was £293 less than it was in 1892. The cost of repairs last year had been exceptionally heavy, but in view of their relations with the other companies, who were so much interested with them in the joint-purse traffic with the Cape, it was absolutely necessary that every endeavour should be made by them to maintain the through communication. They had, therefore, at considerable cost diverted the cable, as far as it was considered necessary, out of the region affected by the River Congo, and they could only hope that the cable would now be free from the frequent interruptions which had occurred in that district. In order to meet the deficit and to balance the revenue account they had applied £10,741 from the reserve fund, and they trusted that the result of next year's working would prove more satisfactory.

Sir Henry C. Mance seconded the motion, which was adopted.

ELECTRICAL POWER STORAGE COMPANY, LIMITED.

Directors: John Irving Courtenay, Esq., chairman and managing director; Sir Daniel Cooper, Bart., G.C.M.G; Frederick Green, Esq.; James Pender, Esq. Manager: Frank King, Esq., M.I E.E. Secretary: J. W. Barnard.

Report of the directors presented to the shareholders at the fifth ordinary general meeting held on Thursday, July 19, 1894, at the offices of the Company, 4, Great Winchester-street, E.C.

The net profit for the year is £4,936. 4s. 11d., which, with a balance of £158. 19s. 5d. from last year's accounts, amounts to £5,095. 4s. 4d., out of which the directors recommend the payment of a dividend of 5 per cent. on the ordinary share capital, which will absorb £4,101. 10s. 2d., leaving £993. 14s. 2d. to be carried forward. Provision has been made for the effective main-

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tenance of buildings, plant, tools, etc., at a cost of £2,297. 6s. 2d. The sum of £3,323. 1s. 4d., the proceeds of sale of the Company's shares in the Société Française, together with a further sum of £4,000 out of the profit of the year's working, and £1,500 written off patents in 1892-3, have been applied to the formation of a reserve fund for diminution in value of assets, as shown in the balance-sheet. The directors are pleased to be able to report the continued success of the Company's operations, and that there has been during the year a substantial increase of orders and of the uses to which batteries are being applied. The reduction in the selling price of the Company's manufactures has operated towards increasing the number of users, and so extending the goodwill of the business. Constant attention has been devoted to improving the conditions under which E.P.S. batteries are manufactured, and the directors are sanguine of further success in this direction. The development of electric traction has received the unremitting attention of the manager. The Company and its licensees have been successful in patent litigation abroad. The retiring director is Mr. Frederick Green, who, being eligible, offers himself for re-election. The auditors, Messrs. James Meston and Co., chartered accountants, also offer themselves for re-election.

BALANCE-SHEET, MAY 31, 1894.

Dr. Liabilities.	£	s.	d.
Share capital authorised—20,100 shares of £5 each, of which 100 are founders' shares	100,500	0	0
Shares issued 66 founders' shares of £5 each, fully paid (exclusive of four shares forfeited)	330	0	0
15,120 ordinary shares of £5 each, fully paid	75,600	0	0
3,137 ditto of £5 each, £3 called (exclusive of 400 shares forfeited)	9.411	0	0
18,323	85,341	0	0
Deduct calls in arrear	354	4	5
	84,986	15	7
Current accounts owing by the Company	5,853	8	1
Bills payable	10,000	0	0
Reserve fund for diminution in value of assets—			
Amount set aside from profits of year 1892-3 in reduction of cost of patents, etc, now transferred 1,500 0 0			
Amount received from sale of shares in Société Française d'Accumulateurs Electriques (included in the amount £75,760 as *contra*) 3,323 1 4			
Amount received on shares forfeited (as above) 492 5 9			
And amount set aside from profits of 1893-4 ..... 4,000 0 0	9,315	7	1
Profit and loss account—Balance at credit May 31, 1893, after paying dividend at 5 per cent. 158 19 5			
Add profit for year 1893-4 ..... 4,936 4 11	5,095	4	4
	£115,250	15	1

Cr. Assets.	£	s.	d.	£	s.	d.
Patents, &c., as per last balance-sheet				75,760	0	0
Plant, tools, furniture, fixtures, and fittings	1,243	8	8			
Less 10 per cent. depreciation	124	6	10	1,119	1	10
Stock on hand, at cost or under				10,929	19	2
Current accounts due to the Company (less reserve for discounts and doubtful debts)				16,425	16	6
Bills receivable				1,955	12	4
Investments, 2¾ per cent. consols at cost	3,003	16	2			
Debentures and shares in other undertakings	1,660	0	0	4,663	16	2
Cash at bankers	4,326	3	9			
In hand	70	5	4	4,396	9	1
				£115,250	15	1

PROFIT AND LOSS ACCOUNT, YEAR ENDED MAY 31, 1894.

Dr.	£	s.	d.
Rent, taxes, licenses, etc	5,852	12	6
General expenses, management, directors' fees, etc.	6,057	9	1
Advertising, insurances, and travelling expenses, etc.	2,492	3	3
Patent fees and charges and law expenses	1,460	3	3
Amount set aside this year to fund for diminution in value of assets	4,000	0	0
Maintenance of buildings, plant, and tools, etc.	2,172	19	4
Depreciation written off plant, tools, etc.	124	6	10
Auditors' fees	60	0	0
Balance, being net profit carried to balance-sheet	4,936	4	11
	£27,155	19	2

Cr.	£	s.	d.
Balance from trading account (after deducting discounts and all allowances)	27,011	7	9
Interest on investments, etc.	144	11	5
	£27,155	19	2

Mr. John Irving Courtenay, who occupied the chair, said that he proposed to offer but few observations, as the directors' report and statement of accounts spoke for themselves. They recommended a dividend of 5 per cent, and to carry forward a substantial balance to next year. The reserve fund stood at £9,315. 7s. 1d., and it was satisfactory that they had been able to bring it up to that amount. He was glad to be in a position to state that the volume of business had very considerably increased, and that the actual cash turn-over was larger than it was last year, although the reduction in the list prices of 20 per cent. had been in operation during the whole of the year under review. In this business there was an increasing competition, but the E.P.S. batteries had held their own thoroughly well. The policy adopted by the directors and manager had been to continually improve the quality of the Company's manufactures, and the results showed the E.P.S. batteries to be the most appreciated and reliable in the market; and that the sound commercial policy was to improve them in various details (though no startling new departure had been made), rather than to spend money and time in spasmodic efforts to obtain entirely new types or designs. One of the most important features to be noted was that the life of E.P.S. secondary batteries was steadily lengthening, so that, in fact, a sum equal to 5 per cent. per annum on the cost price was now amply sufficient for the maintenance in perfect working order of the batteries used under ordinary conditions. Those who remembered the pessimistic views expressed only a few years ago as to what would be the safe annual percentage to cover maintenance, would feel gratified at the practical illustration given by this Company of the correctness of the views of its representatives. The Chairman remembered being told that it would never pay any company to guarantee the maintenance of storage batteries at twice the figure now commonly adopted, but their manager had always contended that it could safely be done at about the present prices. Numerous fresh uses continued to be found for the employment of secondary batteries, and the number of their customers is larger than ever. They were not as yet able to point to a decided success in the application of E.P.S. batteries to traction, but they must make a success of this important branch of the industry, and the speaker believed that Mr. King would not fail in his efforts to this end, though the difficulties in the way of its development had been great. As stated in the report, unremitting attention had been given to the improvement of the batteries for traction purposes and to appliances in connection therewith, and he hoped that vehicles belonging to their friends the Pioneer Electric Carriage Company, Limited, fitted with the latest type of traction battery, would ere long be publicly working. During the year various improvements had been made in the plant and in the arrangement of the works at Millwall with the object of cheapening production but he did not consider it advisable to indicate more fully the direction these improvements had taken. Their works had been to a certain extent remodelled, and several suggestions made by the Board of Trade for the greater comfort and health of their workmen had been carried out. The Company's continental patents had been admirably protected by the Hagen Company and their legal and technical advisers, who had been most successful in upholding the patent rights. Mr. Courtenay concluded by moving the adoption of the report and accounts, and **Sir Daniel Cooper** seconded the motion, which was carried.

On the motion of **Mr. Courtenay**, seconded by **Mr. J. W. Barclay**, Mr. Frederick Green was re-elected a director.

On the motion of **Mr. J. W. Barclay**, seconded by **Mr. F. King**, Messrs. James Meston and Co. were reappointed auditors.

FASTERN TELEGRAPH COMPANY, LIMITED.

The half-yearly ordinary general meeting was held last week at Winchester House, Sir John Pender, M.P., in the chair.

The **Chairman**, after referring in detail to the chief items in the accounts, spoke of the money which their ships were earning, which was, he said, a new feature in their system of working; and the directors thought it a good plan, when their ships were not in service for themselves, to employ them in serving others who paid. The ships were kept well fitted for any emergency which might arise. He thought, upon the whole, that the report was favourable, and that they would all concur in that opinion. Paying the dividends they did, and carrying to the general reserve fund £110,000, was no small mark of success. This had been done during very bad times. He had been engaged in commercial life many years, and had never before known such a prolonged term of depression such as had existed, and still continued to exist, not only in London, but throughout the world. But there would be an end of this, and there was a boom coming, which was shown already in their colonies, and their energies would not long lie quiet. When the revival came there would be a great response from London, because, after all, a great amount of money had to come from London, and these times would be very good times for their submarine telegraph system. He moved the adoption of the report and the statement of accounts and the declaration of the dividends.

The **Marquis of Tweeddale** seconded the motion, which was carried.

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CONTRACTS FOR ELECTRICAL PLANT.

CONTRACTS OPEN.

York Town (Surrey).—The Lighting Inspectors require by the 31st inst. tenders for lighting the street lamps for ensuing season—namely, September 1, 1894, to May 14, 1895. Specifications may be obtained of Mr. George W. Mason, secretary, York Town.

Warrington.—The Sanitary Works Committee of the Warrington Corporation require by the 23rd inst. tenders for the supply of a water-tube boiler. Specifications may be seen and further information obtained from Mr. James Deas, Longford Depôt, Warrington.

Bilston.—The Bilston Township Commissioners invite tenders by the 26th inst. for the electric lighting of their Market House. Specification of the works required may be seen on application to the clerk or to Mr. Wilson, C.E., township surveyor, at the offices, Town Hall, Bilston.

London.—The London County Council also invite by the 31st inst. tenders for the supply of boilers and fittings, steam and exhaust piping, surface condensers, and air-pumps for the station to be erected for the electric lighting of the embankment. Tenders are to be addressed to the clerk of the County Council.

Watlington (Oxon.).—The Lighting Inspectors invite tenders for lighting streets, roads, and other places comprised in the parish either with oil or with gas, or any other illuminant. Tenders should be sent at once to the Inspectors, Market-place, Watlington, of whom full particulars may be obtained.

Cheltenham.—The Corporation invite tenders by the 24th inst. for the supply of six 12-kilowatt transformers and 10 6-kilowatt transformers. Specifications may be obtained on application to the borough engineer, Municipal Offices, Cheltenham. Tenders are to be addressed to the Electric Lighting Committee, and are to be delivered to Mr. E. T. Brydges, the town clerk.

Rugeley (Staffs.).—The Local Board desire by August 1 tenders for the lighting of the street lamps for the winter season, commencing September 1, 1894, and ending April 30, 1895. Particulars may be obtained of the chairman of the Lighting Committee, Local Board, Rugeley, to whom tenders should be sent. The clerk to the Board is Mr. Robert Landor.

Nelson.—Those who are desirous of tendering for the wiring and fittings in connection with the new technical school may obtain plans and particulars (on payment of £1. 1s., which will be returned on receipt of a *bonâ fide* tender) by applying to Messrs. Holtom and Fox, architects, Dewsbury. Tenders are to be sent to Mr. R. M. Prescott, town clerk, Town Hall, Nelson, by 30th inst.

London.—The London County Council invite by Tuesday, the 31st inst., tenders for the supply of engines, dynamos, motors, switchboards, and other electrical appliances required for the electric light installation for the Victoria-embankment and Waterloo and Westminster Bridges. The drawings may be inspected and specification, bills of quantities, form of tender, and other particulars obtained at the Engineer's Department, County Hall, Spring-gardens, S.W., on payment of £2. This amount will be returned to the tenderer provided he shall have sent in a *bonâ fide* tender and not have withdrawn the same. Tenders are to be delivered at the County Hall in a sealed cover, addressed to the clerk of the London County Council, Spring-gardens, S.W., and marked "Tender for Engines, Dynamos, etc., for Electric Lighting Generating Station."

Edinburgh.—The Corporation of Edinburgh invite tenders for the following work in connection with the electric lighting of the city: Contract No. 13, supply and erection of Willans engines, alternators, etc.; No. 14, switchboard, instruments, and connectors; No. 15, arc lamps; No. 16, Ferranti rectifiers for arc lighting; No. 17, insulated concentric cable. Copies of the specifications can be obtained on application from the resident electrical engineer, City Chambers, Edinburgh. All information will be supplied by Prof. Alexr. B. W. Kennedy, the consulting electrical engineer to the Corporation, at his office, 14, Old Queen-street, Westminster, London, S.W. Tenders must be received in Edinburgh not later than 30th inst. for contract No. 15 (arc lamps), or on August 6 for contracts Nos. 13, 14, 16, and 17. Further particulars are given in our advertisement columns.

Harlow.—The Lighting Inspectors invite by August 4 the following tenders—(1) a tender for lighting the district from September 1, 1894, to April 20, 1895, from dusk until 11 p.m., excepting six nights before the two nights after full moon; (2) for cleaning, repairing, and painting one coat (in the colour now painted) of all the glass lanterns (inside and out), and refixing the lanterns in the columns and brackets, leaving all perfect and clean, ready for lighting on September 1, removing and storing at the end of the season the lanterns (including rent of storage), for keeping the whole of the lanterns during the season in good repair, and glazing when necessary; (3) for supplying new tinned copper-framed 14in. lanterns, glazed and painted similar to present ones, at per lantern. Further particulars may be obtained of Mr. W. E. Deards, secretary, Broadway, Harlow, to whom tenders are to be sent.

RESULTS OF TENDERS.

Wolverhampton.—The tender of Messrs. H. Willcock and Co. has been accepted by the Town Council for £372 for work at the electric lighting sub-stations.

Leith.—The Dock Commission have accepted the estimate of the Brush Company for the electric light installation at £3,300, and also the estimate of Messrs. R. Bruce and Sons to erect the engine-house for £640.

Bolton.—The Gas, Lighting, and Electricity Committee of the Bolton Corporation have accepted the tender of Messrs. Siemens Bros. for laying the requisite mains for extensions in Knowsley-street, as suggested by the engineer.

Worcester.—The Town Council have accepted the tender of the New British Electric Installation Contractors, Limited, for wiring and fitting up the Guildhall and police station. The Council have also accepted the tender of the same company for wiring the public hall, small hall, etc., at £177. 19s. 2d., and the tender of Messrs. Verity and Sons for the fittings at £154. 1s. 4d.

Tunbridge Wells.—The Town Council have accepted the following tenders:

Babcock and Wilcox, boilers	£1,726	0	0
Johnson and Phillips, engines and dynamos	2,778	13	0
Johnson and Phillips, arc lamps and posts	989	1	6
Johnson and Phillips, steam-pipes	277	10	0
Crompton and Co., transformers	832	14	0
Crompton and Co., switchboard	428	10	0
Crompton and Co., wiring of station	46	0	0
Callender's Bitumen Company, mains	2,306	12	0

BUSINESS NOTES.

Carlow.—Several additional lamps are to be erected by the Town Commissioners.

Aberystwyth.—The work in connection with the electric lighting of the town is progressing.

Western and Brazilian Telegraph Company.—The receipts for the week ended July 13 were £2,295.

Aberdare.—A new dynamo for lighting the Empire Music Hall has been put down by Messrs. George Wilson and Co.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 15th inst. amounted to £965.

Ipswich.—The Electric Lighting Committee of the Town Council are enquiring into a question of dust destructor.

Paddington.—The Vestry have resolved to enquire of electric lighting companies if they can supply electric light for the streets, and at what cost.

Central London Railway.—It is now said that the prospectus of the Central London (Electric) Railway will not be issued for some weeks to come.

Radcliffe.—The Electric Lighting Committee of the Corporation have nominated Mr. Hammond to advise them on electric lighting, at a fee of 50 guineas.

West India and Panama Telegraph Company.—The receipts for the two weeks ended July 15 were £114 more than for the corresponding period of last year.

Bristol University College.—Our advertisement columns contain a statement referring to the 1894-95 session (electrical engineering) of this university college.

Anglo-American Telegraph Company.—After placing £12,000 to the credit of the renewal fund, the directors announce a quarterly interim dividend of 10s. per cent.

St. Bride's Institute, E.C.—Messrs. Edmundsons, Limited, are carrying out the wiring of this institute according to the specification of Mr. W. H. Trentham, of Westminster.

Dewsbury.—Dr. Beattie has decided to have his house in Springfield-terrace lighted by incandescent lamps. The work will be carried out by Mr. A. R. Turner, of Dewsbury.

Whitechapel.—The report of the electrical engineer on the subject of introducing the electric light is to be considered at the next meeting of the committee of the Board of Guardians.

Hanley.—A letter has been received by the Town Council from the Local Government Board sanctioning a loan of £4,000 for the electric wiring and fitting of the various municipal buildings.

St. James's and Pall Mall Company.—The current sold by the Company during the quarter ending June 24 amounted to £7,380, as compared with £5,848 for the corresponding quarter of 1893.

Hampstead.—The Vestry have decided to make certain reductions, in the form of a sliding scale, in the charges for electrical energy where the annual invoice of consumers exceeds from £25 to £500.

City of London Electric Lighting Company.—The warrants for the interim dividend due on this Company's preference shares at the rate of 6 per cent per annum for the six months ended June 30 last have been posted.

Lambeth.—The Vestry has received notice from the St. James's and Pall Mall Electric Lighting Company that it intends to apply for a provisional order to supply electric light for private or public purposes in the district.

Arbroath.—The Town Council, having received an intimation of the intention of the Northern Electric Supply Company to apply for a provisional order, have decided to themselves apply for electric lighting powers.

Baslow and Burnell.—The Local Board have received an offer of a loan of money at 3½ per cent. to carry out an electric lighting scheme. The Board have decided to postpone the matter until the new council is formed.

Business Disposal.—An electrical engineer advertises that he desires to dispose of his business, established 15 years in London.

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Communications are to be sent to Messrs. Cobbett and Co., 96, Great Russell-street, W.C.

Tunbridge Wells.—The Town Council intend to introduce the alternating system for public and private illumination, and to employ a Ferranti rectifier and transformer at the central station for dealing with the public lighting.

Denbigh.—The gasworks company having refused an offer of 3s. 8d. per 1,000 for the gas for the public lamps, the Town Council have agreed to consider the best steps to be taken to secure electric lighting for the town.

Rugby.—The Rugby School Electric Lighting Company are laying a new cable across the Hillmorton-road to supply the new science department, lecture-rooms, etc., which are being built in the schoolhouse gardens, with electricity.

Maidstone.—At a meeting of the Local Board a member enquired what had become of the electric light. Mr. Monckton, the assistant clerk, said he had received a letter from the company, and that the committee would meet at once.

Tuam.—The Irish Electrical Supply Company have notified the Tuam Town Commissioners that they intend to apply for a provisional order in the forthcoming session for the supply of electricity in the borough and district of Tuam.

Laying of New Mains.—The District Palace Electric Supply, the City of London Electric Lighting, and the House-to-House Companies have notified the London County Council of intention to lay down new mains in various thoroughfares.

Ramsgate.—The town clerk has been instructed to give the usual notice of opposition to a notice from the Brush Company, stating that the company intended applying for a provisional order to introduce the electric light in Ramsgate.

Nelson.—In a report on refuse destructors, a sub-committee of the Corporation of Nelson propose that a refuse destructor station should be erected at a cost of some £5,000, and that a dynamo for lighting the station by electricity should be laid down.

Hammersmith.—The Vestry have asked the Board of Trade to extend by two years the time within which to comply with the provisional order. The Electric Lighting Committee are examining the report presented to them by Messrs. Morgan, Williams, and King.

Postal and Packing Boxes.—Messrs. H. Nixdorff and Co., of 30, Maidstone-street, Hackney-road, N.E., have forwarded us samples of their wooden postal boxes for the transport of small electrical appliances through the post. The company also make packing boxes for larger goods.

Luton.—The Town Council have received a letter from the Municipal and Electric Lighting Corporation, Limited intimating that they would apply to the Board of Trade for a provisional order for the supply of electric light in the borough. The Council will oppose the application.

Plymouth.—Messrs. Hele and Co., of Wyndham-street, are now showing two fine organs at their manufactory. One is fitted with the Hope-Jones electric action, and is pronounced by the representative of the Hope-Jones Company to be superior to most organs of this kind of electric action.

Economic Electric Speciality Company, Limited.—This Company has been registered, with a capital of £50,000 in £1 shares, to carry on the manufacture and sale of electrical and scientific machines and instruments, and the business of mechanical, metallurgical, chemical, and general engineers.

Chiswick.—The Committee of Works of the Local Board have given instructions to the surveyor to press Messrs. Bourne and Grant to proceed with the plans and elevations of the building proposed to be erected at the pumping station for the purpose of providing the district with the electric light.

Fareham.—A number of ratepayers has signed a petition to the Board of Trade to withhold consent to the proposed purchase by the Local Board of the electric light company's undertaking until the new district council is in office, and until the company's undertaking has been valued by a competent authority.

Salford.—The annual report of the electric light department of the Town Council shows that the Corporation have raised £32,000 on loan. Of this sum they have spent on land, £2,972; on the generating and distributing station, £71; on mains and services, £54; and on preliminary matters, £376—leaving a balance of £28,527 unexpended.

Tonbridge.—The Holloway Electricity Supply Company have written to the Local Board that they intend to make application to the Board of Trade for a provisional order authorising them to supply electricity within the district of the urban sanitary authority of Tonbridge. The letter has been referred to the Highway and Lighting Committee.

Llandudno.—The Improvements Commissioners have received a letter from the Llandudno Lighting Company intimating that they intended to apply for a provisional order authorising them to supply electricity for public or private purposes within the area of the Commissioners. It was decided to refer the communication to the Water and Gas Committee.

Huddersfield.—The Town Council, on Wednesday, on the recommendation of the Electric Lighting Committee, appointed Mr. A. B. Mountain, who has superintended the construction of the electric lighting works, permanently as borough electrical engineer and manager, at a salary of £250 a year, this being an increase of £50 upon his previous salary.

Venezuela Telephone and Electrical Appliances Company.—Coupon No. 8 of the 5 per cent. first mortgage debentures of the Venezuela Telephone and Electrical Appliances Company, Limited, due July 31, will be paid from that date at the Consolidated Bank, Limited, Threadneedle-street, London, or at the banking house of Messrs. Westendorp and Co., Amsterdam.

Edinburgh.—The Cleaning and Lighting Committee of the Town Council have recommended that the following streets should be lighted by electricity: George-street, St. Andrew-square, South St. David-street, South St. Andrew-street, South Hanover-street, South Frederick-street, South Castle-street, South Charlotte-street, Hope-street, and Charlotte-square.

Harrow.—A meeting of ratepayers has been held respecting the proposed introduction of electric light. The meeting was the outcome of a requisition signed by several large ratepayers and influential persons in Harrow, asking the Board to call a public meeting before proceeding with the electric light. The majority of those present were in favour of electric lighting.

Crystal Palace.—A Committee of the House of Commons has passed a Bill which confirms a provisional order authorising the Crystal Palace District Electric Lighting Company to supply electricity within portions of the district of the Beckenham Local Board, the borough of Croydon, the parishes of Lambeth and St. Giles, Camberwell, and the Lewisham District Board of Works.

Broughty Ferry.—The Northern Electric Supply Company having intimated to the Police Commissioners their desire to lay down an electricity supply service in the burgh, and also that they purpose applying to Parliament for a provisional order to authorise them to do so, the matter has been remitted to the Gas Committee, with power to consult an electrical engineer on the subject.

Kensington.—The Vestry have received notice from Messrs. Jordan and Son, on behalf of the Commercial Electricity Supply Company, of the intention of the company to apply for a provisional order empowering them to supply electricity in various parishes, districts, and extra-parochial places in the Metropolis, including the whole or some part of the parish of St. Mary Abbott, Kensington.

Buxton.—The Local Board have received a letter from Messrs. Baker, Lees, and Postlethwaite, of 22, Great George-street, Westminster, stating that the Bill to confirm the provisional order (electric lighting order) has received the Royal assent. They enclosed an account of their charges and disbursements in the matter, towards which the Board sent them £100, the total cost having been £191. 13s. 10d.

Ladders for Electric Lighting.—The Lancashire and Yorkshire Railway Company has just ordered one of Heathman's patent telescopic ladder towers for the use of the electric light attendants at the Exchange Station, Liverpool. Messrs. Heathman and Co. have also received instructions to build two more ladders for the Great Eastern Railway stations and a portable ladder-carriage for the Bath Electric Light Company.

Newcastle.—The City Lighting Committee of the Corporation on Tuesday received a communication from the Newcastle and Gateshead Gas Company respecting the dispute between the Corporation and the gas company. It was decided to receive the directors of the gas company at a conference, and that the order for several new electric lamps, previously decided upon by the committee, be held over pending the conference.

Ship-Lighting.—The twin-screw steamer "Seaford," which has been built by Messrs William Denny and Bros. for the Newhaven and Dieppe service, is lighted electrically. The generating plant comprises a Chandler engine and Crompton dynamo. The fourth vessel built by Earle's Shipbuilding Company for the Great Eastern Railway Company's continental service, which was launched on Wednesday at Hull, will be equipped with the electric light.

Bolton.—The Gas and Electricity Committee of the Corporation has received an estimate prepared by the electrical engineer of the cost of substituting electric light in place of gas in the large lamp on the Town Hall-square, and it has been decided that the work shall be carried out. The engineer has reported that the applications for current continues to be very satisfactory, there being up to the present 20 consumers, with a total demand of over 2,000 8-c.p. lamps.

Leeds.—A sub-committee of the Highways Committee of the Leeds Corporation have had under consideration the question of laying telephone wires in the city. The committee have accepted the terms offered by the Government for the laying of wires underground in Leeds. The National Telephone Company wish to have further wires in the city, and the committee agreed to let them be laid underground, but at a certain charge per subscriber using the wires. The company, it is said, will consider the matter.

Greenock.—Provost Shankland drew attention at a meeting of Greenock Police Board on Tuesday to a notice submitted by the clerk to the Law and Finance Committee, by the Caledonian Electric Supply Company, Edinburgh, of the intention of that company to apply to the Board of Trade for a provisional order to supply electricity within the districts comprised within the municipal boundaries of Greenock. The clerk was instructed to intimate to the company that the Board of Police would oppose the application if made. It was not desirable, the Provost said, to encourage private companies amongst them.

Portsmouth.—The cables have now been carried through Russell-street, and they will shortly be laid down along the Clarence and South Parades at Southsea. The esplanade is already lighted from pier to pier. Elm-grove Baptist Church has adopted incandescent lamp lighting. For private lighting incandescent lamps are being readily taken up, especially at Southsea. Applications are being received from streets and localities outside of the area to be connected, and when a sufficient number have

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been received to justify them in moving, the committee will take the necessary steps to extend the cables in other directions.

Shrewsbury.—Among the measures which have passed the House of Commons Committee on the Unopposed Bills is the Electric Lighting Provisional Orders (No. 3) Bill, confirming certain orders relating to the towns of Shrewsbury and Oswestry. The Shrewsbury Electric Lighting Company are on the point of building suitable works in Foundry-square, at the bottom of the Seventy Steps, where operations are to be begun in a month's time. The company have acquired power to supply current throughout the borough.

Direct United States Cable Company, Limited.—The report of this Company for the six months ended June 30 states that the half-year's revenue amounted to £34,843, as compared with £40,836. The expenses, including income tax, amounted to £18,750, leaving a net balance of £16,093, and making, with £3,080 brought forward, a total of £19,173. Three quarterly interim dividends have been paid during the financial year, and a final payment of 2s. per share is now proposed, making 2⅝ per cent. for the year. After transferring £6,000 to the reserve fund, which now stands at £281,551, a balance of £1,031 is carried forward.

Leicester.—The electric light cables are about to be laid for the supply of current for the centre of the town, and the Gas Committee ask those intending to adopt the electric light at once to make application for the same, so that arrangements may be made in laying the cables for the necessary house connections. The charge for current will be 6d. per Board of Trade unit. The Gas Committee anticipate being able to supply the light in the district referred to during the coming autumn, probably by the end of October. The committee are prepared to carry out and supply everything required in connection with house wiring and electric light fitting.

Metropolitan Electric Supply Company, Limited. — This Company is this week issuing £150,000 4½ per cent. first mortgage debentures, at 105 per £100 stock. This stock is redeemable at the Company's option on six months' notice on and after January 1, 1916, at £110 for every £100 stock. The holders of the existing £100,000 5 per cent. registered debentures may exchange their debentures at par for debenture stock of this issue, receiving payment of interest at 5 per cent. accruing from June 1 to the 19th inst. All debentures not presented for conversion will be repaid on, and cease to bear interest at, the expiration of six calendar months.

Brasyer v. Harness and Others.—In this case the jury, after a six days' trial, were only able to answer some of the questions put to them, and whilst a verdict was entered upon the findings for Dr. M'Cully, nothing was done as to the remainder of the first case, nor as to the cross action. Mr. Witt, Q.C., having since then applied to have the case set down for further consideration, Mr. Justice Charles said that he did not see how, under the circumstances, more could be done than had been already done, and thought that to put down the case for further consideration would only be to incur unnecessary expense. Mr. Abinger, who was for Dr. M'Cully, asked for the costs of the day; but the judge declined to accede to the application.

Glasgow.—The Statute Labour Committee reported to the Police Commissioners on Monday that at a meeting of the sub-committee on Glasgow Bridge the clerk submitted an account which he had received from the postmaster and surveyor of the city for the work of diverting underground wires from Glasgow Bridge to the temporary new bridge, etc., by the engineering branch of the Post Office, amounting to £349. 0s. 1d., and the sub-committee having considered the same, and having regard to the Post Office statutes on the point, agreed to recommend that it be passed on to the Statute Labour Committee for payment. Mr. Martin moved, and Bailie Hamilton seconded, the adoption of the minute, which, after some discussion, was carried.

Devonport.—The Highways and Streets Committee recommended the Burgh Council that a contract be entered into with the Devonport Gas Company for supplying the public gas lamps for seven years at the present rate—viz., £3. 7s. 6d. per lamp per annum. The feeling was expressed that in view of the rapid progress being made with electric lighting, the Council ought not to tie their hands for seven years, more especially in view of the letters which had been read at that meeting from electric lighting companies intimating their intention of applying for provisional orders to supply electrical energy. Eventually it was decided that the contract with the gas company should be determinable at the end of the third, fifth, and seven years by six months' notice.

City and South London Railway Company.—The accounts of the City and South London Railway Company show a balance, after providing for the debenture interest and the full dividend on the 5 per cent. preference shares, sufficient to allow the payment of a dividend on the consolidated ordinary stock at the rate of 1 per cent. per annum. A balance of £1,335 is carried forward. The dividend for the corresponding period last year was at the rate of ¾ per cent. per annum, and the balance carried forward £898. The receipts of the Company for the week ended July 15 were £882, against £776 for the corresponding week of 1893, or an increase of £106. The total receipts for the current period of the present half-year amount to £1,761, as against £1,845 in the corresponding period of 1893.

Shoreditch.—The Highways Committee of the London County Council reported on Tuesday that the Vestry of Shoreditch had made an application to the Board of Trade for an extension of the time specified in the Shoreditch Electric Lighting Order, 1892, within which the compulsory works are to be carried out. The Board has intimated that it does not appear to have power to grant the extension asked for, but that the question whether the order shall be revoked on account of non-compliance with its requirements is within the Board's discretion, and that it proposes, subject to any representation which the Council may make, to defer the consideration of this question for 12 months. The committee were of opinion that it is unnecessary for the Council to take any action with reference to the matter.

The Douglas Tramway.—The electric tramway from Douglas to Groudle has been largely patronised during the past week, from 2,000 to 3,000 persons passing over it every day. Dr. Hopkinson is making arrangements for the opening of the line to Laxey. The whole of the electrical plant and machinery is now nearly completed, and it is expected that in a few days a carriage will be sent right through from Douglas to Laxey. The electric tramway company have already received intimation from the Leeds Corporation that a deputation from that body will visit the island for the purpose of inspecting the line and its mode of working, and the secretary of the Tramway Institute of Great Britain has also intimated that the members of that body will visit the island for the same purpose when the line is completed.

County Court Case.—The Abell Electrical Engineering Company, at the St. Helens County Court on Wednesday, sued Robert Pownall, watchmaker, of St. Helens who has lately added farming at Sutton to his operations, for £2. 17s. 6d., the price of an electrical regulator to his incubator. The defendant refused to pay, as he alleged that the regulator had failed in its work and destroyed about 600 eggs. He had attached to his incubator this apparatus, which was to regulate the temperature, instead of which, he submitted, it failed, and the heat rose to about 130deg., spoiling all his eggs Mr. Abell said the regulator had been improperly used, but it could easily be repaired. As the company was now in liquidation, his Honour said they ought to have sued in the name of Mr. Marsh, the liquidator. He, however, non suited with costs.

Windermere.—A notice has been received by the Local Board from the Windermere District Electric Supply Company, intimating their intention to apply for a provisional order. The Clerk, being asked to explain, said the object was to obtain compulsory powers, same as those possessed by the gas and water company, as to breaking up streets. At present they could only proceed by consent. The important thing was to see that the Board got proper clauses for their protection as a public body. The best way would be to leave the matter in the hands of a sub-committee to consider what action to take in the matter. The Chairman said there was another view of the matter. It was a question whether the Board, as a public body, would ever wish to undertake the public lighting themselves, but he did not see that the Board, as a body, would ever wish to take the public lighting.

Grasmere.—At a meeting of the Local Board a letter was read from the Windermere Electric Light Supply Company stating that it was their intention to apply to the Board of Trade before December 21 for a provisional order to authorise the company to supply the electric light within the Grasmere Local Board district, such order to be confirmed in the following session of Parliament. The Chairman said it was a very important question, and if they were of opinion that the work should not be allowed, it would be necessary to oppose the application. Mr. Dixon said that they were well situated as to means to supply the electric light for their own district. If they let the company get a monopoly it would be very expensive buying them out. The other members were of opinion that the Board would do best to supply their own district. It was agreed to let the matter stand over for further consideration.

Aberdeen.—The Watching and Lighting Committee of the Town Council have been informed that the Gas and Electric Committee propose to increase the charge for the electric lighting of the streets from 2¼d. to 3⅜d. per lamp per hour. It is understood that, including the supply of carbons and the expense of cleaning, etc., which will now have to be borne by the lighting department, the total cost will be about 4½d. per hour, and some members were of opinion that it was too much. It has been resolved to endeavour to arrange a joint meeting of the Watching and Lighting and Gas and Electric Committees to consider the matter. The electric light installation at the Northern Co-operative Company's central premises in Loch-street was started last week. The ceremony was performed by Mrs. Doig, wife of the chairman of the company, in presence of the directors. Prof. Kennedy, who had previously tested the installation, congratulated the company on the public spirit they had shown in adopting electric lighting at this early stage of its history.

The Belfast Central Station.—The new central electric lighting station will be situated between Chapel-lane and Marquis-street. There will be an entrance from each of these streets. The entire site is now being piled, sleepered, and sheeted to prepare it for the concrete foundations and floor. The contractors are Messrs. Harvey and M'Laughlin, of Belfast, while the architect is Mr. C. Stanley Peach, F.R.I.B.A., of 8, John-street, Adelphi, London, W.C. The work is being carried out under the superintendence of Mr. V. A. H. M'Cowen, the resident electrical engineer, the clerk of works being Mr. James Moore. The Belfast installation is modelled on that of the Westminster Electric Supply Corporation, of which Prof. Kennedy is the engineer. The chief difference will be the use of gas engines instead of boilers and steam-engines. It is calculated that the total cost of the central-station scheme will be £19,000 exclusive of land, buildings, and meters, but inclusive of the whole of the plant and machinery, mains and roadwork.

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Ulverston.—An application has been sent to the Local Board by the Windermere and District Electric Lighting Company to supply electric light within the Ulverston Local Board district. Mr. Tosh referred to the Board having obtained powers some years ago for providing electric light in their district, but not having exercised those powers they had got notice that the order had outrun its time, and there had been a communication with Sir Courtney Boyle upon the subject. It was then stated that if any company wanted to assume the powers, notice should be sent, and the local authority should have the first right, and that a new order would cost a few pounds, the idea being that the Board could not play the part of the dog in the manger—neither use the electric light itself, nor allow anyone else to do so. He proposed that the application be referred to the Gas and Water Committee. Mr. Pearson alluded to the former action of the Board, and said no good had resulted from it. He did not think the town was prepared to adopt the electric light. Mr. Atkinson seconded Mr. Tosh's motion, which was carried.

National Telephone Company, Limited.—The report of this Company for the 14 months ending June 30 states that the net result, after deducting Post Office royalties amounting to £73,945, is a profit balance of £316,483, as compared with a balance of £217,725 for the preceding 12 months. An interim dividend at the rate of 6 per cent. per annum on the first and second preference shares and 5 per cent. per annum on the third preference and ordinary shares has already been paid. The Board now recommend a further payment at the rate of 6 per cent. per annum on the first and second preference shares, and 5 per cent. per annum on the third preference and ordinary shares, making the dividend for the 14 months at the rate of 6 per cent. per annum on the first and second preference shares, and 5 per cent. per annum on the third preference and ordinary shares. They also propose to transfer £63,429 to the reserve fund, so as to bring it up to £225,000, and to carry forward £1,765. Letters of allotment in respect of the issue of £1,10C,000 3½ per cent. debenture stock in the National Telephone Company, Limited, have been posted.

Yarmouth.—At the meeting of the Town Council in committee, to determine the position of the electric light lamps, the surveyor said he proposed to place the lamp-posts in the centre of the carriageway along the drive, where the distribution would be most effectively utilised, the traffic best regulated, and the lighting of the cross roads rendered easier. The centre of the roadway was the usual position for electric lamps where the roads were of sufficient width. Mr. Chamberlin moved that the lamps be placed on the inside kerb of the east footpath, and not in the centre of the roadway, but his proposal was defeated. It was also resolved to place two additional arc lights on the east side of the Beach Gardens. With respect to the position of the lamps Mr. Preece telegraphed that the "taste of the committee should rule the matter." The School of Art is to be repaired and added to. The estimated cost of introducing the electric light in the principal rooms is £130 (or less ventilation which would not be needed if electric light were put in instead of gas, £32. 10s , £97. 10s.). The Council will extend the electric light leads from King-street to the School of Art, at a cost of £30.

The City Electric Inspector.—In connection with this appointment, a correspondent signing himself "Electricity" in the *City Press* writes as follows: "I should esteem it a favour if you would ask the following questions in your next issue, as there appears to be some heartburning about the recent appointment of a City inspector of electric lighting: (1) Whether it is not a fact that the appointment of an electric inspector for the City of London was referred to Mr. Preece, and practically settled by him, instead of by the Commissioners of Sewers? (2) Whether it is not a fact that in the recent competition for this post Mr. Preece, to whom the matter was referred, had not himself given testimonials in support of certain candidates? (3) Whether in such event Mr. Preece was a free arbitrator, and whether it was fair to the other candidates to refer the matter to a gentleman whose testimonials pledged him beforehand to a certain course of action? (4) Whether the Commission of Sewers have not evaded their duty by referring the matter to anybody, instead of settling it themselves, and, further, whether such a course of action does not amount to a confession that they were unfit to make the appointment of such an official?"

Mullingar.—The Board of Guardians have received the following letter from Mr. M. J. Hackett, solicitor, 47, Lower Sackville-street, Dublin: "In conformity with the requirements of the Electric Light Act, 1882 and 1888, and the rules made by the Board of Trade with respect to applications for provisional orders, I hereby give you notice that application is intended to be made to the Board of Trade on or before the 21st day of December next by the Irish Electrical Supply Company, Limited, whose registered office is situated at 47, Lower Sackville-street, Dublin, for a provisional order to be confirmed in Parliament in the ensuing session, whereby it is proposed to authorise the said company to construct works and produce, store, supply, and sell electricity for lighting, motive power, and all public and private purposes within the borough or district of Mullingar. I shall be glad to be informed that the local authority assents to the proposed application to the Board of Trade and to be furnished in due course with a certificate signed by you reciting copies of the notice, and of the resolution, and declaring that the notice was duly given and the resolution passed as required by the said rule." No order has been made on the subject by the Board of Guardians.

Worcester.—At a meeting of the Town Council the Mayor proposed that the Watch Committee should be authorised to organise an exhibition of electrical appliances, etc., in the Public Hall, for about one week in the middle of October next. Mr. Williamson stated that at that time the committee would be prepared to supply the electrical energy to any consumers along the line of route of the mains, and by that time, or the early part of next year, the Council would be involved in an expenditure of about £4,000 a year in the payment of principal and interest and establishment charges. It therefore behoved them to get as much of the current used as they could this year, and to "keep pegging away" until they got the whole of the energy produced into commercial use. If they had an exhibition they would get all the leading manufacturers of the kingdom to exhibit fittings, lamps, meters, motors on a small scale, and all kinds of apparatus. They hoped to have the Public Hall lighted by electricity at that time, and to show to the people of Worcester the advantage of taking the light. The proposal was agreed to, it being stipulated that the expenses should be limited to £50, not to include the hire of the room or the supply of the current from Powick.

Stafford.—In moving the adoption of the report of the Electric Lighting Committee of the Town Council, Alderman W. H. Peach said they recommended the acceptance of the General Iron Foundry Company's tender for the supply of wrought-iron mitred jointed window frames, this being the lowest. Five tenders were received for an overhead traveller to lift eight tons with a span of 45ft. The highest tender was £225, and the lowest £160. The engineer recommended the tender of Mr. T. Smith, of Rodley, whose traveller appeared the most suitable, for £185. Dr. Hopkinson recommended the acceptance of the tender of Maignen's Filter Company's apparatus to be erected at a cost of £220 in order that the water used for the steam-boilers might be filtered and softened previous to use, it being proposed to apply the river water for the purpose of providing water for the boilers. Mr. Peach explained that to use the Corporation water would entail a cost of £359, the quantity required being large, whilst the river water, yielding an ample supply, would only need softening to assist its condensation. He added that it was proposed by the committee in connection with the erection of the electric lighting station that a commemoration-stone should be laid by the Mayor. It has been arranged to transfer £15,000 from the loan suspense account to the electric lighting account on September 30, and to issue debentures for that amount. The report was carried.

Lighting at Cardiff.—Mr. W. H. Massey, the electrical engineer, informed the Corporation Lighting Committee on Tuesday that the whole of the high-tension cables and the telephone wires had now been drawn in by the Silvertown people, whose men had also made most of the important joints, and the jointing of low-tension and arc light mains was being proceeded with. The work at the station had gone on rather slowly, and, after consultation with Mr. Harpur, the borough engineer, he suggested at the special meeting of the sub-committee that Mr. Fletcher should be temporarily transferred from his service to that of the Corporation, so that he might directly act with Mr. Harpur in little matters which were constantly cropping up, and about which complications might otherwise arise between the Corporation fitters and the contractors. The main switchboard had arrived, and preparations were being made for fixing it in position. The fourth dynamo bed was in place and he hoped that before the end of the week all the engines would be so far erected that the exhaust-pipes could be obtained. Messrs. Siemens had decided to fit new and improved flexible couplings between the engines and dynamos, and some little delay had in consequence taken place. The appointment of Mr. Fletcher, as recommended by Mr. Massey, was agreed to, at a salary of £16 a month. A local paper states that lighting will not commence until the early part of September. The price to be charged will be 6d. per Board of Trade unit.

Woodhouse and Rawson United, Limited, v. Jolin.—In this case, heard in the City of London Court, the plaintiff company claimed the sum of £8. 11s. 9d. for goods supplied to the defendants, Messrs. Jolin and Co., of Bristol. Mr. William Hicks, the solicitor for the plaintiffs, said that the claim was not in dispute, but the defendants had raised a counterclaim for goods supplied by them to the plaintiffs for a larger sum. The goods which were subject-matter of the counterclaim were supplied after Mr. F. D. Leslie had been appointed by the Chancery Division of the High Court as receiver of the plaintiff company's business, with liberty to carry on the business. The question for the Court to decide was whether the defendants were entitled to set up against the receiver a claim which he could only prove against the company, it being in liquidation. It might be hard upon the defendants, but that was no reason why the receiver should have to deal with the counterclaim. The learned Commissioner said that if the defendants did not know that they were dealing with the receiver (and that was admitted) then there was no contract with the receiver. Mr. Hicks said the receiver was acting on behalf of secured creditors who were mortgagees in possession practically. The point was whether an unsecured creditor of a company could set up his claim against a secured creditor. The learned Commissioner said the point was a very fine one. He non-suited the plaintiffs, but as there were many more cases depending upon it he would give them leave to appeal, so that they might raise the question elsewhere.

Canterbury.—The following letter, received from Messrs. Mowll and Mowll, 73, Castle-street, Canterbury, has been read at a meeting of the Town Council: "The committee appointed at the public meeting, held the other day, with reference to the introduction of the electric light into Canterbury, are desirous of ascertaining from the Corporation the amount of street and public lighting the Corporation will give to the company if the works are carried out and the light supplied. As the Corporation are probably aware, the Brush Company are willing to subscribe £12,000 if a sum of £6,000 is subscribed for locally. Before

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taking steps to ascertain whether they are in a position to obtain this capital the committee are, of course, anxious to know the amount of custom they are likely to receive from the authorities of the city." The Town Clerk reminded the meeting that at the last Council meeting he was instructed to affix the corporate seal to a contract with the gas company for one year. Councillor Lukey said he would like to know what decision was come to when it was decided that a provisional order be obtained. Was not there a plan of the district over which it was proposed the electric light should be carried? Councillor Harris stated that Mr. Garcke estimated to be able to light the city by means of 125 lamps at a cost of £2,700, but they showed him that would be impossible. Then a question arose as to what number of lamps the Council could take, and they gave the company to understand that they could not take any. The reason was that if they had 20 electric lamps the gas bill would not be appreciably reduced, because the gas standards would still be needed. The matter ultimately dropped.

Windsor.—At a meeting of the Town Council the following report from the Electric Lighting Committee was read: "(1) Your committee report that the town clerk has made enquiries of upwards of 80 other boroughs and places where the town council or other local authority have themselves obtained provisional orders for the supply of electric light and power, and he has also attended at the office of the Board of Trade and made enquiries there, and has obtained much valuable information which has been placed at the service of your committee. (2) Your committee, considering that it was of great importance that the adjoining towns of Windsor and Eton should act in unison together, and being also unanimously of opinion that the supply of electricity can be carried into effect more economically and with greater certainty of financial success by the inclusion of Eton and Eton College in the scheme, have put themselves into communication with the Eton Local Board, and have met a committee appointed by the Board in conference when the subject was fully discussed, and your committee have since received from the Eton Local Board the following resolution—viz., 'This Board is willing to acquiesce in allowing Windsor to obtain a provisional order for lighting Eton with electricity, supposing satisfactory terms can be agreed upon.' (3) Your committee recommend that the Town Council apply to the Board of Trade to revoke the Windsor Electric Lighting Order of 1890, which your committee are advised is the first step necessary to be taken. (4) Your committee also recommend the Town Council to apply to the Board of Trade for a provisional order to supply electric light and power for public and private purposes within the borough, and also within the district of the Eton Local Board. (5) Your committee ask the Council to grant to them authority to employ an electric engineer, to advise and report upon the subject." The report was adopted.

Appointments Vacant.—The Corporation of Derby invite applications for the position of assistant engineer. Applicant must have had experience of high speed engines, condensers, alternators, arc lamps, and have served time as a fitter. Applications, with three recent testimonials, are to be addressed to Mr. J. E. Stewart, engineer and manager, Electric Light Station, Full-street, Derby, by to-morrow (Saturday).—The Governors of the People's Palace will shortly appoint for their evening classes a head of the electrical department, who will be expected to give all his evenings to the work of the department The salary offered is £150. Applications are to be sent to the director of evening classes, People's Palace, London. E —An assistant master for physics and elementary mathematics, and an assistant master for physics and electrical engineering are required for the municipal technical schools at Hull. The salary offered in each case is £120 per annum, and applications are to be sent to Mr. J. T. Riley, Town Hall, Hull, by Tuesday next.—The South-West London Polytechnic require, by the 28th inst., a principal to undertake direction of the whole educational work, the higher teaching in at least one department of science, and head-masterships of day schools. The salary offered, from April 1, 1895, is £600 per annum. Meanwhile the successful candidate will be expected to advise governing body as to equipment, etc., and occasionally visit building in course of erection, from time of appointment, for an honorarium of £100. Forms of application may be obtained from Mr. F. P. Murray, secretary to the governing body, 47, Duke-street, St. James's, S.W.—The Plymouth Technical Instruction Committee invite, by August 1, applications for the appointment of head master of the science, technological, and commercial department of their science, art, and technical schools. He must hold a university degree, and be highly qualified in chemistry, physics, and mechanical subjects. The salary is £300 per annum.

Bath.—The Town Council have received a notice from the electric lighting company stating that they intended to apply to the Board of Trade for a provisional order extending their work for private and public lighting to any place within the city of Bath. The Clerk added that this notice was served on June 30. The Act required that it should be served before July 1 The Chairman: What time must elapse before the company can take another step? The Clerk said they must present a memorial to the Board of Trade, and must advertise their application in a local paper two consecutive weeks. This notice would show the extent to which they applied. The committee would probably like to know how the matter stood at present. The company now derived its power from the Board of Trade by a license which was granted about three years ago. This license gave the company the power to carry out their electric lighting over certain specified areas for seven years from the date of the license, and in the license there was a provision that at the expiration of the seven years the urban authority had the power of purchasing the whole of the works if they thought fit, either by agreement or, if they could not agree, by arbitration. This provisional order would not be sanctioned by the Board of Trade except with the consent of the authority, and if it were granted it would give the company 21 years from the date of the provisional order within which they might carry out their work. Not only would it very much extend the time they now had, but it would include the whole of the district, whereas their license at present only extended to the area which was now lighted by electricity. In this case, of course, the authority would then not be able to entertain any application by any other company, as they now might, with respect to that part of the district not included in the present electric area. Alderman Sturges said the matter had been before the Lighting Committee in a very cursory manner. They did not feel called upon to accede to the terms of the electric lighting company, but they were extremely anxious to do justice on both sides They wanted to look at the question in all its bearings, and therefore he moved that it be sent to the Electric Lighting Committee, who would bring up a report. This was agreed to.

Electric Pumping Plant.—Messrs. Ernest Scott and Mountain, Limited, Newcastle, have completed for Messrs. Strakers and Love, Brancepeth Colliery, an electric pumping plant, which is capable of delivering 300 gallons of water per minute through two miles of 6in. pipe against a head of 250ft. Owing to the friction in the pipes this equals a total head of 410ft. The installation consists of a set of three-throw ram pumps driven by an electric motor. The current is generated by a Tyne compound-wound dynamo capable of giving an output of 55 units, and is driven by a horizontal steam-engine developing 80 b.h.p. The engine is of the horizontal single-cylinder long-stroke type, capable of developing 100 i.h.p., or 80 b.h.p., with a steam pressure of 40lb. per square inch. The cylinder is 23½in. diameter by 33in. stroke. The dynamo is of Messrs. Scott and Mountain's improved mining type, capable of giving an output of 60 units—*i.e.*, 120 amperes at an E.M.F. of 500 volts—when running at a speed of 550 revolutions per minute. The armature is of an improved type, constructed to admit perfect ventilation and ready repair in case of accident. The dynamo is mounted on a cast-iron sliding bedplate, with tightening screws and brackets enabling the slack of the belt to be taken up whilst the machine is running. The switchboard consists of one double-pole switch with double-pole cut-outs provided for switching on and off the current to the pumps, and is fitted with Scott and Mountain's improved sparking contacts, preventing the metal surfaces of the switch being injured by sparking; one voltmeter to read to 600 volts, with measuring key; and one ampere-meter to read to 150 amperes, with measuring plug. The conducting cables between the main switchboard and the pumps consists of 1,300 yards of stranded high-conductivity copper cable, composed of seven wires No. 11 B.W.G. This cable is supported on poles with oil insulators. The pumping plant is placed at a distance from the engine-house of 700 yards. The pumps are capable of delivering 300 gallons of water per minute against a head of 410ft. when running at a speed of approximately 36 strokes per minute. They are the three-throw ram type with rams 9in. diameter by 15in. stroke The electric motor is capable of giving 55 effective horse-power when running at a speed of approximately 600 revolutions per minute. In general design the machine is similar to the dynamo, but the bedplate is extended and two additional bearings are fitted, and on the extension to the shaft two driving pulleys are placed running between main bearings, and from these pulleys the power is transmitted to the pumps. The motor is mounted upon a cast-iron sliding bedplate fitted with tightening screws and brackets, so that the slack of the belt can be taken up whilst running. A main starting switch is provided, so that the motor can be stopped or started slowly, and all shock taken off the pumps.

St. Pancras.—The Finance Committee of the London County Council made the following report on Tuesday: "We have considered the application from the Vestry of St. Pancras for a further loan of £14,600 for 42 years, on the annuity system, for electric lighting purposes. On July 25, 1893, we reported on the Vestry's application for a loan of £30,000 for electric lighting works, when we recommended (having regard to the amount already borrowed—viz., £10,000—and £8 000 for sites, and £60,000 for works, and to the circumstances referred to in our report) that the loan should be limited to £15.400 The Council concurred in our recommendation and agreed that the repayment should be spread over 42 years. This loan was not taken up at that time. On February 13, 1894, we reported very fully on a renewed application for the loan of £30,000, in which application the Vestry asked that the order sanctioning the borrowing of the £15,400 should be cancelled, and the Council on our recommendation directed that the resolution of July 25, 1893, sanctioning the borrowing of £15,400 for 42 years should not be further acted upon, and in lieu thereof sanctioned a loan of £29,700 (inclusive of the £15,400 previously sanctioned), to be repaid in 25 years. This resolution was communicated to the Vestry on February 16, and we have just been informed that the Vestry, on March 30, notwithstanding this intimation and without notice to the Council, borrowed elsewhere the sum of £15,400, thereby ignoring the last resolution of the Council, and assuming that the previous sanction for raising £15,400 repayable in 42 years, although withdrawn, was effectual; and they now ask consent to borrow £14,600 for 42 years, making up the original £30,000, in place of the £29,700 dealt with by the Council as above stated. In view of the Council's decision of June 26 lost in the case of the Hampstead Vestry, allowing 42 years for repayment of a loan of £24,400 for the cost of initial electric lighting works,

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and in deference to the opinion of the Council as expressed in that case we are now recommending that a period of 42 years should be allowed for the proposed loan to the Vestry of St. Pancras. As the Vestry has taken up a loan for the £15,400, the resolution of the Council of February 13 conditionally sanctioning the Vestry borrowing £29,700 should be withdrawn, and a substituted resolution passed limiting the loan to £14,300, making with the £15,400 borrowed the sum of £29,700, the amount to which we previously recommended the loan should be limited. We accordingly recommend (*a*): That the resolution of the Council of February 13, 1894, agreeing to advance to the Vestry of St. Pancras the sum of £29,700 for works for electric lighting purposes, be not further acted upon. (*b*) That, subject to the Council hereafter giving its written consent under seal to the borrowing, and subject to all necessary consents and evidence being furnished to the satisfaction of the solicitor of the Council, the application of the Vestry of St. Pancras for a loan of £14,600 towards defraying the cost of electric lighting works in the parish be granted, to the extent of £14,300, on condition that the loan be taken up at once, interest being charged thereon at the rate of £3 10s. per cent. per annum, calculated quarterly, and with the principal being repaid by such equal half-yearly payments of principal and interest combined as will repay the amount borrowed within a period of 42 years; that it be referred to the solicitor to take the necessary measures for completing the loan, and that the amount be advanced out of the consolidated loans fund." This report was adopted by the Council.

PROVISIONAL PATENTS, 1894.

JULY 9.

13216. **Magnetic separator.** William Henry Ryder and James Insole Ryder, 36, Slaney-street, Birmingham.

13259. **Improvements in automatic electric exchange** Robert Pippette. 51, Upper Tulse-hill, Brixton-hill, London.

13267. **Improvements in galvanometers.** John Hopkinson, 5, Victoria-street, Westminster.

13286. **Improvements in electrical apparatus for stopping horses.** Carl Pack, 40, Chancery-lane, London.

JULY 10.

13319 **Improvements in electric arc lamps.** Peter Kirkegaard, 70 Market-street, Manchester. (Complete specification.)

13331. **An electrically-controlled lubricating device.** Lancelot Walter de Grave, 24, Crompton-street, Derby.

13358. **Improvements relating to electrolysis, and to apparatus therefor.** Henry Harris Lake, 45, Southampton buildings, Chancery-lane, London. (Isaiah Lewis Roberts, United States.) (Complete specification.)

13363. **An improved plate for secondary voltaic batteries.** William Alfred Baxter Buckland, 28 Southampton-buildings, Chancery-lane, London. (Complete specification.)

13377. **Improvements in process and apparatus for electrolytically treating salts in solution or in molten state.** Peter Jensen, 77, Chancery-lane, London. (Henrik Christian Fredrik Störmer, Norway.) (Complete specification.)

JULY 11.

13410. **Improvements in electrical switches.** Charles Mark Dorman and Reginald Arthur Smith Ordsal Electrical Works, Salford, Manchester (Complete specification.)

13416. **Continuous electric brakes for railway trains.** Alexander Young, 2, Merchiston Bank terrace, Edinburgh.

13422. **Improvements in or connected with electric relays.** William Phillips Thompson, 6, Lord-street, Liverpool. (Charles Eugène Maréchal, Pierre Claude Henri Rigollet, and the Société E. Ducretet and L Lejeune, France)

13433. **Improvements relating to electric telegraphy** Claude Joseph Augustin Munier, 6, Bream's buildings, Chancery-lane, London.

JULY 12

13478. **Electric arc hood.** Sidney George Brown, 22, Hamlet-road, Chelmsford.

13499. **Improvements in process and apparatus for electrolytical decomposition of alkali salts** Alf Sinding-Larsen, 77, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883 sec. 103, December 12, 1893, being date of application in Norway.) (Complete specification.)

13523. **Improvements connected with reflectors for electric arc lamps.** Carl Coerper, 166, Fleet-street, London. (Complete specification.)

JULY 13.

13549. **Improvements in apparatus for working electric tramways by means of underground cables.** Chris Anderson, Lane House, Jack-lane, Hunslet, Leeds

13550. **Improvements in apparatus for working electric tramways.** Chris Anderson, Lane House, Jack-lane, Hunslet, Leeds.

13579. **Improvements in coin-controlled electrical apparatus.** John Orlando Frost, 323, High Holborn, London. (Date applied for under Patents, etc, Act, sec. 103, December 30, 1893, being date of application in United States.) (Complete specification.)

13568. **An improved combined electric switch and regulator.** Francis Tallack, Francis William Tallack, and Louis Héndlé, 10, Great Turnstile, Holborn, London.

13581. **Improvements in electric cables.** Silvanus Phillips Thompson, 6, Lord-street, Liverpool (Date applied for under Patents, etc., Act, 1883, sec. 103, December 19, 1893, being date of application in United States.)

13594 **Improvements relating to the insulation of wires for electric heating apparatus.** Hugo Helberger, 18, Buckingham-street, Strand, London.

JULY 14.

13623 **An invisible electric switch and bracket combination.** Thomas Ernest Waltham, Chapel-place Works, Great Chapel-street, Westminster.

13634. **Improvements in arc lamps.** James William Rogers, 37, Cursitor-street, Chancery-lane, London.

13636. **Improvements in perforators used for transmitting telegraphic messages and cablegrams.** Henry Whawell, 11, Aldebert-terrace, Clapham-road, London.

SPECIFICATIONS PUBLISHED.

1886.

6027* **Recording and reproducing speech.** Johnson. (Volta Graphophone Company.) (Third edition.)

1893.

7806. **Telephonic apparatus** Anders and Köttgen.

12257. **Electricity meters.** Binswanger and Coates.

12516. **Telephone.** Graham.

15610. **Electrolytical decomposition of brine, &c.** Baily and Guthrie.

15736 **Covering telegraph etc., cables and wires.** G. and T. Edward.

15781. **Electric wiring system.** Rennoldson.

16197. **Electric traction apparatus.** Schoop.

1894.

140. **Telephone exchange systems.** Callender.

4197. **Electric switches and fuses.** Busch.

9761. **Electrolytic apparatus.** Craney.

9949. **Electrolytic apparatus.** Craney.

9967. **Electric arc lighting.** Day. (Higham Electric Company.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	5	5¼-5⅝
Bournemouth Electric Company	—	—
Brighton and Hove Company Original	100	210-215
—— "A" Ordinary	—	162-166
Brush Company, Ordinary	3	2⅝-3
—— Nom. Cum, 6 per cent. Pref.	2	2⅛-2⅜
—— 4½ Debenture Stock	100	110-113
Charing Cross and Strand	5	4½-5⅛
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	12½-13
—— 6 per cent. Cumulative Pref.	10	14-14½
—— 5 per cent. Debenture Stock	115	128-130
City and South London Railway, Consolidated Ordinary	100	36-38
—— Debenture Stock	100	119-121
—— 5 per cent. Pref. Shares	10	12⅜-13¼
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2⅛-3
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	95-100
Elmore's French Company	2	1⅛
Electric Construction, Limited	2	1⅝
—— 6 per cent. Debentures	—	87-92
—— 7 per cent. Cumulative Pref.	2	1⅛-1⅜
Elmore's Copper Depositing	2	1⅛-1⅜
Electricity Supply Company for Spain	5	—
Elmore's Wire Company	2	1⅛-1⅛
Fowler-Waring Cables	5	1-1⅛
W. T. Henley's Telegraph Works, Ordinary	10	6⅞-7⅛
House-to-House Company, Ordinary	5	1-1⅛
—— 7 per cent. Preference	5	5⅛-5⅜
India Rubber and Gutta Percha Works	10	23-24
—— 4½ per cent. Debentures	100	103-105
International Okonite, Ordinary	10	1-2
Kensington and Knightsbridge	5	4⅜-5⅛
Liverpool Electric Supply, Ordinary	5	6⅛-6⅜
—— Pref.	—	—
Liverpool Overhead Railway	10	8⅛-8⅜
—— Pref.	10	12⅜-13⅛
—— 4 per cent. Mortgage Debentures of £100	100	111-113
London Electric	5	1-1⅛
Metropolitan Electric Supply	10	8⅛-8⅜
—— 5 per cent. Reg. Debentures, 1-10,000 in Bonds of £10, £20, and £40	—	106-109
National Telephone, Ordinary	5	4⅜-5
—— 6 per cent. Cum. First Pref.	10	14½-15⅛
—— 6 per cent. Cum. Second Pref.	10	14-15
—— 5 per cent. Nom. Cum. Third Pref	5	5⅛ 5⅜
—— 4½ per cent. Deb. Stock	—	109-112
Notting Hill Company	10	4½-5⅛
Oriental and Electric Company, £1 shares	1	1-1⅛
—— £5 Shares	—	6-6⅛
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7-7⅛
—— 7 per cent. Pref.	5	8⅛-9
Swan United	—	—
Telegraph Construction and Maintenance	12	40-42
—— 5 per cent. Bonds	100	102-105
Westminster Electric Supply, Ordinary	5	6⅛-6⅜
Yorkshire House-to-House	4½	4⅛-4⅜

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NOTES.

Western Australia.—The Ministry propose to extend the telegraph system.

Saint Chamond.—A local company has been formed to supply electric light and to transmit power.

Electric Lighting at Waldenburg.—A scheme has been projected for lighting this town electrically.

Cliff-Lighting.—The North Cliff at Bridlington Quay was lighted by electricity for the first time on Saturday.

Electric Traction at Baden, Austria.—A trial run has been made on the new electric tramway here with success.

Ship-Lighting.—The "Ceylon," built for the Peninsular and Oriential Steam Navigation Company, is lighted by electricity.

New South Wales.—An experimental electric tramcar is running regularly between Bridge-street, Sydney, and the Redfern terminus.

Electric Organs.—Those interested in the subject of electric organs will find an illustrated article dealing with them in *Cosmos* of July 23.

Cambridge.—The Cambridge Electric Supply Company will give on October 8 an uninterrupted supply of current at all hours of the day and night.

Electric Lighting at Stuttgart.—Work has been commenced by Messrs. Schuckert and Co. on the erection of a central electric lighting station here.

Electric Lighting of Urbeis.—Mr. Karl Amel intends to utilise the water power of the falls at Urbeis, Alsace, for electric lighting and power purposes.

Cable Communication.—The Eastern Telegraph Company state that the Sierra Leone Accra cable is repaired, thus restoring communication by that route.

Telephony in Austria.—Telephonic communication is to be established between Vienna and Linz by autumn. In the course of next year the line will be extended to Salzburg.

Electric Lighting at Schneidemuhl.—Messrs. Schuckert and Co. propose to erect a central electric light station here. The mechanical plant will be supplied by Mr. H. Panksch, of Landsberg.

Electric Power at Lagerdorf.—An electric installation, on the rotary-current system, has been carried out by the Allgemeine Elektricitats Gesellschaft at the Breitenburg Portland Cement Works, near Itzehoe.

Electric Lighting at Helmstedt.—The local clay works are being supplied with an electric light installation by Messrs. Schuckert and Co., of Nuremberg. There are 200 incandescent lamps and four arc lamps.

Electric Traction in France.—The Compagnie Nationale d'Electricité has under consideration the introduction of electric traction on tramways in those towns where they have established central stations.

Hanley Central Station.—This central station was to be set in operation yesterday (Thursday) evening by the Mayor (Mr. E. J. Hammersley). The Brush Electrical Engineering Company have carried out the work.

Central Electric Station at Furth.—A central station is to be erected here for the supply of current for lighting and power purposes. The station will be built to be able to supply 1,000 16-c.p. incandescent lamps.

Electric Power in a Factory.—The firm of M. Joseph and Co., of Plauen, who are manufacturers of trimming, are erecting new works at Stuttgart where the machinery is to be driven by means of electric motors.

Grunberg (Silesia).—The water power of the Bober at Christianstadt will be used by Mr. Sothmann for an electrical plant for the transmission of current for lighting and power purposes at Grünberg. About 350 h.p. is available.

French Lighthouses.—The lighthouses on the Isle of Yeu in Vendee is about to be equipped with an electric light, which is to be of large illuminating powers, and to flash at intervals of five seconds. The light will be visible in clear weather a distance of 52 miles.

Electric Lighting at Tutzing.—Count von Landberg Hallberger has erected a central electric supply station at Tutzing. The castle, two hotels, and a brewery are connected, and negotiations are in progress for lighting the railway station, post office, and streets.

A "Laberatorium."—A French contemporary regards as an important institution a laboratory that has been established at 49, Rue d'Amsterdam, Paris. The "laboratorium" is provided with all kinds of motive power, and analyses and industrial investigations will be undertaken.

Electric Lighting at Trent.—The local authorities of Pergine, near Trent, have erected a central electricity station, and over 100 h.p. is being used for electric motors. The price charged for a 5-c.p. incandescent lamp is 4s. 7d. per year, and the wiring is undertaken by the authorities.

Telephony in France.—The number of subscribers to the telephone in France was 11,440 on September 1, 1889, 6,255 being in Paris, and the remainder in the provinces. On May 1, 1894, the total had increased to 25,858, of which 13,060 were in the capital, and the remainder in the provinces.

Electric Traction in Berlin.—In connection with the exhibition to be held in the Treptow Park in 1896 the Berlin Horse Tramway Company propose to build an electric tramway from Berlin to the park. A scheme is also on foot for the construction of an underground electric railway between Stralau and Treptow.

Electrical Exhibition at Ealing.—As will be seen from our "Business Notes," the Ealing Local Board have decided to hold an electrical exhibition during October, by which time the central electric light station will be in operation. The exhibition is, of course, intended to popularise the various applications of electricity.

A Moot Point.—Youth (standing with open eyes in respectful awe) to Great Traveller: "Did you ever catch an electric eel, Mr. Gadder?" Great Traveller: "Well, now, I wouldn't like to answer that question off-hand. I had an experience with an electric eel once; but whether I caught it, or whether it caught me, is a matter that was never settled satisfactorily to my own mind."

Fatalities.—"Another Fatality from Electricity" is the heading which the *Journal of Gas Lighting* gives to a paragraph. If we went on the same lines a few columns would have to be devoted each week to the fatal results, explosions, conflagrations, suffocations, etc., due to the use of coal gas, in which the gentleman who searches for an escape of gas with a lighted candle would be well to the front.

City and Guilds of London Institute.—The matriculation examination of the Central Technical College will be held on September 17-20, and the entrance examination of the Day Department of the Technical College, Finsbury, on September 18. The matriculation examination of the City and Guilds Central College will be held on September 17-20, and the new session will commence on October 2.

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Electric Motors. — The Hohenzollern Locomotive Works of Düsseldorf have been using electromotors in their pattern shop and foundry since November last. A comparison of the expenses under these conditions with those preceding has proved so favourable to the new system, that the company intend to use electric power in the whole of their works. The estimated saving amounts to £1,000 a year.

Lighthouse Illumination. — The United States Lighthouse Board are arranging, as mentioned in our last issue, to place a powerful light on the Fire Island approach to Sandy Hook, the first land usually made by vessels arriving at New York. It is stated that it will be a Lepante lens with a light of 250,000,000 c.p. placed at an elevation of 168ft., revolving and flashing every 10 seconds, and visible to a vessel 140 miles from New York.

The Douglas Electric Tramway.—This tramway, to which we have referred from time to time, has been completed by the Isle of Man Tramways and Electric Power Company along the coast between Douglas and Laxey, a distance of eight miles. The first trial car was run through on Saturday. Dr. Hopkinson, who is a director of the company, was in charge of the trial, which was a complete success. The Board of Trade inspection is to take place to-day (Friday).

Direct-Current Dynamos.—The graphical solution of some practical questions in regard to direct-current dynamos is discussed by Mr. J. Fischer-Hinnen, of Oerlikon, in the *Elektrotechnische Zeitschrift* of July 19. After dealing with the form of the characteristic, the author passes on to consider the determination of the diminution in pressure of shunt machines. He next treats of the electrical transmission of power by means of two series dynamos and calculations regarding tramway motors.

Self-Contained Vehicles.—We referred in our issue of June 1 to the competition of self-contained vehicles, which had been promoted by the *Petit Journal* of Paris. The final race took place on Sunday between Paris and Rouen, after a weeding out process had been gone through. There were originally five electric carriages entered, one of which was of English make, but four of these, including the last named, were withdrawn. The Comte de Dixon was declared the winner. He did the journey of 128 kilometres in 9 hours 40 minutes, including stoppages.

Electricity in France.—At the close of the past year there were in France 321 central electric light stations at work and 38 in course of erection. There were 127 stations operated solely by water power to the extent of 6,615 h.p.; 114 stations operated solely by steam-engines to the extent of 10,527 h.p.; 33 stations operated both by water and steam power to the extent of 2,911 h.p. of the former and 2,095 h.p. of the latter; and nine stations operated solely by gas-engines to the extent of 396 h.p. There were also several stations using both gas and water power to the extent of 355 h.p. of the former and 715 h.p. of the latter.

A Curious Perversion.—In a note in our issue of June 15 we gave the following item: "It appears that the members of the Italian fire brigade are very prompt in responding to alarms of fire. According to an illustration in *L'Elettricità*, the firemen arrive at houses struck by lightning before the lightning flashes disappear from view." This now crops up in the *Electrical Age* (U.S.A.) in the following deceptive form: "The Best Fire Department.—It is stated that the members of an Italian fire brigade are so quick in responding to a fire call that, in one instance, where a house had been struck by lightning, the firemen arrived before the flash had disappeared."

A Peculiar Accident.—An unusual electrical accident, which recently occurred at the Norfolk Navy Yard, appears to have been explained, and with the explanation comes the necessity of making provision to ground steel or iron vessels that are in dry dock, especially during the season of electrical storms. The *Electrical Review* of New York states that two men standing in water under the vessel, which was insulated by its supports of dry wood, were apparently struck by lightning, although men on the deck of the vessel felt no shock. One of the men was killed instantly and the other died in a few hours. The explanation now given is that the vessel was not struck by lightning in the ordinary sense, but that it acted as an enormous condenser. As it was insulated from the ground it became heavily charged, and was discharged through the men when they, standing in the water and thus making a good ground, touched the metal sides. The remedy will be to ground such vessels while they are in dry dock.

Lighting Power of Incandescent Lamps.—A lecture was recently delivered by M. Larnaude before the Société Internationale des Electriciens in Paris on the subject of incandescent lamps. The lecturer, who is the manager of the Société Générale Incandescente Edison, dealt first with the improvements made in the manufacture of this type of lamp, and stated that it is easy to understand whether there is any advantage in using lamps run economically with a short life. As an instance he gives the following comparative table, which is based on the unit price of 1f. per lamp and on the corresponding lives at different conditions of working the lamps:

1,200 hours for lamps of 4 watts per candle.
800 " " 3·5 "
400 " " 3 "

Cost per kilo-watt-hour in francs.	Cost price per 16-candle lamp hour in centimes. 4 watts per candle.	3·5 watts per candle.	3 watts per candle.
·50f.	3·28c.	2 92c.	2·65
·75f.	4·88c.	4·32c.	3·85
1·00f.	6·48c.	5·72c.	5·05

Manual of the Electrical Company, Limited.—A substantial volume has been issued by the Electrical Company, Limited, 122 and 124, Charing Cross-road, W.C. In the first place, there is a general treatise on electric lighting projects in which rules are given for the distribution of light, and an arrangement of storage batteries is shown, as well as details of wiring, fixing engines and boilers, and there is also a view of a complete generating plant. The transmission of power is dealt with, and plans are given of an electric lighting and power plant installed in a factory. We next have directions for preparing approximate estimates, and other sections treat of continuous-current machines and accessories, of switchboards and instruments, conductors, cables, etc., safety fuses and safety plugs, switches and circuit connectors, installation and insulation material, arc lamps and accessories, incandescent lamp fittings and electroliers, A. E. G. incandescent lamps, and of electric motors. In the last section there are illustrated descriptions of a piston pump driven by electricity, a circular pump, a ventilator, a portable drilling machine, a radial drilling machine, a lathe, lift, travelling crane, and a jib crane worked by means of electric motors. The manual is well got up, and forms a valuable compilation.

The Junior Engineering Society.—The members of this society recently visited the electric and hydraulic installations of the Great Eastern Railway at and in the

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neighbourhood of Liverpool-street by permission of the engineer, Mr. John Wilson, on whose behalf the district engineer, Mr. H. Wilmer, received the party and superintended the arrangements for their guidance over the extensive area included in the visit. The electric lighting station, situated in Norton Folgate, contains three 100 h.p. and four 200-h.p. compound vertical steam-engines, each driving a dynamo. Steam is supplied by five Lancashire boilers, working at 140lb. pressure. The lights will consist of 212 arc lamps, and 4,773 16-c.p., 272 32-c.p., and 55 50-cp. incandescent. The hydraulic engines and pumps, of which there are two sets, are placed at Bishopsgate-street low-level station, and to meet the demand occasioned by the extension of the system are about to be duplicated, as are also the two boilers and accumulator, etc. There are numerous capstans, truck hoists, parcels lifts, and cranes operated throughout the passenger stations and goods yards and warehouses, and a 50ft. diameter engine turntable has lately been connected up to be worked by hydraulic power. At the conclusion of the inspection Mr. W. H. Le Rittar, member of council, expressed the members' acknowledgments for the reception accorded them on the occasion.

Overhead Electric Railways.—The Americans are beginning to recognise the practical and commercial importance of overhead electric railways, and this is no doubt due to the success of our Liverpool line. Having derived as a commencement some experience from the intramural railway at the Chicago Exhibition, it has now been decided to operate the West Side Elevated Railway at Chicago by electric power. The West Side line, which connects that part of Chicago with the main city transit systems, is to be a four-track line for a greater part of the way, so as to allow of an express service. The power is to be obtained from four dynamos. Two of these are to be of 2,000 h.p. each, and the two smaller dynamos are to be of 1,000 h.p. The current will be conveyed from the generating station over the line by means of a "third rail" placed at the outside of each service track. A sliding shoe contact, hanging from the truck of each motor-car will pick up the current for the operation of the motors. It is intended to fit two motors only to each motor-car at first, but eventually two additional motors will be placed on each motor-car. With the two-motor motor-cars, four car trains will be run during the crowded hours of the morning and evening, and three car trains during the hours of slack travel, at a speed of 13 miles an hour, including stops. With the four-motor motor-cars, the trains will consist of six cars, and the speed will be increased to 15 miles an hour.

The Elevated Electric Railway in Berlin.—It is now some time since any information of real value has been forthcoming concerning the proposal to construct an elevated electric railway in Berlin from the Warschau Bridge to the Zoological Gardens, and about which we have kept our readers well informed as occasion has arisen. It now appears, however, that a definite scheme has been laid before the Municipal Council by the magistrate, and the consideration of the project has been referred to a committee. According to the proposed agreement to be entered into between the town and Messrs. Siemens and Halske, the former grants to the latter permission to utilise the streets and ways for the purpose of constructing the projected railway. The concession is to be given for 90 years, and in return Messrs. Siemens and Halske will pay to the town a percentage of the annual gross receipts from passenger and goods traffic, or on the former alone should there be no transport of merchandise. The percentage will range from 2 per cent. on an income of £300,000 to £350,000 to 4 per cent. on a revenue of £800,000 or over. The railway, which is to be completed and set in operation within four years from the date of the concession, is to provide a five minutes' service, and the line may be acquired by the town at certain periods during the duration of the concession. Connection is to be made with local lines and wagons from the latter must be conveyed over the electric railway.

Pure Water and its Electric Resistance.—Until recently the purest sample of water that has been physically examined was that obtained by Prof. F. Kohlrausch by distillation in vacuo, and which showed an electric conductivity only one-third of that of water distilled under atmospheric contact. The *Engineer* states that such low conductivity only endured for a short time, owing to the water taking up foreign matter from the sides of the containing vessel of the electrodes. The distilling apparatus used on that occasion, after standing full of water for nearly 10 years, has lately been used by Messrs. Kohlrausch and A. Heydweiller in some new experiments, which have been described in the *Transactions* of the Academy of Sciences at Berlin. The water obtained has, when tested at 18deg. C., only one-sixth of the conductivity of the former sample; the resistance of one square millimetre at the freezing point being the same as that of a copper conductor of the same section, 25,000,000 miles long, or more than a thousand times the circumference of the earth. The foreign matters contained in this water only amount to a few thousandths of a milligramme in the litre.

Lighting in Australia.—It is stated in a recent report that the New South Wales Parliament have thrown out every Bill promoted by private companies to light Sydney by electricity on the ground that such powers ought to belong solely to the Corporation. A report to the Adelaide City Council by Mr. George Anderson, C.E., of that city, shows that the Corporation of Melbourne have an Act empowering them to light the streets; the necessary buildings are finished, and the plant has arrived. The gas lamps will be extinguished, and several hundreds of pounds are expected to be saved out of the cost of the present lighting. In all the busy streets of the city electric lights are used, besides all the principal shops and many of the public buildings. In Sydney similar progress is recorded, where the main streets, wharves, railway stations, arcades, theatres, hotels, refreshment-rooms, and shops are all lighted by electricity. All the installations are in the hands of private individuals. Brisbane has also made a beginning now: Queen-street and its shops are lighted by a private firm. The report states that the price charged in Victoria for an incandescent light of 20 c.p. varies from 6d. in some country towns to 1s. 6d. a week in Melbourne. In Sydney the price is 1s. per week, and in Brisbane, where there is no competition, the price is 1s. 9d. per week. On the average the price is 1s. per week or 4s. per month. It appears that for cooking purposes electricity is being also largely applied.

Large Rotary Current Plant.—The central electric light station at Chemnitz, which has been carried out for the municipality by Messrs. Siemens and Halske, has been arranged on the high-tension rotary-current system in consequence of the large extent of the district to be served with both light and motive power. It is noteworthy that the station is the largest which has been designed according to this system in Germany. The works, which are situated on the outskirts of the town, contain three fixed triple-expansion condensing engines, made by the Saxon Engineering Works, of Chemnitz. Each engine, when running at 150 revolutions, and with an initial pressure of 165lb., gives from 150 h.p. to 220 h.p. The boilers were constructed by Messrs. Steinmüller, of Gummersbach. Each

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engine drives a rotary-current dynamo, which is direct coupled, as is also the exciter. At 150 revolutions, and when fully excited, each generator yields 180,000 watts at from 2,000 to 2,200 volts. The current is conveyed to the points of consumption by triple concentric cables, and here it is reduced by transformers to 120 volts. Provision has up to the present been made for 19 transformers of outputs ranging from 10,000 to 50,000 watts. The low-pressure current is again transmitted by triple concentric cables to places outside the inner town, where it is distributed by bare copper conductors. The most distant part to which current is led is about two miles from the central station, but future extensions provide for the transmission of current over a distance of four miles. A special feature of the station is the fact that there has been a large demand for motive power, and of the total output of the generators about one-third is required for this purpose. The working of the rotary current machines is satisfactory, especially in the case of parallel running.

Rating Appeals.—Two important rating appeals were decided on behalf of members of the Machinery Users' Association at the recent quarter sessions. At Chelmsford Messrs. Henry Tate and Sons, who appealed against the assessment of their sugar factory by the West Ham overseers, were represented by Mr. Stevenson-Moore (instructed by Messrs. Dollman and Pritchard, of 39, King street, Cheapside), who informed the court that an arrangement had been come to by which it was agreed the new assessment should be reduced from £9,898 to £7,800. Mr. Montifiore (instructed by Mr. Banes, vestry clerk of West Ham) intimated the consent of his clients to the course, and the rate-book was altered accordingly. Mr. Edward Boyle had been specially retained on behalf of the appellants, and Mr. Balfour Browne, Q.C., on behalf of the respondents, but in view of the compromise which had been arrived at their attendance was not necessary. The witnesses retained for the appellants were Messrs. Humphreys-Davies, S. Green, and R. W. James, M.I.M.E., and for the respondents Messrs. Ryan and R. Hedley. At the Aylesbury sessions the appeal of the Anglo-Swiss Milk Company against the recent reassessment of their factory by the union was heard before Mr. Cripps, Q.C., and a large number of magistrates. Mr. Castle, Q.C., and Mr. Hammond-Chambers were for the respondents, and Mr. E. Boyle and Mr. Stanley Fisher appeared for the appellants. The expert witnesses for the appellants were Mr. Humphreys-Davies, Mr. W. Barnett, and Mr. R. W. James, M.I.M.E., and for the respondents Messrs. Castle and Mason. After a long day's hearing, the chairman decided to adjourn his decision until he had made a view of the premises, which he did on the following morning, and at the opening of the court gave judgment for the appellants, reducing the assessment by £100.

The Telautegraph. — The wires between St. Margaret's and the General Post Office, London, were, a few days ago, used for the purpose of some experiments with the telautograph—the invention of Prof. Gray, of New York, and to which we have referred on previous occasions. The experiments took place between the General Post Office, London, and Cable Hut, St. Margaret's Bay, through which the London and Paris telephone passes. Special instruments were fixed up at both ends, and as this was the first time that long-distance experiments in telautography have taken place in this country, they were watched with unusual interest. The results were good, the messages transmitted being, in every respect, most successful, and the instruments working without the slightest hitch over a distance of 83 miles. Messages were both sent from and received at St. Margaret's Bay. It will be remembered that the principle of the instrument is that it automatically records a *facsimile* of the writing contained in messages. In the experiments on Sunday the receiving pencil recorded with ease and clearness different handwritings, giving thick and thin strokes, dotting i's and crossing t's correctly. In this connection Mr. Armytage Bakewell writes: "It has been stated that the recent experiments in the transmission of autographic messages by electricity between St. Margaret's Bay and London were the first which have been made in this country in long-distance telautography. Will you allow me to point out that this is a mistake, as more than 40 years ago the copying electric telegraph, invented by the late Frederick Collier Bakewell, successfully transmitted autographic messages between Brighton and London. Invisible messages, which could be rendered legible by the recipient, were also transmitted by that system. Great interest was taken by the late Prince Consort in my father's invention, and the inventor had the honour of exhibiting the instruments and of explaining their mechanical and electrical details to His Royal Highness at Buckingham Palace. The copying electric telegraph was subsequently exhibited at the great exhibition of 1851 and received the highest award—viz., the Council medal."

Electric Lighting of Railway Carriages.—An interesting pamphlet on this subject has reached us from the Allgemeine Elektricitäts Gesellschaft (General Electricity Company, of Berlin), who have for several years made a special study of train-lighting, and have carried out exhaustive experiments in this direction on one of the lines of the Prussian State Railways. The company's system differs from that introduced in England in the sense that they recommend the use of storage batteries which, when exhausted, are removed from the train to be recharged, a fresh set of accumulators being in the meantime substituted. Unless otherwise desired, one or more batteries are placed under or in each coach. It is pointed out that in determining the battery pressure, and therefore the number of cells to be used, the loss in pressure through internal resistance of the conductors is comparatively less when high tensions are employed. A battery to supply five 5-c.p. lamps for 40 hours weighs 466lb., with a discharge current at 15 volts, 515lb. at 22·5 volts, and 590lb. at 30 volts. Generally, a pressure of 22·5 volts (12 cells) is recommended, and 30 volts at the highest, although 15 volts is sufficient. If two lamps are to be installed for the lighting of a compartment it is better to provide two batteries, one for energising each lamp. The batteries are placed in a wooden box, either arranged under the floor of the compartment or under the seats of the latter. Connection is made from the battery to the service conductors by means of flexible insulated wires and spring contacts, the wires outside the carriages being protected by gas-piping. A suitable switch is provided for each battery, and this is under the control of the guard or other attendant. The batteries are removed from the train when necessary for recharging at any railway station where a charging-room is available, and fresh ones substituted. The pamphlet recommends two lamps of from 8 c.p. to 10 c.p., or four of from 4 c.p. to 6 c.p. for first and second-class coaches, and two of from 6 c.p to 8 c.p. for third-class compartments. It is mentioned that in the case of the Dortmund-Gronau-Enschede Railway the working results of the electric lighting of the trains have proved that this method is not more expensive than gas illumination, although the service is not very extensive.

The Transvaal.—In our issue of 29th ult., we referred in a note to Messrs. Siemens and Halske's proposal to supply electric power from a central station at Witwatersrand. Commenting on the subject, the *Johannesburg Critic*

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says: "Whether the scheme of supplying Rand mines with electricity on a large scale will be anything like the success the *Star* so gushingly predicts is at present a matter of opinion. Rand mining companies may take the view that for the sake of a very doubtful saving of a few pounds yearly, it will be a good thing to place themselves at the mercy of a company formed to make profits out of them—and they may think just the contrary, which is the more likely of the two. The fact is, similar schemes to the one in hand have been discussed in a desultory way over the nuts and wine for years, but the first real move to come to business has only just now been taken, and it is rather late in the day. Unfortunately for the eminent Berlin firm, the use of electricity is common on the Rand now, and nearly every company runs its own dynamo and produces its own light, One or two have gone further, and have extensive plants for working as well as lighting purposes. In the former cases the dynamos are run from the large engines, and their running does not make any perceptible difference in the consumption of fuel, so that, although the cost of lighting is worked out in the mine returns, it is really only a book-keeping item. In the latter case the dynamos are run by special engines at a comparatively small cost, and the difference between the cost of production by such a plant, and the cost of production with added profit and allowance for waste in transmission by a central company, cannot be more than a trifling amount which it will not be worth any company's while to save by sacrificing its own plant. A central company may get an opening with the companies which are not so far advanced, as the majority of main reef companies, but it must be prepared to do business on a much bigger scale than the present project involves, and it must also be prepared with up-to-date appliances for the use of the electric fluid as a motive power. No doubt in the future we shall see all the work of a mine performed by electricity, and then a central producing station may do well. Meantime, I wish success to the company, if it goes through, on the ground that it is a step in advance, and does not need a concession to bring it into being."

A New Electric Heater.—An electric heater, which is claimed to mark a distinct advance in this branch of industry, has been devised by Mr. H. Ward Leonard, who has forwarded us the following particulars of the appliance. Mr. Leonard points out that in electrically heated tools the conductor has been hitherto surrounded by a considerable thickness of such fireproof insulation as is a bad conductor of heat, and that therefore the heat is but slowly passed through this bad conductor. The necessity of a resistance which will stand a very high temperature has been such that platinum wire is often used in the construction of such tools, the expense of which is, of course, extremely high, but even this is said to have failed under such conditions. Mr. Leonard has many modifications of the general principles of his heater, but the description of one modification will give a general idea of the invention: the resistance, which is a metal wire, is thinly coated with some form of fireproof insulation, which hermetically seals the conductor from the air—such as enamel or glass. The wall of insulation around the conductor is quite thin. The conductor so insulated is placed in a mould, and a suitable metal is cast about the insulated resistance so as to completely embed it in the cast metal. This surrounding body of metal as it cools subjects the insulated conductor to strong pressure, ensuring perfect mechanical contact throughout. The surrounding metal also hermetically seals the resistance from any possible contact with the air, and from all chemical action. While the insulation surrounding the conductor is of comparatively poor quality as a conductor of heat, the wall of this insulation is so thin that it affords the least possible resistance to the flux of heat from the heated resistance to the surrounding metal body; consequently, the temperature of the heated resistance and the temperature at the surface of use will be as nearly the same as possible, and the resistance is therefore not subjected to a temperature appreciably higher than that of the surface of use. It is claimed to be possible to operate tools heated on this system at a bright red heat without any destructive effect whatever. The Carpenter Enamel Rheostat Company, of which Mr. Leonard is president, will manufacture apparatus under this patent. Among the various kinds of apparatus in which this system will be embodied are soldering and embossing irons, flat-irons, and tailors' gooses, cooking utensils, electric stoves, ovens, egg-boilers, etc.

The Thermogen.—In writing of the last Royal Society conversazione, the *Lancet* mentioned as an exhibit of particular interest to the medical man an invention by Mr. C. T. Snedekor for heating by electricity a quilt or cushion. It was obvious that such a quilt could be used in private or in hospital for many therapeutic purposes. This quilt, which he named the thermogen, the *Lancet* has since had an opportunity of putting to practical trial under more lengthened observation, and has no hesitation in reporting upon it thoroughly favourably as an appliance that might be of great value in all hospitals, or, for that matter, in all private houses where an electric main is handy. The quilt contains a coil of wire consisting of a special alloy of known composition and electrical resistance, and bent in the fashion of a gridiron. The coil is enclosed in suitable insulating and non-conducting material, the whole being embedded in cotton-wool or other soft substance provided with a silk or woollen covering. The resistance offered by the coil to the flow of the current—the friction set up, so to speak, by the passage of the current through the wire—produces the heat, in accordance with the laws of Ohm and Joule, in the same way that heat, and eventually light, are produced in the filament of the electric incandescent lamp when a current is forced through it. The coil contained in the quilt which was examined is constructed to admit of connecting with the terminals of an ordinary installation supply of 100 volts pressure, which effects a uniform temperature in the quilt of about 150deg. F. In the event, however, of the temperature rising beyond that point, which would be the case if there were an increase of pressure in the electric mains, a safeguard is provided in the end of the coil in the form of a "fuse," which would instantly melt and so automatically shut off the current. The quilt may be readily attached to wall plugs, pendants, or still more conveniently to table lamp terminals. In places where the electric current is not supplied for lighting purposes an accumulator may be substituted with equally satisfactory results. The direction in which such an invention might be medically useful is first, and our contemporary thinks in chief, on the operating table. In lengthened operations, or in those necessarily attended with much hæmorrhage, where artificial means to sustain the patient's temperature are required, most surgeons can recollect cases when the blankets and hot water at present in vogue have proved a decided nuisance. In such cases this quilt would be found literally invaluable as a soft, dry, warm, and convenient covering. Again, in cases of chronic rheumatism or of that undefined neuralgia generally called lumbago the quilt might prove comforting. Also, in cases of senile slowness of circulation attended with general chilliness such an appliance would be very useful. The thermogen is receiving trial at several of our largest hospitals.

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PHYSICAL UNITS.

BY MAGNUS MACLEAN, M.A., F.R.S.E.

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(Continued from page 35.)

§ 37. All electrical quantities can be expressed in terms of the mechanical or chemical or thermal effects produced by electricity. Chemical and thermal effects are, however, measured in terms of some mechanical unit, so that it is only necessary to attend to the relations between the electrical quantities and the mechanical units. We may start (*a*) from the experimental results of Coulomb, by defining the force between two quantities of static electricity, or the force between two quantities of magnetism; (*b*) from Ampère's formula by defining the force between two elements of currents of electricity. We thus arrive at what is commonly called the *electrostatic* units, the *electromagnetic* units, and the *electrodynamic* units. It shall be shown subsequently that by giving a certain value to the constant in Ampère's formula, the electrodynamic unit current is equal to the electromagnetic unit current.

§ 38. The clearest statement of the relations between the electric quantities of which I know is given in a report by Clerk Maxwell to British Association meeting at Newcastle-on-Tyne, 1863, and reprinted with various other reports by Spon, London, 1873. I quote from the second report, the members of the committee being Prof. Wheatstone, F.R.S., Prof. Williamson, F.R.S., Mr. C. F. Varley, Prof. Thomson, F.R.S., Mr. Balfour Stewart, F.R.S., Mr. C. W. Siemens, F.R.S., Dr. A. Matthiessen, F.R.S., Prof. Maxwell, F.R.S., Prof. Miller, F.R.S., Dr. Joule, F.R.S., Mr. Fleeming Jenkin, F.R.S., Dr. Esselbach, Sir C. Bright:

"... The electrical phenomena susceptible of measurement are four in number—current, E.M.F., resistance, and quantity. ... Their relations one to another are extremely simple, and may be expressed by two equations.

"First by Ohm's law, experimentally determined, we have the equation

$$C = E/R \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where C = current, E = E.M.F., and R = resistance. From this formula it follows that the unit E.M.F. must produce the unit current in a circuit of unit resistance; for if units were chosen bearing any other relation to each other, C would be equal to x E/R, where x would be a useless and absurd factor, complicating all calculation, and confusing the very simple conception of the relation established by Ohm's law.

"Secondly, it has been experimentally proved by Dr. Faraday that the statical quantity of electricity conveyed by any given current is simply proportional to the strength of the current, whether electromagnetically or electro-chemically measured, and to the time during which it flows; hence, in mathematical language, we have the equation

$$Q = C\,t \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where t = time, and Q = quantity. From this equation it follows that the unit of quantity must be the quantity conveyed by the unit current in the unit of time; otherwise we should have $Q = y\,C\,t$, where y would be a second useless and absurd coefficient. From equations (1) and (2) it follows that only two of the electrical units could be arbitrarily chosen, even if the natural relation between electrical and mechanical measurements were disregarded. Thus, if the E.M.F. of a Daniell's cell were taken as the unit of E.M.F., and the resistance of a metre of mercury of one square millimetre section at 0deg. C. were taken as the unit of resistance, it would follow from equations (1) and (2) that the unit of current must be that which would be produced by the Daniell cell in a circuit of the above resistance, and the unit of quantity would be the quantity conveyed by that current in a second of time. Such a system would be coherent; and if all mechanical, chemical, and thermal effects produced by electricity could be neglected, such a system might perhaps be called absolute. But all our knowledge of electricity is derived from the mechanical, chemical, and thermal effects which it produces, and these effects cannot be ignored in a true absolute system. Chemical and thermal effects are, however, now all measured by reference to the mechanical unit of work; and, therefore, in forming a coherent electrical system, the chemical and thermal effects may be neglected, and it is only necessary to attend to the connection between electrical magnitudes and the mechanical units. What, then, are the mechanical effects observed in connection with electricity? First, it has been proved that whenever a current flows through any circuit it performs work—or produces heat or chemical action equivalent to work. This work or its equivalent was experimentally proved by Dr. Joule to be directly proportional to the square of the current, to the time during which it acts, and to the resistance of the circuit; and it depends on these magnitudes only. In mathematical language this is expressed by the equation

$$W = C^2\,R\,t \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Where W = the work equivalent to all the effects produced in the circuit, and the other letters retain their previous signification. This is the third fundamental equation affecting the four electrical quantities, and represents the most important connection between them and the mechanical units. From equation (3) it follows (unless another absurd coefficient be introduced) that the unit current flowing for a unit of time through a circuit of unit resistance will perform a unit of work or its equivalent. If every relation existing between electrical and mechanical measurements were expressed by the three fundamental equations now given, they would still leave the series of units undefined, and one unit might be arbitrarily chosen from which the three other units would be deduced by the three equations; but these three equations by no means exhaust the natural relations between mechanical and electrical measurements. For instance, it is observed that two equal and similar quantities of electricity collected in two points repel one another with a force, F, directly proportional to the quantity, Q, and inversely to the square of the distance, d, between the points. This gives the equation

$$F = Q^2/d^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

From which it would follow that the unit quantity should be that which at a unit distance repels a similar and equal quantity with equal force. The four equations now given are sufficient to measure all electrical phenomena by reference to time, mass, and space only, or in other words, to determine the four electrical units by reference to mechanical units. Equation (4) at once determines the unit of quantity, which by equation (2) determines the unit current; the unit of resistance is then determined by equation (3), and the unit E.M.F. by equation (1). Here, then, is one absolute or coherent system, starting from an effect produced by electricity when at rest. The units based on these four equations are precisely those called by Weber electrostatical units, although, it may be observed that he chose those units without reference to what is here called the third fundamental equation, or, in other words, without reference to the idea of work, introduced into the system by Thomson and Helmholtz.

"The four equations are sufficient to determine the four units, and into this system no new relation can be introduced. The first three equations may, however, be retained, and a distinct absolute system established by substituting some other relation between electrical and mechanical magnitude than is expressed in equation (4); and, indeed, the electrostatical system just defined is not that which will be found most generally useful. It is based on a statical phenomenon, whereas at present the chief applications of electricity are dynamic, depending on electricity in motion, or on voltaic currents with their accompanying electromagnetic effects. Now, the force exerted on the pole of a magnet by a current in its neighbourhood is a purely mechanical phenomenon. This force (f) is proportional to the magnetic strength (m) of the pole of the magnet, and to the strength of the current, C; and if the conductor be at all points equidistant from the pole, or, in other words, be bent in a circle of the radius, k, round the pole, the force is proportional to the length of the conductor (L); it is also inversely proportional to the square of the distance (k) of the pole from the conductor, and is affected by no other circumstances than those named. Hence we have

$$f = C\,L\,m/k^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

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From this equation it follows that the unit length of the current must produce the unit force on a unit pole at the unit distance. If the equations (1), (2), (3), and (5) are adopted as fundamental, they give a distinct absolute system of units, called by Weber the electromagnetic units. Equations (4) and (5) are incompatible one with another, if equation (2) be considered fundamental; but the electromagnetic units have a constant and natural relation to the electrostatic units. It will be seen that in the fundamental equation (5) of the electromagnetic system, besides the measurement of time, space, and mass, alone entering into the other equations, a fourth measurement (m) of a magnetic pole is required; but this measurement is in itself made in terms of the mechanical units, for the unit pole is simply that which repels another equal pole at unit distance with unit force. Thus in the electromagnetic, as in the electrostatic system, all measurements are ultimately referred to the fundamental units of time, space, and mass. The electromagnetic units are found much the more convenient when dealing, as we have now chiefly occasion to do, with electromagnetic phenomena.

"The relations of the electromagnetic units one to another and to the mechanical units may be summed up as follows: The unit current conveys a unit quantity of electricity through the circuit in a unit of time. The unit current in a conductor of unit resistance produces an effect equivalent to the unit of work in the unit of time. The unit current will be produced in circuit of unit resistance by the unit E M.F. The unit current flowing through a conductor of unit length will exert the unit force on a unit pole at unit distance. (In the electrostatic system, all the above propositions hold good except the last, for which the following must be substituted: The unit quantity of electricity will repel a similar quantity at the unit distance with unit force)."

Electrostatic System of Units.

§ 39. Coulomb, experimenting with his torsion balance, found that the force of repulsion between similar quantities of electricity varied inversely as the square of the distance between them, and directly as the product of the two quantities of electricity. In symbols, if q, q^1 be the two quantities of electricity, and r the distance between them, then $F \propto \frac{q\,q^1}{r^2} = \text{constant} \times \frac{q\,q^1}{r^2}$.

Faraday proved that different substances have different powers of transmitting electric disturbances, so that the force of repulsion between two similar quantities of electricity depends not only on the quantities and on their distance apart, but also on the intervening medium. Let us denote this power of transmitting electric disturbances, or the specific inductive capacity of the medium by K, then $F = \text{constant} \times \frac{q\,q^1}{K\,r^2}$.

It is thus necessary to fix on some standard medium for defining the electrostatic quantity of electricity. In the ordinary electrostatic system the standard medium is air, at temperature 0deg. C., and at standard atmospheric pressure. The constant in the equation will be unity if we define unit quantity of electricity as that quantity which, concentrated at a point* one centimetre from an equal and similar quantity also concentrated at a point, would repel it with a force of one dyne, when the medium across which the electric action is transmitted is air. The dimensional formula for unit *quantity* of electrostatic electricity is therefore

$$[q] = [F \,.\, K \,.\, L^2]^{1/2};$$
$$= [L\,M\,T^{-2} \,.\, K \,.\, L^2]^{1/2};$$
$$= [L^{3/2}\,M^{\frac{1}{2}}\,T^{-1}\,K^{1/2}].$$

In the ordinary electrostatic system of units, K for air is supposed to be of zero dimensions, but Prof. Rücker, in a paper entitled "Suppressed Dimensions of Physical Quantities,"† advocates the retaining in the tables of dimensions the symbols K and μ (inductive capacity and magnetic permeability), and speaks of these as secondary fundamental units. The dimensions of K and μ are thus supposed to be undetermined, and the ordinary electrostatic and electromagnetic systems can be derived from what follows by deleting K and μ respectively.

Oliver Heaviside* advocates, for no valid reason, that the constant in the above equation should be $\frac{1}{4\pi}$, so that $q^2 = 4\pi\,K\,L^2\,F$, and hence deduces what he terms rational units.

§ 40. Electric *surface density*, σ, of a conductor at any point is measured by the number of units of electricity per unit of area. Hence its dimensional formula is

$$[\sigma] = [q\,L^{-2}] = [L^{-\frac{1}{2}}\,M^{\frac{1}{2}}\,T^{-1}\,K^{\frac{1}{2}}].$$

§ 41. The unit of *current*, γ, in a conducting wire is the current in which the unit quantity passes in the unit of time. Hence its dimensional formula is

$$[\gamma] = [q\,T^{-1}] = [L^{\frac{3}{2}}\,M^{\frac{1}{2}}\,T^{-2}\,K^{\frac{1}{2}}].$$

§ 42. The *intensity of an electric field* at a point, f, or the electric force at any point in an electric field, is the force with which a unit of electricity would be acted on if placed at that point. The force, F, on a quantity of electricity, q, in a field of electric force of intensity, f, is $F = f\,q$. Therefore the dimensional formula for the electric force at a point is

$$[f] = [F\,q^{-1}];$$
$$= [L\,M\,T^{-2} \times L^{-\frac{3}{2}}\,M^{-\frac{1}{2}}\,T\,K^{-\frac{1}{2}}];$$
$$= [L^{-\frac{1}{2}}\,M^{\frac{1}{2}}\,T^{-1}\,K^{-\frac{1}{2}}].$$

§ 43. Unit *difference of electric potential*, v, exists between two points in an electric field when unit work is done in carrying unit quantity of electricity from the one point to the other against the electric forces. Hence if q units of electricity is carried through a difference of electric potential expressed by v, the work done $W = q\,v$. Therefore the dimensional expression for difference of electric potential is

$$[v] = [W \,.\, q^{-1}];$$
$$= [L^2\,M\,T^{-2} \times L^{-\frac{3}{2}}\,M^{-\frac{1}{2}}\,T\,K^{-\frac{1}{2}}];$$
$$= [L^{\frac{1}{2}}\,M^{\frac{1}{2}}\,T^{-1}\,K^{-\frac{1}{2}}].$$

Electric potential at a point due to a quantity, q, of electricity is the quotient obtained by dividing the quantity of electricity by the distance and by the inductive capacity. Thus $[v] = [q\,L^{-1}\,K^{-1}] = [L^{\frac{1}{2}}\,M^{\frac{1}{2}}\,T^{-1}\,K^{-\frac{1}{2}}]$.

§ 44. The *capacity* of a conductor, c, is the quotient obtained by dividing the quantity of electricity with which it is charged by the potential which this charge produces in it. Hence its dimensional formula is

$$[c] = [q\,v^{-1}] = [L^{\frac{3}{2}}\,M^{\frac{1}{2}}\,T^{-1}\,K^{\frac{1}{2}} \times L^{-\frac{1}{2}}\,M^{-\frac{1}{2}}\,T\,K^{\frac{1}{2}}] = [L\,K].$$

Hence, if, as in the ordinary electrostatic system, we suppose $[K] = 1$, then the dimensions of capacity will be that of length, and is correctly expressed as so many centimetres.

§ 45. The *resistance* of a conductor, r, is by Ohm's law measured by the difference of potential at its extremities divided by the current produced in it thereby. Therefore its dimensional formula is

$$[r] = [v\,\gamma^{-1}] = [L^{\frac{1}{2}}\,M^{\frac{1}{2}}\,T^{-1}\,K^{-\frac{1}{2}} \times L^{-\frac{3}{2}}\,M^{-\frac{1}{2}}\,T^2\,K^{-\frac{1}{2}}$$
$$= [L^{-1}\,T\,K^{-1}].$$

The resistance of a conductor is also measured by the time a unit of electricity requires to pass through it when unit difference of potential is maintained between its ends. Hence $[r] = [v\,.\,T\,.\,q^{-1}] = [L^{-1}\,T\,K^{-1}]$.

§ 46. *Conductance* is the reciprocal of resistance, and its dimensional expression is therefore

$$[L\,T^{-1}\,K].$$

* Of course it is physically impossible to concentrate a quantity of electricity at a point; but a practical problem can be stated similar to that in footnote to § 11.

† *Proceedings* of the Physical Society, vol. x., 1888-90.

* "Electromagnetic Theory," by Oliver Heaviside, pp. 117 to 127.

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§ 47. These electrostatic quantities may now be put into a tabulated form for convenience of reference.

Name.	Symbol.	Relation to other quantities.	Dimensions in L M T K.
Quantity ...	q	$\sqrt{\text{force} \times (\text{distance})^2 \times K}$	$L^{3/2}M^{1/2}T^{-1}K^{1/2}$
Surface density ..... Electric displacement...	σ	quantity ÷ area	$L^{-\frac{1}{2}}M^{\frac{1}{2}}T^{-1}K^{\frac{1}{2}}$
Current	γ	quantity ÷ time	$L^{\frac{3}{2}}M^{\frac{1}{2}}T^{-2}K^{\frac{1}{2}}$
Intensity of electric field	f	force ÷ quantity	$L^{-\frac{1}{2}}M^{\frac{1}{2}}T^{-1}K^{-\frac{1}{2}}$
Potential ...	v	work ÷ quantity / quantity ÷ distance	$L^{\frac{1}{2}}M^{\frac{1}{2}}T^{-1}K^{-\frac{1}{2}}$
Capacity ...	c	quantity ÷ potential	$L\ K$
Resistance ...	r	potential ÷ current	$L^{-1}T\ K^{-1}$
Conductance.	$1/r$	—	$L\ T^{-1}\ K$

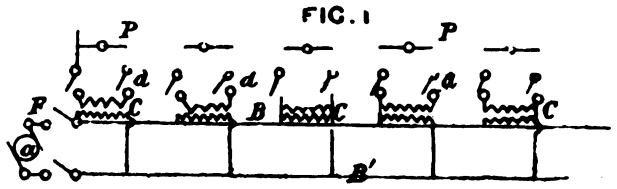
(To be continued.)

DISTRIBUTION OF ELECTRICAL ENERGY BY ALTERNATING CURRENTS.

We have received the following description of Mr. W. Lowrie's intraposed automatic system of electrical distribution:

Experience has shown, and it has come to be generally admitted that the present methods of distributing electric energy over large areas and of safeguarding the circuits are open to great improvement. After years of patient work and the trial of many systems of distribution only two now practically hold the field. The simple parallel or low-tension system, at once the most simple and safe, is unfortunately limited to a very small area of supply. A modification of the low tension called the three-wire system (which is in reality a series parallel system), has been extensively used with a view to increase the low-tension area of supply. The application of this and other cognate systems must, however, inevitably grow less and less as the use of electricity becomes more general throughout the country and the densely populated quarters of large towns or districts are supplied with it. The public opposition to the erection of electric lighting stations in crowded areas has already been so great that any attempt to sufficiently increase their number in order to cope with anticipated public requirements is sure to be stoutly resisted, and the time is not far distant when they will no longer be tolerated in such places as we now see them.

FIG. 1.

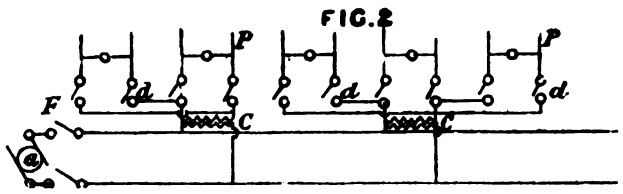


The enormously increasing difficulties met with in all endeavours to extend the low-tension system to meet the demands over even moderate areas of supply have driven electrical engineers, in order to obtain economy, commercial efficiency, and comply with the Board of Trade requirements, to adopt the high-tension system of distribution with transformers, to reduce the pressure to the limits imposed by it and the requirements of translating devices. A short *résumé* of the progress of the high-tension system taking it step by step, and illustrating these steps by diagrams showing how it gradually advanced to the position now claimed for it by its supporters, will help to a better understanding of them and a just appraisement of their value.

When the high-tension parallel system was first installed, a pair of high-tension mains were laid throughout the area of supply, and converters connected in parallel were placed on the premises to be lighted, and secondary mains installed for the low-tension supply to the lamps taking current direct from the converters, as shown in Fig. 1.

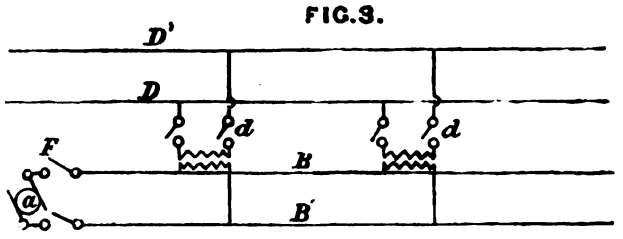
It was, however, soon found that when small installations and many of them were connected to the circuit each with its own small converter, the magnetising current at the time of light loads was nullifying the advantages gained by the use of high tension. It was in consequence changed in many places to the form described in Fig. 2, which shows several premises served from one large con-

FIG. 2.



verter fixed in one of them; in other words, more than one house was dependent on one transformer. This led to connecting the transformers together by pairs of compensating or secondary mains, and connecting the house circuits (not shown) to these mains, instead of direct from the converters, as shown in Fig. 3, thus making every house dependent on more than one transformer, and converting the system into a compound system of high and low tension. This, although a great step forward towards the solution of the electrical distribution problem, did not do away with

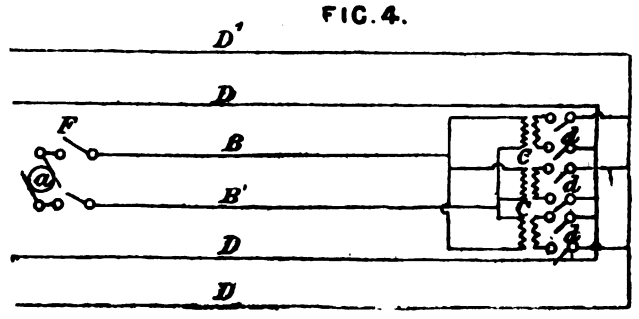
FIG. 3.



the many serious difficulties encountered when transformers were working in parallel, or the magnetising current losses, or enable transformer or high-tension connections to be made without stopping the supply over the whole circuit, or the great danger run by the operatives while testing or repairing it.

This led to the sub-station system (Fig. 4), which consists of a high-tension supply to a number of converters, placed in a suitable building, and a low-tension system diverging from these converters. Any converter could be cut out by hand, thus saving the magnetising current; but

FIG. 4.



the same laws that condemn the simple low-tension supply apply equally here, and the cost of the low-tension system from the sub-station is found to be prohibitive except in very densely populated towns or districts, and recourse has here again been had to the three-wire system.

A further development consists of a system sufficiently illustrated by Fig. 3, but here the converters are either in the roadway or in elevated street-boxes, or on walls of houses, so that an attendant is required to go round and turn off both high and low tension from the converters. This is manifestly both a dangerous, expensive, and unreliable method, so that it has been suggested to switch the primary at the central station. This control of the primary supply over the area brought with it the necessity of controlling the secondary windings of the converters so that they could be severed from the secondary or distributing

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system, to which all converters are connected in parallel. It has been proposed to accomplish this by hand-worked switches at the converters; this is not practicable where immediate control is required to meet the exigency of a variable demand. It has also been proposed to accomplish the same object by separate control wires run from the central station to each converter, but the obvious expense, complication, and difficulties of such a system will prevent this method being used. Added to the disadvantages just referred to, none of the systems mentioned provide against a most serious danger to all electrical machinery working in parallel, either alternators or converters—that is, the risk in case of the failure of any machine on the circuit, that the failing machine will cut out the fuses of the sound machines instead of its own, and thus break down the whole system; nor yet do they make provision for immediately reconnecting the failing machine if it should be restored. Further, in case of any hand-worked switch being inadvertently left on, the primary main, although switched off at the station, would remain charged at full pressure by the back action from the secondary mains through the converter so left on. The same danger occurs in mains working in parallel, as should two mains of different signs make accidental earth at one time they would form a short circuit and blow out the fuses of both circuits.

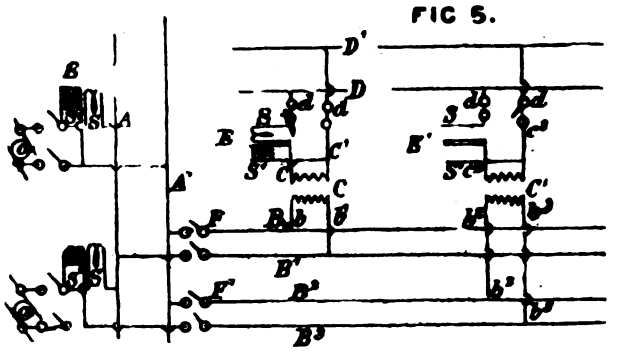
The latest of these developments is the compound intraposed automatic system recently designed by Mr. W. Lowrie. It is claimed that Lowrie's compound intraposed automatic system completely removes the foregoing and all other difficulties hitherto met with, and obtains both safety, economy, and easy control of electric current circuits, where two or more units of supply apparatus are worked in parallel, as in the examples following:

(*a*) Two or more primary generators working in parallel, directly supplying a distributing system of mains. (*b*) Two or more primary generators, working in parallel, supplying a transformer or group thereof; (*c*) two or more primary generators, working in parallel, supplying two or more transformers, whose secondary windings are connected in parallel to a distributing system of mains; (*d*) two or more feeder mains, each supplied from a separate source, feeding in parallel a distributing system of mains; (*e*) two or more feeder mains, supplied from a common source, feeding in parallel a distributing system of mains; (*f*) two or more feeder mains, supplied from a common source, feeding the primary circuits of transformers; (*g*) two or more feeder mains, each supplied from a separate source, feeding transformers which are arranged in parallel to supply a distributing system of mains; (*h*) two or more transformers arranged in parallel to supply a distributing system of mains.

By the accompanying drawings it will be seen that Mr. Lowrie, in his compound intraposed parallel system of electrical distribution, places converters at intervals on the lines of mains covering the area to be supplied buried in the road, or in chambers in the roads, or on the premises to be supplied (or some of them), and connects the primary winding of the converters alternately to two or more separate pairs of mains or conductors coming direct from the switchboard at the generating station, or other suitable place, as shown in Figs. 5 and 6. The converters being so arranged on the said sub-divided primary mains (the aggregate of such mains as to sectional area of copper being only equal to that of a single pair) that a converter or group of converters, or a number of converters or groups of converters at intervals along the line of mains can be cut out by suitable switching apparatus at the central or other station, and the converters separated from the secondary supply mains by an automatic controller switch placed in circuit with each converter or group thereof, the action of the controller being called into play by the act of making or breaking the primary circuits of the converters to which they are attached, whether the same be purposely or accidentally done. It is proposed to place controllers near each alternator to protect them and the system in case their pressure should fall below the required voltage.

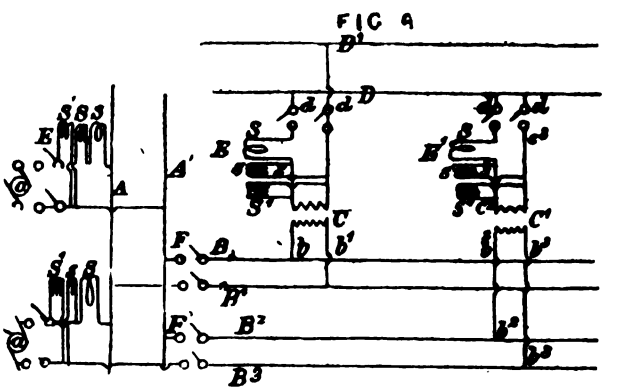
Figs. 7 and 8 are diagrams of one form of Lowrie's automatic controller switch, with electric connections thereto, adapted for use with alternating or interrupted currents, the difference between them consisting mainly of an extra shunt winding in Fig. 8, which may also be used with continuous currents. Figs. 5 and 6 are also diagrams indicating the relative positions of the said switches in a sub divided system of mains for the distribution of electrical energy, Fig. 5 being adapted for alternating currents only.

FIG 5.



In these diagrams, A A^1 indicate the omnibus bars, or their equivalents, in a station fed by generators, *a* a^1. Two or more separate mains, B B^1 and B^2 B^3, are connected directly to the bars, A A^1, at the station, and thence are connected alternately to the primary windings, *b* b^1 and b^2 b^3, of two or more transformers or converters, C and C^1. The secondary windings, *c* c^1 and c^2 c^3, of the said transformers are connected to the distributing system of mains, D D^1, which connect together the secondary terminals, *d d*, of the transformers, and all the supply or lamp wires are joined to the distributing mains, D D^1.

FIG 6



When the primary circuit, B, for example, is put in action at the station, by hand at F, or otherwise, the automatic switch, E, operates to put the secondary terminals, *d d*, of the transformer, C, in connection with the distributing mains, D D^1, and consequently with all the supply wires joined thereto. If the load increases the second converter shown, C^1, is similarly put into action at the station by joining up the primary circuit, B^2 B^3, with the bars A A^1, and the same method is employed with any other converters, similarly arranged, that may be on the circuit D D^1. Each converter, C, shown on the drawings

FIG. 8.

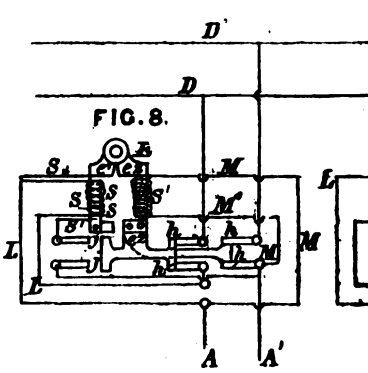
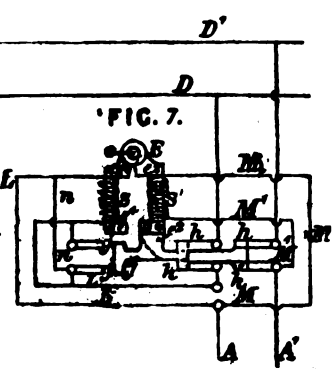


FIG. 7.



is intended to represent either a single converter or a group of converters fed by a separate primary main or conductor, whatever may be the number of converters in the group. These converters, or groups of converters, may be added along the same line of mains at intervals indefinitely,

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and these primary feed mains, B B^1, may be laid close to, though insulated from, each other, so that the primary current may be operating in one pair of conductors, and not in another pair adjoining thereto or they may have a common return.

In the diagram, Fig. 7, of the automatic controller switch, E, an electromagnet is shown having two limbs pivoted together at *e*, one limb, e^1, being rigidly fixed, the other limb, e^2, being pivotally movable on the joint *e*. Polar projections are formed in any convenient manner, and the core is laminated. The movable limb, e^2, carries four contact-pieces, *h* (suitably connected to the secondary circuit, *c* c^1, of the converter, E, as in Figs. 5 and 6 for example), operating simultaneously in one direction, and two contacts, *j*, operating simultaneously in the opposite direction. These are so arranged that when the contact-pieces, *h*, are in circuit, the contact-pieces, *j*, are out of circuit; and conversely when the latter are in circuit, the connection is broken at all four of the, *h*, contacts. The several, *h*, contacts each form a pole switch on the mains, of the shunt coil, S^1, upon the series coil, S, which is in series with the feeder mains, A A^1, from which it will be seen that the electromagnet, E, acts as an auxiliary transformer. The series and shunt coils, S and S^1, are adapted to produce poles of the like name, and when this occurs the movable limb, e^2, is repelled, the contacts, *h*, are made, and the short-circuit contacts, *j*, are broken, as shown in the drawings, Figs. 7 and 8. When the current potential falls in the feeder mains, A A^1, from any cause, and so fails to maintain its power to feed the distributing mains, D D^1, then the direction of the current through the series coil, S, will be reversed (through the higher back E.M.F. from the mains, D D^1, fed by other sources in parallel), while the direction of current in the shunt coil, S^1, would remain the same—thus bringing about unlike poles of the limbs, e^1 e^2, with mutual attraction, which, breaking all the contacts, *h*, in one direction would make the *j* contacts in the opposite direction, and short-circuiting the series coil, *s*, through the circuit, *n n*, the feeder mains, A A^1, and both series and shunt coils, S and S^1, are rendered dormant.

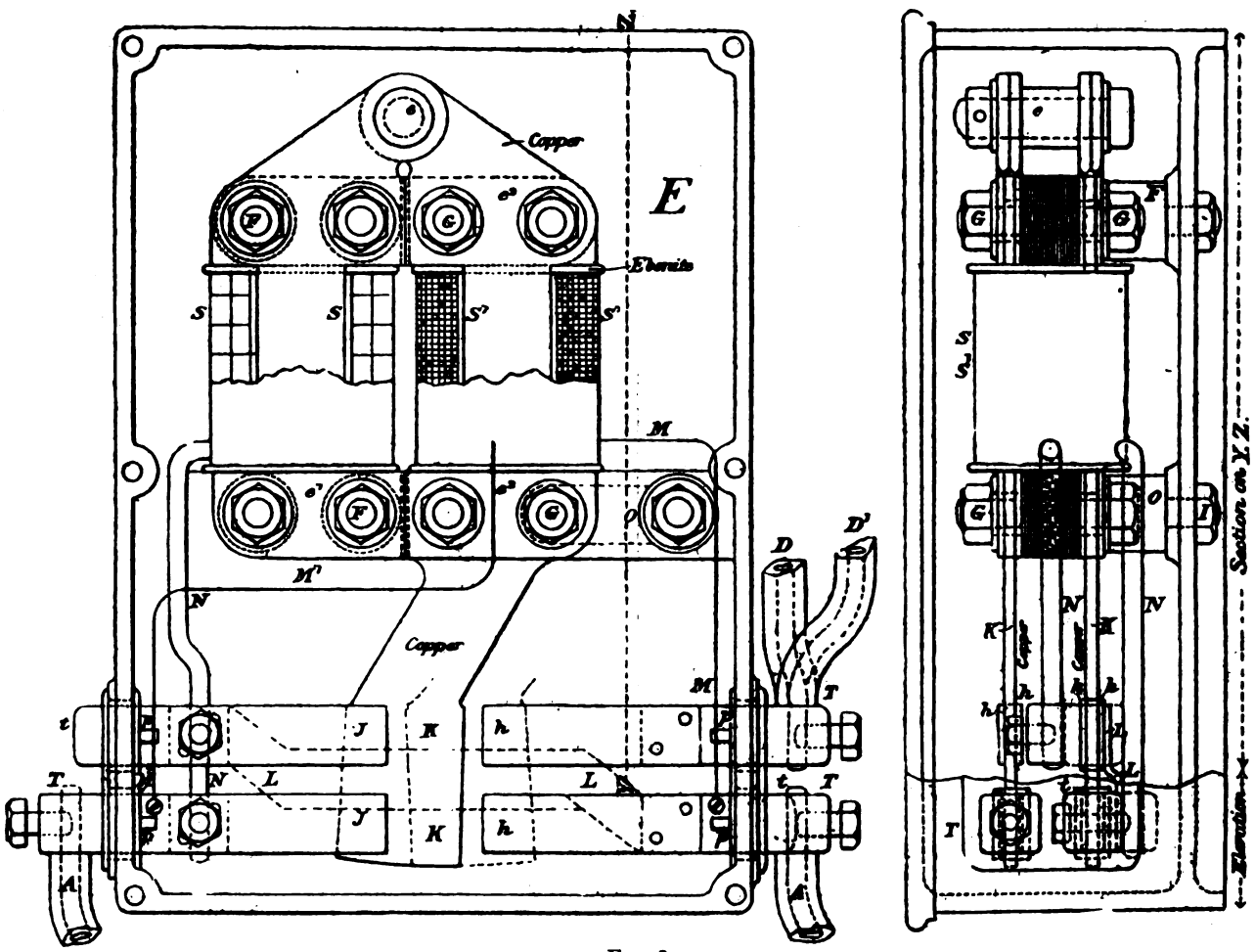

FIG. 9.

and all the parts are suitably insulated, as well understood by electricians. The other two contact pieces, *j*, when in circuit, form a short circuit for a series coil, S, through the circuit, *n n*, in Fig. 7, and connect a cross-wound shunt, in Fig. 7.

In these controller switch diagrams, Figs. 7 and 8, the mains, A A^1, are to be taken as feeder mains to the controller, whether supplied from a primary or secondary source, and D D^1 the distributing mains, fed by two or more sources (primary or secondary) of electrical energy. The series coil, S, is connected by the circuit L L to work in series with the main circuit, A A^1, while the shunt coil, S^1, is placed across the circuit by the conductors, M M^1. The action of the switch, as shown in Fig. 7, is as follows: The circuit is closed on the right-hand side at all the, *h*, contacts, the feeder mains, A A^1, being in action on the distributing mains, D D^1. The current in the feeder mains, A A^1, is designedly a little lower in E.M.F. than that in the circuit D D_1, but the voltage is increased to that in the circuit D D^1 (after passing the switch) by the action

When the current is again switched on—or the necessary potential maintained—in the feeder mains, A A^1, the shunt coil, s^1, is at once put into action through the circuit, M M^1, but it could not act on the series coil, S, if it were not for the short-circuit contact, *j*, as the said coil would be on open circuit. The short circuit, therefore, will admit of a strong current being induced in the coil, S, which, producing like polarity in the limb e^1 to that of e^2, repels the latter or movable limb—thus making good all the *h* contacts, and breaking that of the short circuit, *j*, makes all the circuits good for feeding the distributing mains, D D^1.

Fig. 8 is a diagram of an automatic switch and its connections adapted for working with either alternating or continuous currents. The arrangement is similar to that of Fig. 1, and the description of the latter will apply likewise to Fig. 2, with the exception that the short circuit upon the series coil, S, by the line *n n* is omitted and replaced by the shunt coil, *s*, wound on the same limb, e^1, as the series coil, S; while its circuit (the circuit of *s*) is made or broken at *j*. The connections are so made when

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using continuous currents that when the mains, A A^1, are put into action, the two shunt coils, S^1 and *s*, by producing like poles, repel each other, and so make good the circuit through the contacts, *h*, and series coil, S, while at the same time the second shunt coil circuit is broken. On the other hand, on the cessation or reduction (to any required degree) of potential energy in the feed mains, A A^1, a reversal of current takes place in the series coil, S, thus bringing about unlike poles of the limbs e^1 e^2, with mutual attraction, consequently breaking the *h* contacts, and making the *j* contacts as before.

Fig. 9 is a drawing of a 200 ampere controller for use with transformers, the reference letters remaining the same as in the foregoing, with the following additions: K, connecting pieces of hard copper; O, stop and guide for moving arm; T, terminals for cable connection; *t*, dummy terminals to carry contact pieces, *h*, where T are not required; D and D^1 are cables leading thereto. It is to be noted that solenoids only may be employed instead of the electromagnet described; and that the limbs or coils referred to may be reversely arranged, or even both limbs movable or any other mechanical arrangement may be used embodying the electrical principle entailed without departing from the nature of this invention. The advantages claimed for the Lowrie compound intraposed automatic system are as follows:

(1) It will save largely the costs of installing, as it will in all cases permit the use of the copper in the mains to its fullest carrying capacity over very extended areas, for although subdivided and possessing, therefore, all the advantages of duplication the aggregate of such mains as to sectional area of copper will not exceed that of a single pair. (2) It will reduce loss in transmission in the mains to a minimum and prevent variation of pressure due to varying load without regulation on the circuits, while additions to the number of primary mains can be made from time to time, thus increasing its aggregate section and increasing thereby the capacity of the low-tension distributing mains without increasing their section by the interposition of additional converters at suitable points fed by such additional primary mains. (3) It will save cost of working, as only sufficient converters and dynamos actually required to do the work on the circuits need be in action, thus avoiding the consumption of energy by friction and useless magnetising current. (4) It will permit the regulation and control of the whole system from the central station, and the act of breaking or making any primary circuit will disconnect or connect the secondary windings of the converters thereon from the general low-tension supply system without interrupting the supply to any consumer. (5) It will ensure in case of any dynamo or transformer breaking down that the faulty machine is automatically cut out and not the sound machine as at present when two or more are working in parallel, and also automatically replace it if the fault is only temporary and removed. (6) It will prevent any dynamo or transformer being reversed or fed by the others when working in parallel should its E.M.F. fail from any cause. The automatic controller will act as a non-return valve, and will cut out any machine not doing its duty, and restore it if the cause is only temporary and removed. (7) It will not consume energy in the automatic control switches when the machines are either in or out of action. (8) It will be absolutely reliable, as the automatic switch may be made to any power desired, as the energy is only used at the moment of making or breaking. (9) It will not rely on an instantaneous rush of current, as the power in the control switch will remain in action until the duty of the switch has been performed, then will instantly cease. (10) It will entirely remove serious risks from the accidental earthing of any two mains of opposite polarity when two or more pairs are working in parallel from common omnibus bars or through transformers—the most faulty will be automatically cut out, and if necessary be immediately reinstated by a cross-switch making the faulty mains of same sign, the exciting circuits of alternators breaking down, or accident to any part of any machine interfering with the constant supply to consumers. (11) It will permit repairs, additions, testing, etc., to be done at any time without danger to the operatives or interference with the constant supply to any consumer, as any section of the subdivided main may be cut out of action for any such purpose without the remainder being affected thereby. (12) It will not require any disturbance of the roads when once the culverts are installed, as by this method of sub-division all the mains, both of high and low tension, even for very dense districts, will be of small section, flexible, and therefore easily handled, drawn-in, added to up to the capacity of the culverts, and all joints made from the surface. (13) It is easily applied to existing systems, and will greatly increase their capacity, safety, reliability of supply, and decrease their cost of working.

If, therefore, due consideration be given to the above advantages, and the fact be recognised that the loss in mains on any parallel circuit must, for the sake of the regulation of the pressure, be only a small percentage of the total E.M.F. of the circuits, the unsuitability of the low-tension as compared with the compound intraposed automatic system for distributing electricity over even moderately large areas will be at once apparent, and in this relation the following law should be strictly borne in mind—viz., that in an electrical circuit distributing equally along its length, the loss in the mains is as the square of length; or, the mains must be increased in like proportion; when, the carrying capacity of the copper could only be utilised inversely as the square.

The writer of the foregoing in comparing the value to be attached to the system described, had recourse to the Board of Trade returns for 1893, and the annexed is a summary of a *pro forma* balance-sheet of average of 29 central stations which will be interesting:

Electricity Supply Only (High, Extra High, and Low Tensions), 29 Stations Averages.

Cr. (1893.)		
15,500,000 units at 5·9		£381,000
Average price received	5·90	
Average price cost	3·78	
Average price margin P. and D.	2·12	
Per cent. cost to revenue	64·55	
Per cent. cost to capital	5·49	
Per cent. revenue to capital	8·50	
Per cent. on capital for redemption	3·33	
Per cent. on capital for deficit	0 32	
Units to the £ capital	1·00	
Dr. Costs.		
Per cent. to capital.		
2·58 costs low tension		£116,000
2·17 costs high tension		96,450
0·74 costs extra high tension		33,540
5·49		£245,990
Say		£246,000
3 33 redemption fund at 3·33 per cent.		149,400
8·82 on £4,482,000		£395,400
·32 deficit.		
8·5 0·32 per cent. deficit		14,400
		£381,000

If redemption fund is reduced to 3 per cent. accounts will balance without deficit.

PHOTOMETRY*

BY CAPTAIN W. DE W. ABNEY, C.B., F.R.S.

What I have undertaken in these lectures is to endeavour to give an idea of the general principles of photometry, almost restricting myself to the scientific aspect of the question. Photometry, in its broadest sense, is the measurement of light, at least, so we must think, from its derivation. Now, the light measured may be light coming from an object, or from a self-luminous body, such as a candle or the sun, or it may be the light transmitted through objects. In the second case, if an appropriate screen be used to receive the light, we are in reality measuring the illuminating power of the source of light rather than of the light itself. Hence almost as much depends upon the screen on which the light is received as on the light itself. A screen is usually what is called white and by white is meant a screen which reflects every colour equally well; but I would remark that in London the white may become imperceptibly brown, and such colour may interfere materially with accurate results. But the photometry that I am alluding to not only includes the measurement of the illuminating power of light, but the measurement of the light transmitted through bodies of various kinds when they are transparent, like plain glass, or translucent, like ground glass or paper.

* Abstract of first Cantor lecture delivered before the Society of Arts.

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We may take it, I think, that the first matter we have to consider is the light we have to use as a standard. Parliament, in its wisdom, in 1860, pronounced its standard of light to be the light of a candle, six candles to the pound, each burning 120 grains of sperm per hour, and this is at present the only legal standard known in England, though why, in the name of common sense, such a definition has been continued our legislators alone can guess, when it has been proved to be so faulty. The standard of light for France is the Carcel lamp, which is equal to about 9·5 candles. Now a light from a candle is a very pretty thing theoretically, but, practically, it is anything but practical, as it has the unhappy knack of burning inaccurately, particularly when one is anxious to shield it from draughts. I show you a trace made by photography of the light from a candle burning under normal conditions. The light was admitted through a slit to sensitive paper, and a fresh portion of paper was continually being

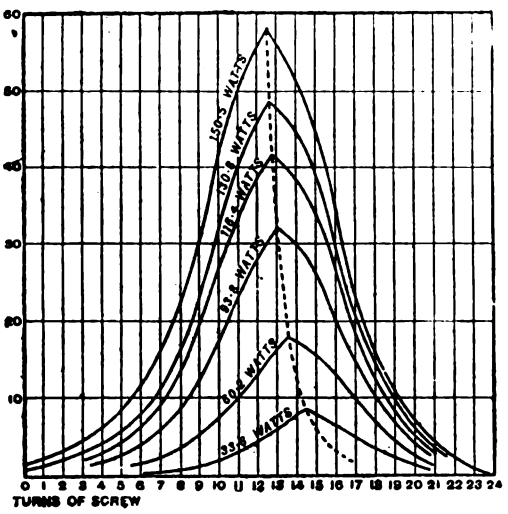

FIG. 1.

exposed. You will now see the irregularity of the burning. Of course, by taking several candles the variation is not so great, but even then you have to be sure that the proximity of the candles to one another does not alter the rate of burning. An Argand burner, however small, will not, during a long series of experiments, differ 1 per cent. in light value. Here we have a proof of this. This small paraffin lamp was allowed to burn for three hours, and you will see that the band it makes is perfectly uniform in appearance, and when the measurement is made of the blackness produced by it on the photographic paper, it proves that my statement is correct.

The apparatus by which these diagrams were made is a very simple one. It consists of a clockwork arrangement drawing a pulley, which pulley is in connection with a drum, which can rotate on its axis. Round this drum is placed sensitive paper, and a box, with a long slit in it, covers the drum. The light is

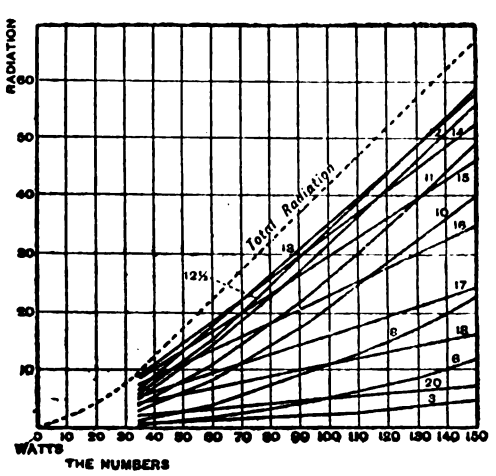

FIG. 2.

placed opposite the slit, which is covered by a moveable lathe, in which is an aperture of a convenient width. As the drum moves, this aperture moves across the slit, and so we have a corkscrew band of exposure produced. With some clockwork the motion is regular in its irregularity, and every tooth of the train can be counted on it by noting the bands of varying exposure, and for this reason the clock was at one time abandoned, and the smooth motion of the sinking of the height in subsiding water was substituted. This gave very good results, but for my purpose the clockwork was sufficient.

The sources of light I have mentioned are what may be called feeble sources of light, and cannot be used when a body is fairly absorptive, if the transmitted light is to be measured. We want in such a case a stronger source of light, and one which is practically constant. Such a source of light we have in the electric arc light. If we project upon the screen an image of the points where the positive pole is slightly behind the negative pole, with a fairly long arc, we become aware that there is a central part, which is higher than any other [shown]. It comes from a depression in the positive pole, and for the last eight years I have been in the habit of using this as a source of light of uniform intensity, and many hundreds of measures have proved it to be so. This, as several years ago I pointed out, was due to the fact that the temperature of this spot was that of the volatilisation of carbon. It is an intense light, and may be taken as 50,000 A.L. per inch of surface, and very useful for a great many purposes, as we shall see as we proceed. Now we call all these lights which I have mentioned white, but it is quite evident that there is white and white if all these be white. I believe myself that Mr. Lovibond's definition of white is a good one, which is the light which is seen in a white fog about midday, and if we compare this light with any other we shall, I think, come back to it as being a very practical white light. Now the electric light is not far from this quality of light, and as such is very useful in comparing the transparency of objects by what is approximately daylight. We can measure the light of each part of the crater passing through a small hole.

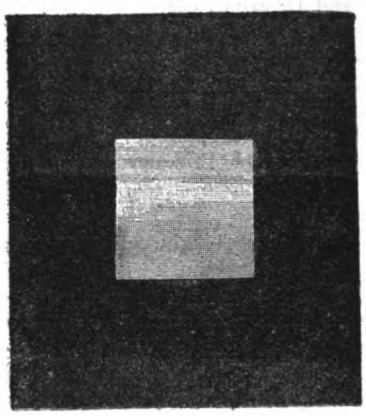

FIG. 3.

We can at once see the difference between all the ordinary lights by a simple experiment. This box is divided into partitions with tissue in front, and in each partition we have a different source of light—a partial gas jet, an Argand gas-burner, a candle, and a paraffin lamp. It will be noticed that the light enclosed in a chimney is much whiter than those burned in free air, but you will also see that all these lights have various depths of yellowness when compared with the electric light. It is quite evident that even supposing they gave the same illumination, that they are not all fit for standard lights. I take it that a standard light in photometry must always have the same quality of light as well as the same quantity of light. Now we can, by appropriate means, make the electric incandescent lamp light of the same visual intervals as a gas jet. The one before us is so, but it is evidently not of the same quality. One of the very best tests that we can make of ascertaining whether any difference in quality exists is to see if, when they are equally strong visually, they give the same photographic results. The amyl acetate lamp is decidedly the worse photographically.

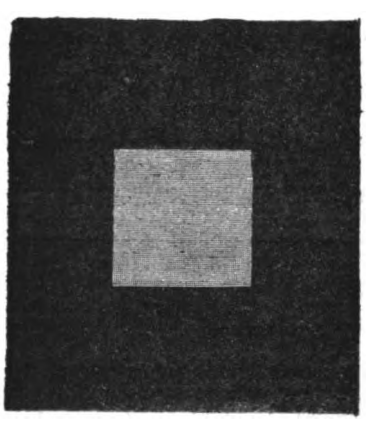

FIG. 4.

Perhaps I can show you why this is. I take an incandescent lamp and cause it to glow: it goes red, to begin with; then I increase the current, it gets yellow, then whiter, and so on, till it is nearly white. I cannot make it as white as the arc light, for the reason that as the temperature increases, the fusing point of carbon is reached, and that, as I pointed out, is the temperature of the crater of the arc light. These temperatures, however, are subject to different amounts of energy expended upon them; and here I have a diagram, showing how, with an increased energy expenditure on the same filament—that is, with an increased temperature—the different rays of the spectrum are altered in proportion. These diagrams are taken from measures made with a linear thermopile, moved through the spectrum. You will see that the higher the temperature, much more rapidly do the rays of high refrangibility increase.

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The value of the abscissæ in Fig. 1 (in wave lengths) is as follows:

	λ		λ
1·25	5,900	13	14,650
5	7,250	17	20,750
9	9,900	21	27,500

These numbers apply to both diagrams, and in Fig. 2 the numbers attached to the different curves are those which are attached to the abcissæ in Fig. 1.

Let me show an experiment. I will balance an electric light against the amyl acetate lamp, and expose a piece of paper to its action. I will increase the temperature and balance again, and expose another portion of the same paper to its influence for the same time. Notice, please, the difference in the two. You will find that the highest temperature filament is much more

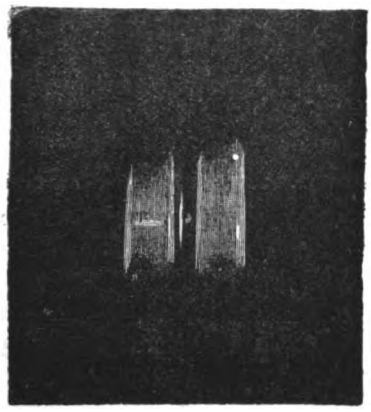


Fig. 5.

"photographic." By this means all lights which are due to the incandescence of solid particles of carbon can be tested as to quality. Make them visually equal, and then see if they are photographically equal. For my own part, I believe that a knowledge of the photographic value of light is essential in the near future, for I cannot help thinking that there will have to be a registration of photometric values for record, independent of the eye, and this must be by photography.

For this purpose the photographic value, and the visual value of every light used, will have to be known and carefully recorded. We shall see soon how these records can be utilised and become of permanent value in themselves, being capable of being measured at any date after being made and remeasured if required. I throw on the screen the photographic values of a candle, an amyl acetate lamp, a gas jet, a paraffin lamp, and an arc light—all made of the same value as a candle visually. You will see that they vary enormously, and the scale of opacity below, which was made by exposing different parts of a plate to a steady light for different times, gives us a means of comparing one with the other.

I have said that all lights which are due to solid particles of incandescent carbon can be tested by means of photography, and I have shown you the deposits which certain lights cause on a photographic plate. There can now be but little doubt that a luminous candle flame is as much due to solid incandescent particles as the incandescent lamp we have been using. The final proof has been long in abeyance, but I think no doubt now can exist regarding it. If a beam of intense light, such as that coming

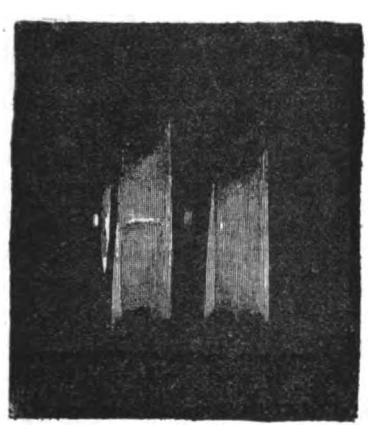


Fig. 6.

from a small image of the sun, be thrown on the flame of a candle, a white beam of sunlight should be seen on the flame, and a beam of white light passing through the flame. Sir G. Stokes examined this white beam in a position at right angles to its direction, and found, by means of a Nicol's prism, that it was completely polarised—that is, that when the Nicol was turned in one direction, the streak of white light in the flame disappeared altogether. This establishes the fact that the luminous part of flame is due to small particles independently of any other proof. It appears to me, therefore, that one is correct in stating that the bright flames are due to measurement carbon. Into the theory of flames I will not further enter at the present time; this is enough for my purpose.

In case there be any doubt amongst you, I will show you some photographs of the phenomena I have taken. Fig. 5 is a photograph of an Argand gasflame, on which the rays of the sun, collected by a lens of about 8in. focus, were concentrated so as to pass along part of the circumference of the cylinder. The Nicol prism was turned in such a direction that the scattered rays would be unaffected in the left-hand photograph, whilst it was turned at right angles to the first direction for the right-hand photograph. In the left-hand figure the track of the beam is readily seen, whereas any trace of it is absent in the right-hand figure. Fig. 6 is the same, but the electric arc light was used in place of the sun. The results are the same. Fig. 7 shows the results when the beam from the electric light is passed through a candle flame. In the one figure a broadish white band is seen, whilst in the other it is absent.

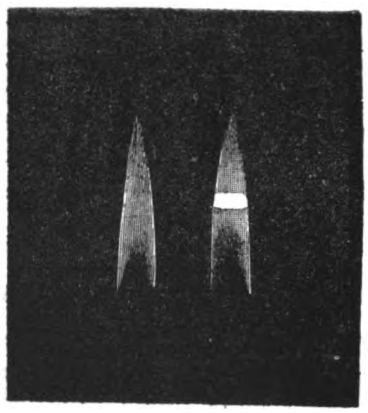
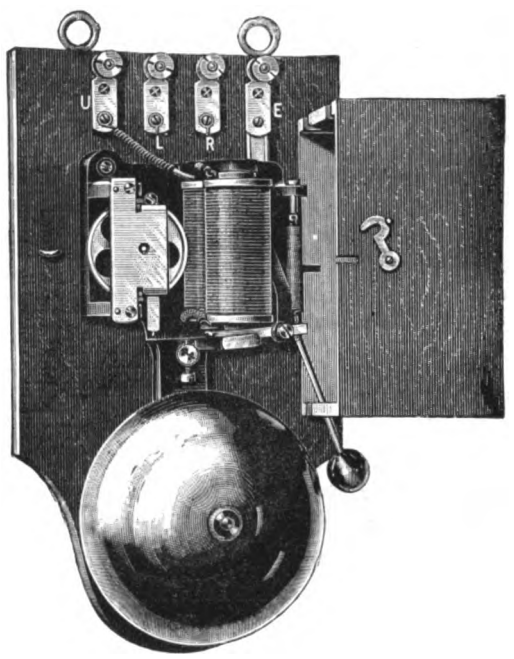


Fig. 7

I should here like to correct a very common notion which exists regarding the blackening of ceilings by gas flames. As a matter of fact, the carbon in a gas flame ordinarily is totally converted into carbonic acid. It is the ascending current of heated air that catches up the floating motes in the room and dashes them against the ceiling, to which some cling tenaciously, and gradually the blackening is encountered.

UNIVERSAL BELL.

The annexed illustration shows the universal bell which is being introduced by the International Electric Company, of 55, Redcross-street, Barbican, E.C. It is well known that the shrill tone of an ordinary electric trembling bell sometimes causes annoyance in large offices, hotels, and even in private houses, and in order to overcome this disadvantage the company



have constructed a slow-striking bell, which has met with approval. They have, however, endeavoured to improve upon the first type, so as to make it not only of service where less rattling noise is desirable, but also to make use of the same bell for dispensing with a No. 2 or No. 3 indicator. It will be seen from the illustration that the bell works with a rack and pinion, thus ensuring a reliable contact pressure. The bell can be used either as a slow-striking bell, as a single-stroke bell, or as an ordinary trembling bell, and the four terminals are connected up as follows: terminal U to ring as an ordinary trembling bell, L as a slow-striking bell, E for a single stroke, and terminal R is intended for the return, and should be connected to the zinc pole of the battery. The bell is made in three sizes.

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DIGNITY AND ——.

There is, admittedly, no small interest even to the general public in a periodical chronicling of science topics and problems, much more so, indeed, than the ventilation of individual ideas and fads of the type so often published in the monthly and quarterly political or literary reviews. The value of a "heavy" science periodical is very considerable, so long as it supplies the highest class of criticism, combined with exact and accurate knowledge (but not necessarily expression) of scientific facts. The responsible conductors of the *New Science Review* (a copy of No. 1, Vol. I., of which lies before us) "address themselves to the public at large: their review yields to none in scientific value of its material, and strives to present it in a popular style." Moreover, the new critic "will speak with authority, after weighing evidence with impartiality." How comes it, then, that this very first number contains two elaborate notices of Mr. John Ernst Worrell Keely (of Keely motor fame) alongside of a brief though flattering notice of Tesla? We had thought that further criticism of Keely, the throwing of ridicule upon his absurd scientific gibberish, the characterising his actions and broken promises as being those of a charlatan and humbug — all these were by this time of no purpose, inasmuch as his patrons had either been fully enlightened and disillusioned upon the subject, or else were blind to his faults and foolishness beyond all power of recovery. For Mrs. Bloomfield Moore, the faithful upholder of this nonsensical fabric, to write long and sympathetically of him, is by no means surprising. One can even go so far as to forgive her for entitling her article "A Newton of the Mind," since to liken Keely to the immortal discoverer of gravitation hurts not the latter, and may sooth the former with pleasant flattery. But what shall we say of a man like Julian Hawthorne, the bearer of an honoured name, who writes of scientific creation, and would therein fain bow down and worship also—if he only felt certain that Keely wasn't making a fool of him?

Mrs. Moore states for the benefit of posterity that Keely discovered the "unknown polar flow" twenty years ago, and he now has "command of a vibratory circuit for running machinery both on land and in air." To do this it was necessary to effect a "sympathetic affinity between his machinery and the polar flow, minus magnetism . . . through this system the dynamo will eventually become a thing of the past, and electric lighting will be conducted by a polar negative disc run by a vibratory circuit of sympathetic polar attraction drawn direct from space." Our readers will surely agree with us in thinking, when they have read thus far, that it should be the immediate aim of the well-to-do in electrical circles to endow almshouses and orphanages for indigent dynamo manufacturers and their offsprings. Nay, what scope will there be for the industrial energy of any man in electrical work, when every householder may have his "polar negative disc" supplied with power free gratis for

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nothing from an indulgent "space," overflowing with vibratory circuits?

We have no space to quote or criticise a tithe of the extraordinary "facts" set forth in this article or to give our readers the pleasure of fathoming the Keely scientific jargon, such choice specimens as "triple subdivision of hydrogen — molecular, atomic, and interatomic; nodal interference in sympathetic negative outreach; positive graduating chladna," and so forth, must stand by themselves, for no amount of context would ever make them clearer. The relief in turning from this "weak, washy, everlasting flood" of talk to the all too brief notice of Tesla's personality and labours in the same review is great enough to be taken as the chief reason for this notice of what would otherwise be a matter of not much importance. There is nothing particularly new in the half-dozen pages given by Lieutenant F. Jarvis Patten to an account of the well-known experiments; under other conditions we might have called the style of the article fulsome to a degree. In substance, however, it appears accurate enough for popular reading; and will doubless serve to educate the man in the street up to an appreciative point of what scientific men are trying to accomplish in the way of improved conditions for human life. It also stands as an antidote to the noxiousness of Keelyism; and for this reason we have not said all the hard things that were at first in mind with regard to the claims made for the new scientific review as compared with the manner in which they are carried out.

PRACTICAL NOTES ON DYNAMO CALCULATION.*

VII.

BY ALFRED E. WIENER.

(*b*) *Energy Dissipated by Hysteresis.*—The iron of the armature core is subjected to successive magnetisations and demagnetisations. Owing to the molecular friction in the iron, a lag, in phase, is caused of the effected magnetisation behind the magnetising force that produces it, and energy is dissipated during every reversal of the magnetisation. The name of "Hysteresis" (from the Greek ὑστερέω, to lag behind) was given by Ewing, in 1881, to this property of paramagnetic materials, by virtue of which the magnetising and demagnetising effects lag behind the causes that produce them.

Although Warburg,† Ewing,‡ Hopkinson,§ and others have made numerous researches about the nature of this property of paramagnetic substances, it was not until recently that a definite law of hysteresis was established. In an elaborate paper presented to the American Institute of Electrical Engineers, on January 19, 1892, Charles Proteus Steinmetz‖ gave the results of his experiments, showing that the energy dissipated by hysteresis is proportional to the 1·6th power of the magnetic density, directly proportional to the number of magnetic reversals and directly proportional to the mass of the iron. This law he expressed by the empirical formula:

$$H_1 = \eta_1 \times B^{1.6} \times N_1 \times M_1,$$

where H_1 = energy consumed by hysteresis, in ergs;
η_1 = constant depending upon magnetic hardness of material ("Hysteretic Resistance");
B = density of lines per cm² of iron;
N_1 = frequency, or number of complete cycles of two reversals, per second;
M_1 = mass of iron, in cm.³

The values of the hysteretic resistance found by Steinmetz for various kinds of iron are given in the following table:

TABLE XXIII.—Hysteretic Resistance for Various Kinds of Iron.

Kind of iron.	Hysteretic resistance. η_1.
Sheet iron, magnetised lengthwise	·0025 to ·005
,, ,, ·0165in. thick	·0035
,, ,, ·015in. ,,	·004
,, ,, ·006in. ,,	·005
,, ,, magnetised across lamination	·007
Iron wire, length-magnetisation	·0035
,, ,, cross- ,,	·040
Wrought iron, Norway iron	·0023
,, ,, ordinary, mean	·0033
Cast iron, ordinary, mean	·013
,, ,, containing ⅛ per cent. aluminium	·0137
,, ,, ,, ½ per cent. ,,	·0146
Mitis metal	·0043
Tool steel, glass hard	·070
,, ,, oil hardened	·027
,, ,, annealed	·0165
Cast steel, hardened	·012 to ·028
,, ,, annealed	·003 to ·009

For the materials employed in building up the armature core, according to this table, we can take the following average values of the hysteretic resistance:

Sheet iron: $\eta_1 = ·0035$,
Iron wire: $\eta_1 = ·040$.

Inserting these values in Steinmetz's equation, and reducing the latter to our practical units, we obtain for the energy loss by hysteresis in any armature having core built of discs or ribbon:

$$w_h = 10^{-7} \times ·0035 \times \left(\frac{\mathfrak{B}_a}{6·45}\right)^{1.6} \times N_1 \times 28{,}317 \times M$$

$$= 5 \times 10^{-7} \times \mathfrak{B}_a{}^{1.6} \times N_1 \times M \quad (36)$$

and in any armature with core of iron wire:

$$w_h = 5·7 \times 10^{-6} \times \mathfrak{B}_a{}^{1.6} \times N_1 \times M \quad . \quad (37)$$

where w_h = energy absorbed by hysteresis, in watts; one watt = 10^7 ergs;
$\mathfrak{B}_a$ = density of lines in armature body per square inch of core section;
N_1 = frequency, in cycles per second, = $\frac{N}{60} \times P$;
N = number of revolutions per minute, P = number of pairs of poles;
M = mass of iron, in armature core, in cubic feet; 1 cubic foot = 28·317cm³.

The mass, in cubic feet, for both drum and ring armature is

$$M = \frac{d_a''' \times \pi \times l_a \times b_a \times k_1}{1{,}728}; \quad . \quad . \quad . \quad (38)$$

d_a''' = mean diameter of armature core, in inches;
l_a = length of armature core, in inches;
b_a = radial depth of armature core, in inches;
k_1 = ratio of net iron section to total cross-section (see Table XVIII., Chap. 12);
1,782 = multiplier to convert cubic feet into cubic inches.

Formulæ (36) and (37) can be rendered more convenient for practical use by uniting the terms $5 \times 10^{-7} \times \mathfrak{B}_a{}^{1.6}$, and $5·7 \times 10^{-6} \times \mathfrak{B}_a{}^{1.6}$ respectively, into one factor, η, the *factor of hysteresis*—that is, the energy absorbed by hysteresis in one cubic foot of iron, when subjected to magnetisation and demagnetisation at the rate of one complete cycle (two reversals) per second.

For convenience, the author, in Table XXIV., has calculated the numerical values of these hysteresis factors, η, for all core densities from 10,000 to 125,000 lines per square inch, thus simplifying the equation for the hysteresis loss into the formula:

$$w_h = \eta \times N_1 \times M. \quad . \quad . \quad . \quad . \quad (39)$$

* From the *Electrical World* (New York).

† Warburg, Weidem. Ann., xiii., p. 141 (1881); Warburg and Heenig, Wiedem. Ann., xx., p. 814 (1884).

‡ Ewing, *Proc.*, Royal Society, xxxiv., p. 39 (1882); *Phil. Trans.*, Part II., p. 526 (1885).

§ J. Hopkinson, *Phil. Trans.*, Royal Society, Part II., p. 455 (1885).

‖ Steinmetz, *Trans.*, A.I.E.E., vol. ix., p. 3; the *Electrical World*, xix., pp. 73, 89 (1892); xx., p. 285 (1892).

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In Table XXIV., columns headed $\eta \div 480$ are added for the case the hysteresis loss is to be calculated for an armature, of which the weight, in pounds, of the iron core is known.

TABLE XXIV.—Hysteresis Factors for Different Core Densities.

Magnetic density in armature core. Lines of force per sq. in.	Watts dissipated at a frequency of one complete magnetic cycle per second. Sheet iron. p. c. ft η	Sheet iron. per lb. $\eta \div 480$	Iron wire. p. c. ft η	Iron wire. per lb. $\eta \div 480$	Magnetic density in armature core. Lines of force per sq. in.	Watts dissipated at a frequency of one complete magnetic cycle per second. Sheet iron. p. c. ft η	Sheet iron. per lb. $\eta \div 480$	Iron wire. p. c. ft. η	Iron wire. per lb. $\eta \div 480$
10000	1·25	0026	14·3	·030	66000	25·72	·0537	294 0	·613
15000	2 40	·0050	27 4	·057	67000	26·34	·0550	301·0	·628
20000	3·79	·0079	43·3	·090	68000	26 97	·0563	308·2	·643
25000	5·42	·0113	62·0	·129	69000	27·61	·0576	315·5	·658
30000	7 30	·0152	83·5	·174	70000	28 26	·0589	322·8	·673
31000	7·70	·0160	88·0	·183	71000	28·91	·0603	330·1	·688
32000	8·10	·0168	92·6	·192	72000	29·56	·0617	337·6	·704
33000	8·50	·0177	97·2	·202	73000	30·22	·0631	345·1	·720
34000	8·91	·0186	101 8	·212	74000	30·89	·0645	352 9	·736
35000	9·33	·0195	106·5	·222	75000	31·56	·0659	360·7	·752
36000	9·76	·0204	111·5	·232	76000	32 23	·0673	368·5	·768
37000	10 20	·0213	116·5	·242	77000	32·91	·0687	376·3	·784
38000	10·65	·0222	121 6	·253	78000	33·60	·0701	384 2	·800
39000	11·10	·0231	126·8	·264	79000	34 29	·0715	392·1	·817
40000	11·55	·0240	132·0	·275	80000	34·99	·0730	400·0	·834
41000	12·01	·0250	137·2	·286	81000	35 69	·0745	408·0	·851
42000	12·48	·0260	142·5	·297	82000	36·40	·0760	416·0	·868
43000	12 96	·0270	148 0	·308	83000	37·11	·0775	424·0	·885
44000	13·45	·0280	153·7	·320	84000	37·82	·0790	432·4	·902
45000	13·95	·0290	159·4	·332	85000	38·54	·0805	440·8	·919
46000	14·45	·0300	165·1	·344	86000	39·27	·0820	449·2	·936
47000	14·95	·0311	170·8	·356	87000	40·01	·0835	457·6	·954
48000	15·45	·0322	176·6	·368	88000	40·75	·0850	466·0	·972
49000	15·96	·0333	182·4	·380	89000	41·50	·0865	474·5	·990
50000	16·48	·0344	188·3	·392	90000	42·25	·0881	483·0	1·008
51000	17·01	·0355	194·3	·405	91000	43·00	·0897	491·5	1·023
52000	17·55	·0366	200·6	·418	92000	43·76	·0913	500 0	1·042
53000	18·10	·0377	206·9	·431	93000	44·53	·0929	509 0	1·064
54000	18·65	·0388	213·2	·444	94000	45·30	·0945	518·0	1·080
55000	19·21	·0400	219·5	·457	95000	46·07	·0961	527·0	1·098
56000	19·78	·0412	226·0	·470	96000	46·85	·0977	536·0	1·116
57000	20·35	·0424	232·6	·484	97000	47·63	·0993	545·0	1·135
58000	20·92	·0436	239·2	·498	98000	48·41	·1009	554·0	1·154
59000	21·50	·0448	245·8	·512	99000	49·20	·1025	563·0	1·173
60000	22·09	·0460	252·5	·526	100000	50·00	·1041	572 0	1·192
61000	22 69	·0472	259·4	·530	105000	54·06	·1127	618·0	1·290
62000	23·29	·0485	266·3	·554	110000	58·23	·1215	666·0	1·388
63000	23·89	·0498	273·0	·568	115000	62·53	·1305	715·0	1·490
64000	24·50	·0511	280·0	·583	120000	66·95	·1400	765·0	1·595
65000	25·11	·0524	287·0	·598	125000	71·50	·1500	817·5	1·705

The values of η contained in this table are graphically represented in Fig. 14, two different scales being used in plotting the curves, as designated.

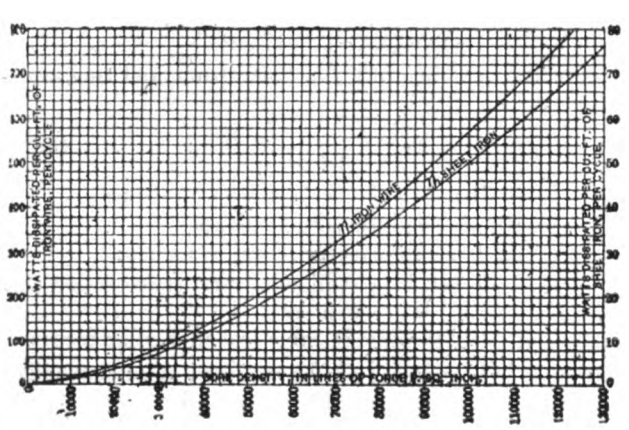

FIG. 14.

With regard to the exponent of $\mathfrak{B}_a$ in formulæ (36) and (37), which Steinmetz found to be approximately = 1·6 over the whole range of magnetisation, Ewing,* by very recent investigations has found that it varies at different magnetisations. In the case of thin sheet iron (·0185in.), for instance, the hysteretic exponent ranged as follows.

* J. A. Ewing and Miss Helen G. Klaassen, *Phil. Trans.* Royal Society; *Electrical Engineer*, XVII., page 417 (May 9, 1894).

TABLE XXV.—Hysteric Exponents for Various Magnetisations.

Magnetisation. In lines per c.m.^{2} (Gausses).	Magnetisation. In lines of force per square inch.	Hysteretic exponent.
200 to 500 ...	1,300 to 3,000 ...	1·9
500 ,, 1,000 ...	3,000 ,, 6,500 ...	1·68
1,000 ,, 2,000 ...	6,500 ,, 13,000 ...	1·55
2,000 ,, 8,000 ...	13,000 ,, 50,000 ...	1·475
8,000 ,, 14,000 ...	50,000 ,, 90,000 ...	1·7

Although Ewing thus has shown that no formula with a constant exponent can represent the hysteretic losses within anything like the limits of experimental accuracy, he concludes that Steinmetz's exponent 1·6 gives values which are nowhere so grossly divergent from the truth as to unfit them for use in practical calculations. This conclusion holds particularly good for the densities applied in dynamo-electric machinery, as from the table given above can be seen that for densities between 4 and 14 kilogausses (25,000 and 90,000 lines per square inch respectively), see Table XVII., chapter 12, the hysteretic exponent, according to Ewing's experiments, varies from 1·475 to 1·7 the average of which is 1·59, indeed, a good agreement with Steinmetz's value.

(To be continued.)

NOTES ON ELECTRIC TRAMWAYS IN THE UNITED STATES AND CANADA.*

BY H. D. WILKINSON, MEMBER.

(Continued from page 69.)

During the progress of this litigation a new tramway company was financed by those most largely interested in the telephone company, with the view of proving that double-trolley was the only way out of telephone interference, and to force the hands of the single-trolley company. Mishaps in winter, however, in the earliest days of its adoption, favoured the final appeal above alluded to, and ended in metallic returns being put on telephone lines instead. The position remains unaltered to-day, and both trolley systems prosper. I found that the insulation of the double-trolley lines was good, so far as the overhead construction was concerned; but that it frequently broke down at the motors, thus putting one or other trolley line to earth. To show what kind of insulation existed, my friends and I boarded a single-trolley car, stopped it, and pulled the trolley arm off the single wire on to one of the double-trolley wires; the lamps lit up inside the car showing an earth on one main of about 200 volts. The leak was not sufficient, however, to run the car, but it appeared that in wet weather this was frequently done. Again, in the Hunt-street station, an earth indicator was permanently fixed, consisting of two rows of five lamps in series. Each row was connected between one of the trolley wires and earth, and I observed during my visit to this station that one of these rows was lighted up to nearly full candle-power. The light was fluctuating slightly, which appeared to indicate that the earth was on a moving car; at all events, I was informed that such earths were of frequent occurrence, and went off as suddenly as they came on, but did not affect good working Earths on a line were "spotted" after all cars were home for the night by switching off one section after another while full power was kept on. The leakage current on two lengths of twelve and nine miles of double track joined in multiple with all cars off was 12 amperes under the full pressure of 500 volts.

The cost of street work in America for double-trolley construction is about £650 per mile, the items being as follows:

	£	s.	d.
100 iron poles	260	0	0
100 hangers	17	0	0
100 solder cars	5	0	0
70 strain insulators	4	9	8
3,000ft. span wire	12	0	0
10,560ft. No. 1 copper trolley wire	84	9	8
5,280ft. No. 0000 feed wire	211	4	0
25 3ft. cross-arms	0	15	0
50 glass insulators	0	12	0
200 sacks of cement	12	0	0
15 loads broken stone	4	10	0
5 loads sand	0	15	0
Labour and superintendence	45	0	0
	£657	15	4

This is about one-third more than the cost of single-trolley construction; but against this must be put the dispensing with bonds. While this system is out of place in cities and confined

* This paper, which will be discussed before the Institution of Electrical Engineers, is taken from the *Journal* of the Institution.

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thoroughfares, and, indeed, wherever span wires must be used, I believe it offers some advantages for heavy passenger traffic or goods traffic in suburban districts. It offers immunity from leakage currents to earth, for such can only take place when more than one earth is on the line. There is therefore no anxiety as to electrolytic action on pipes, even with the heaviest currents, no interference with telephones, and it is not necessary to bond the rails. With neat iron poles and ornamental cross brackets the line is not at all unsightly in the centre of the road. On some lines the appearance is improved by clusters of incandescent lamps, with reflectors, on every second or third post, and all feeder cables kept underground. The only objection to the system is the amount of overhead work at curves, turn-outs, and crossings; but it certainly holds its own in Cincinnati for smooth and rapid transit, and has proved itself a commercial success. On the table are some photos of the city for members to examine, showing some of the overhead construction. I have

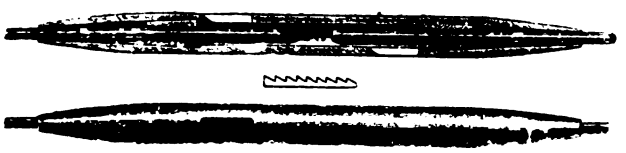

FIG. 11.

here also a specimen of the Kisinger splicing tube, by which breakages in trolley wires are rapidly repaired, Fig. 11. I witnessed two breakages in one street which took only five minutes each to repair by means of these tubes. The broken ends are pulled up and put in the tube, and then the dogs slipped in through the slot. When the tackle is slacked off, the ends are locked and an excellent electrical joint made without soldering. For working at the wires, an emergency wagon with folding ladder is used, and joints have been made in 3½ minutes, including picking up broken ends from the street.

I now pass to the consideration of underground conduit lines, also using an insulated return. During my stay in Chicago, the extensive plant of the North Side Tramway Company, consisting of gas motors fixed to special cars, suffered almost complete destruction by fire. As there had been serious complaints of the noise and smell of these gas motors, the company endeavoured to get a clause revoked in their franchise which prohibited their using an overhead trolley line. Their intention to equip their line in this manner, however, met with great opposition from

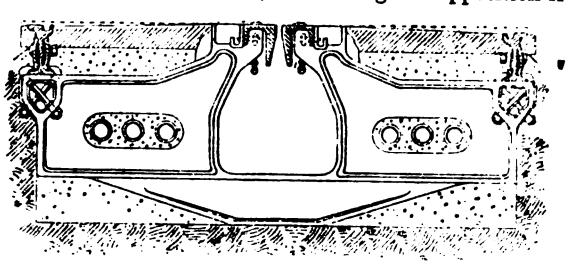

FIG. 12.—Yoke.

property holders, tradesmen, and insurance companies, and the clause was not struck out by the City Council. Previously, however (in March, 1892), in consequence of this clause, the company had equipped about a mile and a quarter of their line electrically with an underground conduit on the Love system. I found this in successful operation last year, and made a few notes on it, which I hope may prove of interest. The illustrations, Figs. 12 and 13, show sections of the line construction and roadway. The depth excavated below the road level is only 2ft., involving no trouble or expense while laying the track in diverting pipes along the route, as is so often necessary in laying a cable track. The slot rails are in 32ft.

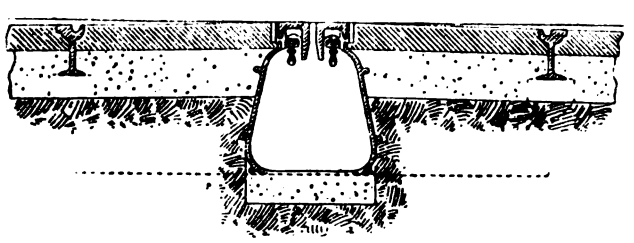

FIG. 13.—Conduit.

lengths, and bolted to the yokes every 4ft. Pockets, or small hand-holes, are provided in the road over every bolt, so that, if required, the rails can quickly be removed, and the conductors and insulators exposed to view. The slot rails are spaced for a ⅝in. slot, and shaped with 5in. inside lips, so as to shed water into the conduit clear of the wires. The track rails are held by claw bolts to the yokes, as shown, and the whole construction rests on a bed of 6in. concrete, and is packed round with concrete as a bed for the stone blocks of the roadway. In the webs of the yokes spaces are left for laying pipes to contain feeder wires, the conductors being in sections of 500ft. The conductors are of bare copper rod, nearly ½in. diameter, grooved longitudinally, and suspended from loose-fitting gunmetal clips, or ears, as shown, Fig. 14. The stalk of each clip is secured to a block of pressed mica or other insulating material, B, which is suspended from two shoulder-bolts bolted to the yoke. To allow for expansion of the conductors, the blocks are free to move about 2½in. on the rods. With the trolley

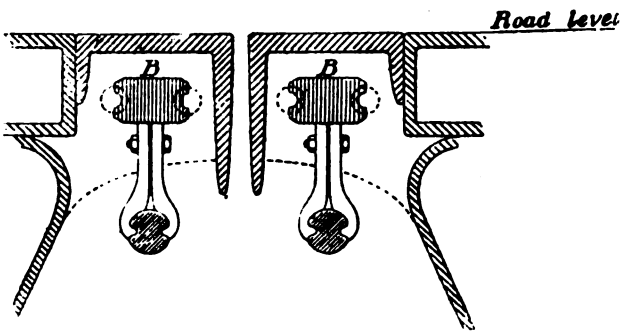

FIG. 14.

wheels travelling in the direction of the arrow, it was found that the blocks shifted a little in the reverse direction every time the trolley wheels passed, and it was necessary to put stops at S, Fig. 15. The insulators are fixed to every alternate yoke, at a distance apart of 9ft. on the straight run. On curves, however, they are closer together, and stronger supports are used, the conductor being circular in section, and clipped in ears having circular jaws, as shown in Fig. 16, which are afterwards filed round below, so as to offer no resistance to the

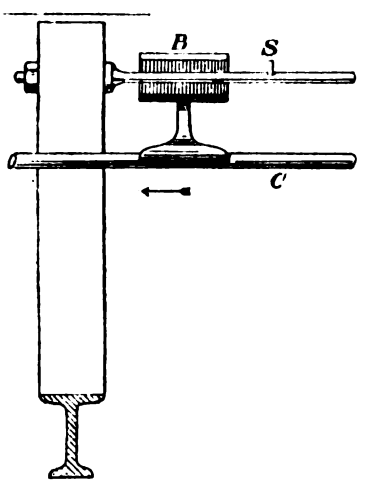

FIG. 15.

trolley wheel. The trolley wheels bear upwards on the underneath side of the conductor, exactly as in overhead lines. The illustration, Fig. 17, shows the arrangement with spring for keeping tension on trolley wire, and back stop for keeping the wheel in place on the wire. The plate travelling in the slot and supporting this gear is of ½in. steel, and 4½in. wide. The trolley arms are jointed to take lateral as well as vertical movement, and thus follow every change of direction of the conductors. The line in Chicago is in the form of a triangle a little

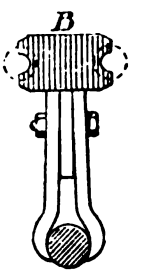

FIG. 16.

over 1¼ miles long, with three straight lengths and three curves, and in one place it crosses over the cable line. The motor cars (which also carry passengers) haul the trailers with passengers left by the Lincoln-avenue cable cars and North Halstead-street horse cars round Fullerton and Webster Avenues. This was the first line on this system, and, as might be expected, some difficulties were met with. These were chiefly due to the breakage of insulators, expansion of conductors, and snow and ice in the conduit. Boys were also a nuisance, stuffing wire into

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slot, which jammed the trolley wheels and short-circuited. I found that in July last there had been five stoppages, two in August, and none at all the following three months. Two of the stoppages were, however, due to burnt-out armatures. Brushes were used attached to cars for sweeping out water and dirt from the conduits into sump-holes every 100ft., which were afterwards pumped out by hand. Water gave no trouble at all, except when it froze in the conduit. Wide extremities of temperature are met with in Chicago, being 15deg. to 20deg. below zero in the winter, to 90deg. in the shade in the summer, and expansion gave a good deal of trouble at first, especially at curves, where the conductors sagged till they nearly touched the side of the iron conduit, upon which the trolleys made earth and short-circuit by touching the sides. This was overcome by dividing the conductors into sections of 500ft. to 600ft., and covering the adjacent ends with a long sleeve. Powerful compressed springs on either side of the sleeve were used as shown in the illustration, Fig. 18, which drew the ends together and took up the expansion.

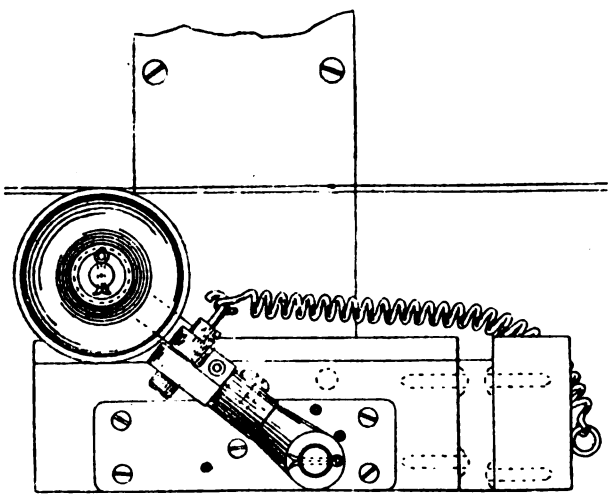

FIG. 17.

At the Milwaukee Convention Mr. M. D. Law read a paper on this system as now operated in the city of Washington (district of Columbia), in which he mentioned the improvements introduced by the Rock Creek Railway Company using the system in that city. I subsequently saw this line at Washington, and found the construction perfected in many details, and the system giving completely satisfactory service, uninterrupted since its inauguration in March, 1892. The line was a credit to this well laid out city, and anyone who could see the smooth and regular running of the cars, with no overhead wires, would say there was a great future for such a system in city traffic. The line of the above company extends some 6½ miles in the suburbs with the overhead trolley system, but at the city boundary it changes to underground trolley. The change from one to the other only involves fixing the trolley bar and switching off the earth connection, which I timed to take 20 seconds. The line then continues along U-street for 1½ miles with double track. On the return journey, close to the junction, the cars have to take a sharp curve, and take an ascent of 1 in 40 at the same time, which they do easily. The insulators and supports

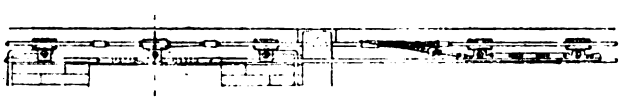

FIG. 18.

at the curves are all strengthened, and the conduit is made 20in. deep by 14in. wide, the extra width allowing ample clearance between the wires and the sides of the conduit. The yokes are also put at 4ft. centres instead of 4ft. 6in., and the conductors are of §in. hard drawn copper. A separate power house was erected to supply the underground system, as it was desired by Mr. Law and Mr. Herbert Claude, the engineers to the company, to thoroughly test the system. Leakage to earth, as shown by a voltmeter between the conductor and earth, was only 0·1 per cent. even in the stormiest weather, and the ammeter remained dead at zero when the full E.M.F. was on and the cars all off. In the wettest weather it was a common thing to find dusty insulators and perfectly dry conductors on removing the slot rails ; this condition being due to the natural draught in the conduit and the umbrella nature of the slot rails. On two or three occasions, however, severe rain storms had flooded the conduit and immersed the wires, but the cars ran without delay. With four fully loaded cars on the line the drop was only 3 volts. The trolley wires were in sections, with main and return feeders, switches, and cut-outs to each section, placed in manholes every 500ft. on the straight run.

(To be continued.)

THE SOUTH STAFFORDSHIRE ELECTRIC TRAMWAY.

WORKING RESULTS.

In the *Electrical Engineer* of November 18, 1892, was published a lengthy illustrated description of the South Staffordshire electric tramway, which commences at a junction in Wednesbury with the line from Handsworth, passing through the Market-place, along the Wednesbury-road to the Pleck, where it is joined by another section of the electric line which connects that point with Darlaston. It then passes along the Walsall-road to Walsall Bridge, where it again divides, one section going to Rushall and the other to Bloxwich. Mr. Alfred Dickinson, engineer to the company, has now contributed to the *Proceedings* of the Institution of Civil Engineers a paper describing the line and giving working results. As we have already fully described the tramway, we content ourselves with reproducing from the *Proceedings* the following particulars concerning the working results.

After the formal inspection on behalf of the Board of Trade, the electric system of lines was opened for traffic on January 1, 1893. From that date to February 28, 1894, the cars have run 310,115 miles, and have carried 1,920,185 passengers. From January 1, 1893, to December 31 inclusive, the cars ran 262,692 miles, and carried 1,668,057 passengers, the local authorities, the public, and the directors of the South Staffordshire Tramways Company being completely satisfied with the results. The line is worked by the Electric Construction Corporation under a contract with the tramways company, and in dealing with the working cost for purposes of comparison the author proposes only to deal with the charges where a direct comparison can be made—viz., all those for running and maintenance, minus traffic charges and maintenance of permanent way. The following statement shows the cost of working several systems of tramway lines in 1893 :

COMPARATIVE STATEMENT OF COST PER CAR MILE FOR RUNNING AND REPAIRS. 1893.

Charges.	South Staffs Tramways Co. Wilkinson locomotive steam-engines vertical boilers.	Birmingham Midland Co. Kitson locomotive steam-engines.	Dudley and Stourbridge Co. Kitson locomotive steam-engines.	Birmingham Central Co. Kitson, Falcon, and Beyer, Peacock locomotive steam-engines.	Birmingham Central Co. Electric accumulator.	Birmingham Central Co. Cable.	South Staffordshire electric system.
Running—	d.	d.	d.	d.	d.	d.	d.
Wages .	1·83	1 99	1·45	2 14	3·37	1·54	1·93
Fuel.....	2·34	1·81	1 94	1·92	1·76	0·60	0·48
Stores ...	0·33	0·30	—	0·27	0·68	0·19	0·43
Water and gas	0 28	0·11	0·35	0 18	0·12	0·03	0·08
Sundries	—	—	—	0·09	0·17	0·05	0·06
Repairs*— Wages & materials	2·26	3·62†	4·83	2·19	5·49	1·81	1·08
Total cost per car mile	7·04	7·83	8·57	6·79	11·59	4·22	4·06
Number of miles run	337,423	256,077	112,299	1,225,996	140,993	641,161	262,694

* The items referring to steam traction include repairs of every description ; those to electric accumulator traction include stationary engines and boilers, dynamos motors, batteries, switches, and all repairs pertaining to an electric installation ; to cable traction—stationary engines and boilers, cable, pulleys in road, cars, and all repairs incidental thereto ; to overhead electric traction—stationary engines and boilers, dynamos, motors, poles, feeders, overhead wire, cars and all other repairs in connection with an electric system.

† This item includes an amount taken from depreciation fund.

The average cost for fuel on the four lines worked by steam is 2·00d., electric accumulator 1·76d , cable 0·60d., and overhead electric traction 0·48d. per car mile run.

Hitherto it has been most difficult to obtain a direct comparison between electric traction and any other system, but such now is not the case, at any rate, so far as the South Staffordshire line is concerned, because the electric

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cars are running upon lines previously worked by steam. When designing the system, the author was in doubt as to the amount of steam-engine power to provide in the generating station per car on the lines, and how to arrange its subdivision, as the number of cars upon the line at different times would vary considerably. However, he ultimately decided to split the power into three elements, so as to be able to reduce it to suit the number of cars running upon the line at any given time. He was prepared, from his experience in the working of the cable line in Birmingham, for a considerable variation in the load; but he certainly never anticipated that its range would be so great in so short a time as he finds to be the case. With 16 cars on the line, the output has been found to vary as much as 233 e.h.p. in the space of five seconds, and with 11 cars upon the road as much as 202 e.h.p in the same period. Taking into account even the extraordinary fluctuations caused during holiday times, it is satisfactory to observe that the cost per car mile for fuel is below that of cable traction; and in this comparison it is well to bear in mind that the power on the cable route is distributed over only three miles of route with double the number of cars running, as against eight miles of route on the electrical section. By many engineers the problem of arranging an economical mechanical plant for working a tramway may be considered simple; but the physical conditions of any district, the ever-varying condition of a tramway rail, demanding within a few hours as much as 50 per cent. increased tractive power, are more important factors in this problem than they are generally considered to be. It is a curious fact that as soon as mechanical traction of any kind is introduced, the public demands that gradients shall be ascended and descended at a constant speed; and the South Staffordshire electric system is able to comply with that demand. During the winter, when snow was on the line, the electric cars kept correct time, whilst the steam cars lost half an hour in a run of six miles. It may seem astonishing that an electric car carrying 40 passengers is occasionally called upon to exert 48 e.h.p., but of this fact evidence is afforded by the author's trials.

He has recently had a motor that had been running for 14 months taken from a car and tested with a "Prony brake," when its mechanical efficiency was found to be 78 per cent.—a most satisfactory result. At the same time he tested the torque of the armature with a current of 48 amperes taken from the trolley wire under normal conditions, and found this would raise a weight of 141lb. at the end of a lever 7ft. long. This is equal to a torsional force of 1,692lb. weight on the armature. Testing with a dynamometer the amount of pull to be obtained on the drawbar, with all the resistance cut out and both motors in circuit, he found it was 1 ton 7cwt. He then tested a Wilkinson engine at a boiler pressure of 150lb., with cylinders 7⅞in. diameter geared 1⅔ to 1, and this gave exactly the same pull.

The author had at first considerable misgiving as to the probable amount of wear and tear upon the trolley-wire, and after running for 14 months it is satisfactory to find that it is scarcely possible to measure it.

TELEGRAPHIC COMMUNICATION BY INDUCTION BY MEANS OF COILS.*

BY CHARLES A. STEVENSON, B.Sc., F.R.S.E., M.I C.E.

In 1892, I suggested that communication could be established between ship and ship by means of coils,† and as a trial of the system on a large scale has recently been made with the view of establishing communication between North Unst lighthouse, situated on Muckle Flugga, and the mainland (Fig. 1), thence to the lighthouse station at Burrafiord, a distance of two miles, a record of the trials may be of interest to the society.

The induction of one spiral on another has been long known, but with a very strong battery current it has been found impossible to bridge a greater distance than 100 yards,‡ so that as a means of practical communication it was impossible. It has also been long known that communication could be established by means of parallel wires, and disturbances in wires no less than ten miles apart had been detected. For many years this system has been under discussion, and only last month a series of elaborate experiments at Loch Ness has been made by Mr. Preece on this parallel wire system on the most approved methods; but I trust to be able to show that the parallel wire system * must give place to the method of communicating by coils.

It is evident that if two coils are placed so that their axes are coincident, their planes being parallel, or if they be placed so that their planes are in the same plane, they will be in good positions to expect electric currents sent in one to be apparent by induction in the other. For a given diameter, and where the electrical energy is small and the number of turns small, the first position is best, but where the energy is great and the number of turns great—in fact, when it is wished to carry the induction to many times the diameter of the coils—then it will be found that it is better to let the two coils be in the same plane, as, when the axes are coincident and the coils a great distance apart in comparison with the diameter, the difference of distance from one side of the coil, say top of primary coil to top and bottom of secondary, becomes almost a vanishing quantity; whereas, when the coils are lying on their side in the same plane, the difference of distance from back of primary to back of secondary, and from front of primary to front of secondary, does not fall off so fast, and consequently is more efficacious. Besides, it becomes impracticable to erect coils of large diameter with their planes vertical, but it is easy to lay them on their sides. It is almost impracticable to introduce a core in these large coils, although the effect would thereby be intensified, and where compactness is necessary a core is advantageous. A number of experiments were made in the laboratory to discover the laws of the action of coils on each other, with a view of calculating the number of wires, the diameter of coils, the number of amperes, and the resistance of the coils that would be necessary to communicate with Muckle Flugga, and, after a careful investigation, it was evident that the gap of 800 yards could, with certainty, be bridged by a current of one ampere with coils of nine turns of No. 8 iron wire in each coil, the coils being 200 yards in diameter.

Two coils, about 850 yards centre to centre, were erected at Murrayfield (and I may here thank Mr. Gibson, telegraph engineer of the General Post Office, and his staff, and also Mr. Asher of the National Telephone Company, and Messrs. Clement and Francis of the North British Railway for their valuable assistance), one coil being on the farm of Damhead, and the other on the farm of Saughton, and as nearly as was possible on a similar scale, and the coils of similar shape,† as was wished at Muckle Flugga.

On erecting the coils, communication was found impossible, owing to the induction currents from the lines from Edinburgh to Glasgow, the messages in these lines being quite easily read, although the coils were entirely insulated and were not earthed. The phonopore which the North British Railway Company have on their lines kept up a nearly constant musical sound, which entirely prevented observations. On getting the phonopore stopped, it was found that 100 dry cells, with 1·2 ohms resistance each and 1·4 volts, gave good results, the observations being read with great ease in the secondary by means of two telephones. The cells were reduced in number down to 15, and messages could still easily be sent, the resistance of the primary being 24 ohms, and the secondary no less than 260 ohms. If the circuit had been of good iron, with soldered joints, and well earthed, the resistance should have been only 60 ohms. The induced current therefore generated in the secondary would therefore be in the ratio of 480 to 210, or with this great resistance, allowing for the resistance in the two telephones in multiple, we got practically only half the current we would have got if the line had been a permanent in place of a temporary one.

A trial was made of the parallel wire system, and with 20 cells the sound was not heard, and with 100 cells it was heard by me as a mere scratch in comparison with the sound with the coil system with 15 cells. A trial was made with a phonopore, and the coils worked with 10 cells with perfect ease, and a message was received with only five cells. Speech by means of Deckert's transmitter was just possible, but it is believed that if the hearing circuit had been of less resistance it would have been easy to hear.

It is difficult to understand how this system of coils, in opposition to the parallel wire system, has not been recognised as the best. For, assume that with the arrangements we had, we heard equally well with 100 cells by both systems, both having the same base (200 yards), then by simply doubling the number of turns of wire, and using thick wire of low resistance, the effect would have been practically doubled, whereas, by the parallel wire system, there is nothing for it but to increase the battery power, which, for practical working, becomes an impossibility. The difficulty of the current is thus removed by using a number of turns of wire. There is shown on the following diagram (Fig. 3) the result of simply increasing the diameter with a given length of wire, keeping current and resistance the same. It shows that the larger the diameter the better; in fact, with a given length of wire, a straight one is the best. But this is not practicable; what is wanted is to get induction at a great distance from a certain given base with a small battery power, and the laboratory experiments and trials in the field show that the way to overcome the difficulty of the current is by using a number of turns of wire. The secret of success is to apportion the resistance of primary and secondary and the number of turns on each to a practical battery power.

Coil System.—(1) At 850 yards from centre to centre of coils averaging each 200 yards diameter, it was found that, with a phonopore, messages were sent with 5 dry cells. The resistance in primary being 30 ohms, and the resistance of secondary 260 ohms, the current being ·23 ampere which, with nine turns, gives two

* From the *Proceedings* of the Royal Society of Edinburgh.

† *Engineer*, vol. lxxiii. p. 292.

‡ *Journal* of Society of Arts, vol. xlii. p. 274.

* *British Association Reports*, 1886, p. 546; 1887, p. 611.

† Shape of coil, circle, square, or rectangle, etc., is not very material, and in practice must be altered to suit circumstances, as for instance in a ship (Fig. 2).

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ampere turns. (2) With a file as a make and break it worked with ten cells, giving ·4 ampere or 3·6 ampere turns.

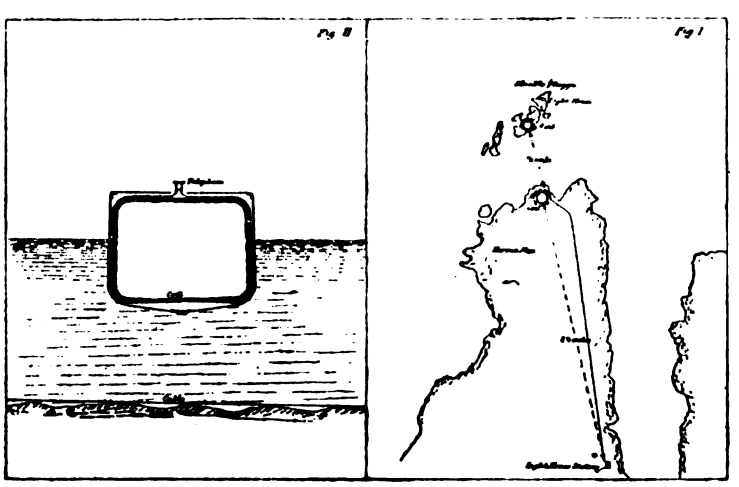
Parallel Wire System.—(3) With a file as a make and break, and with parallel lines earthed, it was heard with 100 cells, giving 1·1 ampere. Fig. 4 shows the variation with number of turns on one coil, the current and resistance remaining constant.

The calculation of the diameter necessary to hear a given distance is simple, from the fact that the hearing distance is proportional to the $\sqrt{}$ of the diameter of one of the coils, or directly as the diameter of the two coils, so that, with any given number of amperes and number of turns to hear double the distance requires double the diameter of coils, or double the number of turns, and so on. But this is within certain limits, for when the coils are close to one another the law does not hold.

There is one point which seems to have been cleared up by these trials, which has even this month been a subject of discussion in London, and that is, whether or not the parallel wire system is actuated by induction or conduction, and there is little room for doubt, from the fact that both circuits were insulated, and was thus a case of pure induction, that to a large extent it is induction; in fact, that they act together, and it will depend how the ends are earthed, or, in short, what is the distance bridged in comparison to the breadth of base, which predominates. Where the wires are [illegible] comparison with the distance bridged, conduction will be the [illegible]working factor, but when the base is small, and the distance bridged is large in comparison, induction will be the main factor, and the number of turns then increases the effect.

The primary coil was insulated in the Murrayfield trials, as at Muckle Flugga it must be so, the impracticability of making and maintaining the sea connections necessitating this, and the secondary was earthed, as is most convenient at Muckle Flugga. When the secondary was also made a complete insulated metallic circuit, there seemed to be little difference in the result.

There is one other point to which reference must be made. Mr. Preece has been repeating the experiments brought before this society on January 30, 1893, and he found, if rightly reported, that when the hearing wire was floating he got results, but when it was allowed to descend that no observations could be got; he attributes this to reflection from the surface of the water; this, however, is unlikely, as the reason that no sounds were then heard was that the major part of the wire lay on an equipotential line. Electro-magnetic waves enter or leave salt water practically unimpaired, as the following diagram (Fig. 5) will show, where A is a wire suspended 10ft. above salt water and B is a wire sunk in salt water. On trial, it was found, as stated in my paper read before this Society in January, 1893, that there was no practical difference in air or salt water to the propagation of electro-magnetic waves, in or out the distance to which waves went—*i.e.*, the distance to which the currents could be heard being immaterial whether the detector was sunk or in air.



It has been attempted to be shown that the coil system is not only theoretically but practically the best. Meantime, my brother has recommended the Commissioners of northern lighthouses to erect the coil system at Muckle Flugga, and the Commissioners have approved, and I hope that we may soon hear of this novel system of communication being erected at the most northern point of the British Isles, where the laying down and after-maintenance of a submarine cable is practically impossible. This system is also applicable to our warships, to assist in their manœuvering, by the establishment of instantaneous communication unaffected by wind or weather.

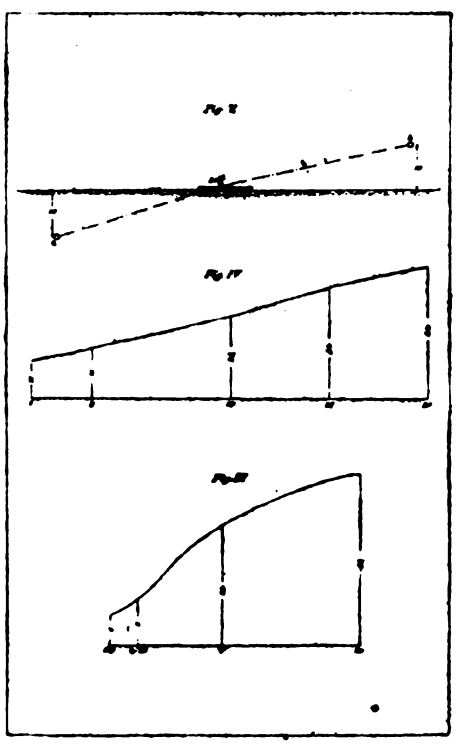
The application of the coil system to communication with light-vessels is obvious, namely, to moor the vessel in the ordinary way, and lay out from the shore a cable, and circle the area over which the lightship moorings will permit her to travel by a coil of the cable the required diameter, which will be twice the length of her chain cable. On board the vessel there will be another coil of a number of turns of thick wire. Ten cells on the lightship and ten on the shore will be sufficient for the installation. The system erected at Kentish Knock and other light-vessels is expensive in moorings, and is liable to derangement, and requires special appliances; whereas, by the coil system there can be no derangement, and the vessel can be moored in the ordinary way. A call arrangement and telephones complete the installation.

SUBMARINE TELEGRAPHY TO THE FAR EAST.

The twenty-fifth anniversary of the establishment of submarine telegraphy to the Far East was celebrated on Friday evening at the Imperial Institute by a banquet, which was given by the Eastern and the Eastern Extension, Australasia, and China Telegraph Companies, followed by a reception which was attended by the Prince of Wales. Sir John Pender, M.P., the chairman of the two companies, presided at the banquet, which was served in the Grand Hall.

After the loyal and other toasts had been given, the **Lord Mayor** followed with the toast of "Submarine Telegraphy in its Commercial Aspect."

The **Chairman**, in acknowledging the toast, said that when it was almost impossible to raise money for the 1865 cables, the Telegraph Construction Company was formed, and they were indebted to that company for the good work they then and had ever since done. Even in those early days it was proved by their late colleague and managing director, Sir James Anderson, to be possible to pick up and repair a cable in 2,000 fathoms of water. For that great work all credit was due to Sir J. Anderson, who devoted the best years of his life to the development of submarine telegraphy. They were also indebted to Sir William Thomson, Cromwell Varley, Fleeming Jenkin, and many other distinguished men for their scientific inventions, which enabled submarine telegraphy to achieve the great scientific and commercial success it had since become. At the present time there were 11 cables in the Atlantic, and another was in course of submersion, so that with the aid of duplex working, for which they were indebted to Dr. Muirhead and others, the carrying capacity was practically equal to twice that number of cables. The first attempt to provide the public with submarine telegraphs to the East was in 1859, when a cable was laid down the Red Sea and along the coast of Arabia and through the Persian Gulf to Kurrachee. Unfortunately this cable worked only a few days in its entire length, and it was afterwards abandoned. The success attending the Atlantic cable caused the idea of submarine telegraph communication to the Far East to be again considered and carried into effect by the formation of various companies, which were afterwards merged into the Eastern and Eastern Extension Telegraph Companies. Twenty-five years ago on the previous day the company that laid the submarine system from Great Britain to the Far East was registered. At that time the nucleus of the present system of Eastern telegraph consisted of about 900 miles of cable, with a capital of £260,000. That day they owned 51,325 miles of cable, and had a joint nominal capital of over nine millions sterling. Two years after the registration of the Eastern Companies the whole submarine system between Great Britain and China was completed and in working order. A year later the Australian colonies enjoyed the benefits of daily intercourse with the mother country and the rest of the world. At present the total mileage of submarine cables was in round numbers 152,000 miles, of which 90 per cent. had been provided by private enterprise and 10 per cent. by the various Governments, costing altogether over 40 millions sterling. The total length of land wires throughout the world was over 2,000,000 miles, estimated to have cost about £65,000,000. If the cables and land lines were added together, a combined capital was represented of £106,000,000. When a Pacific cable was really required, the companies which he represented would not be



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found backward in meeting public requirements. He concluded by acknowledging the good work and hearty co-operation which they had received from their Danish friends, the Great Northern Telegraph Company, and he also desired to acknowledge the good work and co-operation which they had always received from their officers and staff throughout the service.

Other toasts having followed, the banquet terminated. Subsequently the chairman and his co-directors returned to the vestibule, where the Meister orchestra was stationed, and where at about 10 o'clock they began to welcome the guests to the reception. On their arrival the Prince of Wales and the other Royal guests were received by the Lord Chancellor, Sir F. A. Abel, and Sir Somers Vine, and were conducted to the vestibule, where Sir John Pender and his colleagues welcomed them. The Royal party and suite then proceeded to the eastern *foyer* in the upper central gallery, where they inspected an interesting exhibition of cable telegraph instruments and appliances.

In the course of the evening the Prince of Wales despatched telegrams to the Viceroy of India and to the Governor-General of Canada. Telegrams were also despatched by the Prince of Wales to the Governors of other Colonies, and the Royal party were afterwards entertained at supper.

THE HISTORY OF WOODHOUSE AND RAWSON UNITED, LIMITED,

As Detailed in the Bankruptcy Court.

FRIDAY.

The public examination of the directors and officers of this Company was continued on Friday before Mr. Registrar Hood, at Bankruptcy-buildings, Carey-street, Lincoln's-inn.

Sir Rawson W. Rawson was recalled and further examined by the Official Receiver. He stated that he could not give details of the profits which he said, in the course of his speech at a meeting of shareholders held in January, 1891, had been made. He was anxious to give all the information and assistance in his power, but his memory as to matters which occurred three or four years ago was very defective. He was satisfied that the statements he made were justified at the time. It appeared from an analysis of the accounts that about £80,000 out of the total profits of £100,000 was represented by the profits made over three transactions.

The **Official Receiver**: Do you think that these profits were not casual and accidental and were likely to be maintained?

Witness said he thought that they might be repeated, and therefore did not consider them exceptional. The directors had a prospect of obtaining a very valuable French concession and other contracts. He became aware that his son, Mr. F. L. Rawson, was connected as a director with the Phœnix Trust Company and Baron Grant.

The **Official Receiver**: Did you know whether Baron Grant was consulted in connection with the promotion or formation of the United Company?

Witness said he had never heard the suggestion before.

The **Official Receiver**: Was there not a private telephone wire between Baron Grant's office and the Company's office?

Witness said there was, because he understood that Baron Grant was intimately concerned in the Elmore companies, and that witness's son (Mr. F. L. Rawson) was using every endeavour to make them prosperous and in that way Baron Grant became acquainted with the United Company.

Mr F. L. Rawson explained that the telephone was not between the Company's offices and Baron Grant's offices, but between the Phœnix Trust Company and the United Company.

The **Official Receiver**: Was not Baron Grant's office in the same building as the Phœnix Trust Company's offices?

Witness said he was not aware of it.

Mr. Registrar Hood remarked that the line of the examination was calculated to convey a wrong impression by the introduction of well-known names.

Examined by **Mr. F. L. Rawson**, the **Witness** said that considerable profits were realised during the financial year 1890-91 in connection with the Elmore patents. Steps were taken by the directors to ascertain the value of the Epstein securities, the works committee having gone thoroughly into the value of the patents with the co-operation of their electricians. The opinion of the best patent agents as to the value, and the opinion of three or four eminent counsel as to their validity, had been obtained Witness was satisfied as to the profitable use of the invention and the prospects of the Epstein Company. Special reports were made by the managing director as to the value of the Phœnix Trust shares, and the Board was satisfied with them. He could not remember whether any special valuation was made of the Elmore securities in November, 1891.

The **Official Receiver** intimated that there had never been any suggestion that the shares had not been carefully valued.

The **Witness** further said he fully recognised the fact that Mr. H. G. Rawson had made great self-sacrifices in the interests of the Company, and the Board often reproached themselves for having allowed him to do so. When the sum of £28,000 was advanced to Mr. F. L Rawson it was anticipated that he would wipe out the debt by the amount he received from the liquidation of the old company.

Mr. F. L. Rawson here stated that the notes which he had made of the evidence given during the previous sittings of the enquiry had, to employ a term used by the Official Receiver in the early part of the proceedings, been "spirited away." He applied that he might have an opportunity of reading through the transcript of the shorthand notes.

The **Registrar** granted the application

Sir Rawson Rawson was further examined by Mr. Pilling, and stated that the directors had the option of rescinding their contract to purchase the Kidsgrove works in the event of their not being satisfied with the bargain. So far as he was aware, no steps were taken by the Board to be relieved of the contract after there was found to be a loss on the business He did not know that the directors would have been desirous of disposing of the Kidsgrove works, because they were advised by their general manager (Mr. North) that they were capable of producing a profit of £6,000 or £8,000 per annum.

Mr Pilling: How many members of your family, besides yourself, were connected with the administration of the affairs of the Company?

Witness: When the United Company was formed it took over the limited Company with some of its servants and two of my sons.

Further examined, **Witness** said that his son, Mr. H. Rawson, was invited to attend the board meetings and give the directors the benefit of his legal knowledge, as Mr. Pope Q C., intimated that, owing to the great pressure upon his time, he could not give so much attention to the affairs of the Company. Mr. H Rawson had, as a barrister, advised the board on legal points, and also on other matters.

Mr. Pilling: Did he receive any fees?

Witness: Oh! that was settled by Mr. Pope.

By **Mr. H. G Rawson**: He knew nothing of the affairs of the old company and its subsidiaries, because he had never been connected with them in any way. He saw all the documents relating to the formation of the new company, and made general enquiry into the facts. He consulted Sir Albert Cappel, one of the directors who retired before allotment, and was informed that that gentleman did not wish to continue as a director because he was of opinion that sufficient capital, which he put at £200,000, had not been subscribed. Eventually that sum was reached Sir John Coode had also expressed his opinion to witness that the business was a good and sound one. He satisfied himself that all the statements in the prospectus were correct. If it had been suggested that the directors gave little consideration to the industrial branch, but had devoted their energies to the financial side of the business the suggestion was unfounded. The board always did their utmost to foster the industrial business and it was absolutely contrary to the fact that the directors had neglected it. He had incurred liabilities as guarantor on behalf of the Company to the extent of £8,000 or £10 000. During the past 18 months the directors had practically received no fees, and during the last year they had attended three or four times a week for six or seven hours *per diem*. The managing director had received about £13,000 from the Company, which he immediately reinvested in preference shares of the Company. The Board had throughout acted upon the advice of their solicitors, and, so far as he was aware, they had never declined to follow that advice on any important point. Careful consideration had been given to the suggestions of the auditors and witness had no reason to think that they were not satisfied upon any question which arose. To the best of his belief every balance sheet that he had anything to do with had been fairly and correctly drawn, and, to his knowledge, the value of the assets was never exaggerated. In his opinion the directors were justified in every case in paying the dividends which were declared. The circulars and prospectuses were accurate and not misleading, and great care had been exercised to make sure that the statements contained in them were not exaggerated.

Mr. F. L. Rawson, the late managing director of the Company, was next examined. He stated, in reply to the Official Receiver, that he was not a considerable holder of shares in the limited Company. The joint interest of the late Mr. Woodhouse and himself did not, he thought, represent more than from £10,000 to £16,000. He could not say whether he had any interest in the shares standing in the name of Mr. Woodhouse in the Manufacturing Company. He appeared to be a holder of 261 shares in the Supply Company. As to 108 shares in the Contract Company, he believed that he held those for Woodhouse and Rawson, Limited. The business of Woodhouse and Rawson was started in 1881, and five or six years later the concern was undoubtedly solvent. He absolutely dissented from the evidence which had been given to the Official Receiver to the contrary.

The **Official Receiver**: A balance-sheet of the Manufacturing Company, dated June 30, 1890, shows there was a deficiency of £44,000, even taking the goodwill at £37,265.

TUESDAY.

The **Official Receiver**, at the resumption of the proceedings on Tuesday, stated with regard to a remark made by his Honour on the last occasion as to the introduction of well-known City names into the enquiry, that he had correspondence in his possession which would prove that Baron Grant was consulted in connection with the promotion of the United Company.

Mr. Registrar Hood intimated that he did not wish to restrict the examination in any way which might be considered necessary by the Official Receiver.

Mr. F. L Rawson. the managing director of the Company, was recalled and further examined by the Official Receiver. He stated that he considered the report made by the auditors on the position of the Supply Company in October, 1838, was satisfactory. From the report it appeared that the Company had made a loss during every year of its existence, but witness asserted that the amount of such loss was being gradually diminished, and he was of opinion

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that the Company would ultimately prove successful. The partnership of Woodhouse and Rawson guaranteed the book debts taken over by the limited Company, and, so far as he was aware, the whole of the debts had been paid. The Woodhouse and Rawson Manufacturing Company, Limited, was liable at the date of the formation of the United Company to the limited Company for £22,000. The whole of this amount had been discharged in cash and shares. The accounts of the Electric Contract and Maintenance Company at June, 1889, showed a loss of £3,430. The amount of the loss had steadily decreased; but the business was a new one, and, it being of a special nature, a loss would be made until the corner was turned and the Company improved its position. The amount paid for the goodwill of that business was £5,000.

The **Official Receiver**: Do you seriously suggest that a business which has been conducted at a loss throughout can possess any goodwill?

Witness said he did if the loss was diminishing. The prospects of the Company were very favourable, and there was ample ground for considering the goodwill to be valuable.

The **Official Receiver**: Who was the financial adviser who assisted in the promotion of the Company?

Witness said that in the early days he was advised by Baron Grant, who was anxious that certain electrical concerns in which he had a hand should be included in the amalgamation scheme. Baron Grant had nothing to do with the actual promotion of the Company, but witness had taken his advice very frequently. He was advised by his solicitors that Baron Grant was a man capable of giving excellent advice on the promotion of the Company. When several articles appeared in the papers commenting upon the Company witness was advised to take no notice of them. Baron Grant was very particular in respect of the information which he required, and he was a man of great experience. The witness said that he went to the National Financial Corporation for the advice—he was afraid that he had fallen into the bad ways of the Official Receiver in using the name of Baron Grant instead of the corporation. The baron was practically the corporation. Witness consulted Baron Grant with reference to the paragraphs appearing in the Press, because his mode of dealing with those matters was A 1, whereas that of witness was below zero The directors of the United Company went thoroughly into the businesses which Baron Grant had in hand, and decided not to include them in the amalgamation scheme. The baron felt that he had been rather badly treated, and ultimately a fee was given him of £5,000 as consideration for his services. Witness, feeling that the fee was not large enough, agreed to give the baron 10 per cent. upon anything which might be realised from the founders' shares to which witness was entitled in the limited Company.

By the **Registrar**: As a matter of fact the latter had not been received, and the baron only got the £5,000 for his services. The baron had no interest in the limited Company.

The **Official Receiver**: Any money which the baron received was in consideration of his friendly advice.

Witness: Not friendly advice; advising in that way was his business.

The **Witness**, continuing, said that the Phœnix Trust was mainly composed of Baron Grant, the National Financial Corporation (of which the baron was the moving spirit), witness, and his wife. Witness drafted the prospectus of the United Company. In it the statement appeared that the profits of the business of Woodhouse and Rawson, Limited, for the year ending June 30, 1888, as shown by the audited balance-sheet, amounted to £21,440. Witness desired that the auditor should certify these profits, but he declined to do so, and said that if he allowed his name to appear in any way he would have to refer to his report. Witness never understood that the report of the auditor should have been read with the certificate given. The auditor was satisfied, so far as witness was aware, of the correctness of the valuation of the assets, but as he could not certify the value it was impossible for him to give the usual certificate. The certificate was ultimately given as follows: "We have examined the books of the Company and certify the accounts to be correct in accordance with our report." Their auditor (Mr. Pixley) had the reputation of being one of the most particular accountants in the City, and it was one of his habits to give a report qualifying his certificates.

The **Official Receiver**: Can you point to any paragraph in the prospectus which would lead anyone to understand that the Company would engage in a financial business?

Witness said the prospectus stated that considerable profits had been realised from business introduced by patentees and vendors of processes, to whom advice would be given. The memorandum and articles of association clearly set forth the business which would be conducted by the Company, and it appeared that the financial business was contemplated.

The **Official Receiver** next examined the **Witness** with reference to the valuation upon which the United Company acquired the patents. It appeared that they were valued at £159,000, the Company paying £85,000 for them. Witness denied that the valuation was made at his instigation, but alleged it was taken at the instance of the new directors. He was unable, however, to state which gentleman had consented to act as a director at the time it was made.

The **Official Receiver** remarked that it was very difficult to gather from the valuation what was the actual value of the patents.

Mr. Registrar Hood said he was afraid that was a very common occurrence in connection with valuations.

Witness said that he gave the instructions for the valuation on behalf of the directors *in posse*. He could not say whether Lord Aberdare, Colonel Howard Vincent, or other Directors had been consulted upon the subject. He had taken great pains to impress upon the valuer the fact that the valuation was to be made for the United Company and not the limited Company. Referring to his connection with Baron Grant, witness said that no payment was made to the baron personally, but to the National Financial Corporation, through whom all the negotiations were conducted. He could not give the names of any of the directors besides Sir Rawson Rawson and Mr. Philip Rawson who were aware of his connection with the Phœnix Trust Company in September, 1890. The matter was mentioned at several board meetings.

The **Official Receiver** observed that Mr. Philip Rawson denied all knowledge in the matter.

Mr. H. G. Rawson: What is the relevancy of the whole question?

The **Official Receiver**: To show that one director was making a large profit unknown to the other directors.

Witness asserted that at a meeting in October or November, 1890, he stated to the directors that there was nothing incorrect in his transactions with the Phœnix Trust, and that he would not only give up to the United Company the shares he held, but also the dividends he had received during that year. The directors did not think it necessary for him to do this, and it was not done.

Sir Rawson W. Rawson, recalled, stated that he was aware early in 1890 of his son's connection with, and pecuniary interest in, the Phœnix Trust. His recollection was that the circumstances were reported to the board, and that the attention of the directors was first called to the matter some time in 1891. He was not aware who were the principal persons concerned in the Trust until the present enquiry was instituted.

By **Mr. H. G. Rawson**: The managing director had surrendered 25 out of 50 founders' shares which he held in the Phœnix Trust to the United Company.

Mr. F. L. Rawson, further examined by the **Official Receiver**, stated that in conjunction with Mr. Philip Rawson he was appointed a committee to act in connection with the Company's dealings with the Okonite Company. With the sanction of the directors they applied through nominees for and acquired a considerable number of shares in that Company. By some oversight the authority to purchase those shares was not recorded in the minute-book of the Company. Owing to the insufficiency of capital subscribed, Sir John Coode, Sir Albert Cappel, and Colonel Howard Vincent resigned their seats on the board, and Sir A. Cappel desired to have a circular forwarded to the applicants for shares, informing them that they were entitled to withdraw their applications. In the circular this paragraph was omitted. Witness stated that he was responsible for the circular, but added that he disclaimed all responsibility with regard to the omission.

Mr. Registrar Hood observed that the circular was an important one, and the omission of the particular paragraph would be a matter for comment later on.

Witness further stated that the auditor had advised the directors not to pay a dividend, but that gentleman held rather exaggerated ideas upon the subject.

The enquiry was again adjourned until to-day (Friday).

COMPANIES' MEETINGS.

NATIONAL TELEPHONE COMPANY, LIMITED.

The annual meeting was held on Wednesday at Cannon-street Hotel, Mr. J. Staats Forbes presiding.

In moving the adoption of the report, the **Chairman** pointed out that the accounts were made up to June 30 last, and therefore covered 14 months. The object of this was to make the two meetings which it had been decided to hold each year fit in with the calendar year. For the purpose of comparing the progress they had made in the 12 months ended April 30, 1894, with the previous year, an abstract of accounts had been prepared, which showed that the income accrued in respect of the business of the year was £682,950, against £583,590 in the corresponding period of the previous year, while the working expenses and other charges, excluding debenture interest, had risen from £311,644 in the 12 months ended April 30, 1893, to £344,168 in the 12 months ended April 30, 1894, leaving a balance of £338,781, against £271,945. They had, however, to pay the post office 10 per cent. on all the gross receipts arising from what was called exchange business, which for the past year represented a sum equal to 2½ per cent. on the ordinary shares, or £63,254 Deducting this amount from the £338,781 it brought the net result for the year, which they could appropriate to their own purposes, to £275,526, as compared with £217,725 in the preceding 12 months. Out of the available balance, after paying the final dividends recommended in the report, the Board proposed to transfer £63,429 to the reserve fund, so as to bring it up to £225,000, and to carry forward £1,765 Referring to the capital account he remarked that every additional subscriber necessitated an outlay of about £42, and consequently their capital expenditure, owing to the nature of their business, must continue to grow. It was satisfactory to find, however, that the capital outlay during the past 14 months had proved to be remunerative. After referring to the arrangements which had been carried out for the redemption of the £1,000,000 of 4½ per cent. debenture stock of the Company by its conversion into 3½ per cent. debenture stock, he explained the negotiations with the Post Office in relation to the acquisition of the trunk lines of the Company, and added that as all difficulties in the matter had now been practically overcome, the agreement would shortly be submitted for confirmation to the House of Commons, and he did not anticipate any serious objection being raised to it. In conclusion, he moved the adoption of the report.

Lord Balfour of Burleigh, who seconded the resolution,

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referred to the complexity and difficulties of the problems to be faced in giving an efficient service to London.

Mr. Galbraith asked what the chairman had to say in reply to the letter written by the Postmaster-General to Mr. Henniker Heaton, M.P., dated the 6th inst., in which Mr. Arnold Morley said: "On the termination of the license in December, 1911, the right of the National Telephone Company to carry on telephone exchange business will cease. All they will have to sell will be their plant, and even this the Government will be under no obligation to buy."

The **Chairman** said that literally the statements contained in the letter were true, but there were some truths which were a good deal qualified by considerations and circumstances. "All they will have to sell will be their plant," was not true in fact. Mr. Arnold Morley when he wrote the letter no doubt believed it was, but he had not considered the fact that a large portion of their business consisted of private wire business. This was a growing quantity, and if they knew their business and played their game properly it would be a hard nut for the Post Office of the day to crack. At the expiration of their lease this business might, perhaps, be worth £200,000 a year, and that would be something to sell. But long before that the Government would have to make up their mind whether they would take over the exchange business or not. Would they, in that case, six or ten years before the moment arrived, embark upon the enormous expenditure necessary to erect the requisite machinery and plant to supersede that already in existence in order to knock down the value of the Company's business? The idea was so reckless that no one could imagine it being entertained by any responsible person. In these circumstances he though the proprietors would do well to discount the words of Mr. Arnold Morley's letter.

After further discussion the resolution was put to the meeting and adopted.

ELMORE'S FRENCH COPPER COMPANY.

A general meeting of this Company was held last week at Winchester House, under the presidency of Mr. J. H. Duncan (the liquidator).

The **Chairman** said the specific object of the meeting was to appoint a board for the resuscitated company; but the shareholders would probably like to hear a few words as to what had been done in reference to the Company. Meetings were held in December, at which a scheme of distribution was approved, but the long vacation ensued, and the order of the court was not drawn up until February 13. The French Company had now got into thorough working order, and by the beginning of next month would be on even an extended scale of working, having laid down considerably increased plant of an important nature. The first six months of the year had been seriously affected by competition, one large company having put down its price to so low a point that this Company did not care to follow. He thought, however, that things in that respect had now come to a head, and that during the remainder of the year their affairs would be carried on smoothly, and at a profit.

Messrs. Duncan, Strettell, and Shurmer were then appointed the Directors, but it was decided to call a further meeting for the purpose of altering the nature of the office to that of trusteeship, and making them trustees.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY.

Directors: James Staats Forbes, Esq. (chairman), Major Samuel Flood Page (deputy-chairman), the Earl of Lichfield, Shelford Bidwell, Esq., F.R.S., Ernest Villiers, Esq.

Eleventh annual report, presented to the shareholders at the annual meeting, held at the Cannon-street Hotel, on the 26th inst.

In accordance with the agreement entered into with the Swan United Electric Light Company, Limited, and unanimously approved by the extraordinary meetings recently held in conformity with the articles of association, the foreign business and assets of the Swan United Company have been taken over as from October 1, 1893, and the accounts now presented include such business and assets in addition to the British business of the Edison and Swan Company itself. After providing for the interest accrued upon the £100,000 debenture stock, there remains a balance of £31,025. 3s. 3d. available for distribution on the share capital. The Board propose out of this balance to pay a dividend on the A shares at the rate of 6 per cent. per annum. An interim dividend at the rate of 5 per cent. per annum having already been distributed in respect of the business of the first half-year ending December, 1893, a further payment. equal to 7 per cent. per annum, in respect of the second half of the financial year will be paid, the balance being carried to the reserve fund. The business of the Company, thus united, has resulted in a credit balance of £34,400. 3s. 3d.; of this £8,836. 19s. was distributed on March 20 last, as an interim payment on the A shares. The Directors recommend a further distribution of £12,371. 14s. 7d. on the A shares, to be distributed in accordance with clause 87 of the articles of association. This, with £3,375 interest on debenture stock, will absorb £24,583. 13s. 7d., leaving £9,816. 9s. 8d., which the Directors have carried to the reserve fund in accordance with clause 89 of the articles of association. The Directors consider the result as satisfactory, and also that the volume of business has increased during the year, in the face of active opposition in the lamp business since the expiration of the Key patent in November last. The diminution of the money value of the sales is entirely due to the serious reduction in the price of the lamp. Mr. J. S. Forbes retires by rotation from the Board, and offers himself for re-election. Messrs. Welton, Jones, and Co., the auditors, offer themselves for re-election.

PROFIT AND LOSS ACCOUNT YEAR ENDED JUNE 30, 1894.

Dr.	£	s.	d.
Stock on hand, July 1, 1893	63,349	10	10
Wages, purchases, etc.	102,599	17	8
Salaries, directors' remuneration, rent, office expenses, insurance, income tax, general, and law charges	11,651	11	5
Depreciation on plant, etc.	9,431	13	5
Balance	34,400	3	3
	£221,432	16	7
Cr.	£	s.	d.
Sale of lamps, fittings, royalty on holders, etc.	131,250	18	4
Interest, etc.	2,413	11	2
Stock on June 30, 1894	87.768	7	1
	£221,432	16	7

Dr. BALANCE-SHEET, JUNE 30, 1894.	£	s.	d.
Share capital—5,000 A shares of £5 each, fully paid, allotted to the Edison Electric Light Company, Limited	25,000	0	0
12,139 A shares of £5 each, fully paid, allotted to the Swan United Electric Light Company, Limited, ranking up to 5 per cent. for dividend on the amount credited as paid up, and afterwards equally, per share, with A shares partly paid	60,695	0	0
89,261 A shares, £5 each, £3 paid	267,783	0	0
	353,478	0	0
23,564 B shares, £5 each, fully paid	117,820	0	0
4½ per cent. debenture stock	100,000	0	0
Sundry credit balances	26 269	15	4
Reserve fund	72,760	13	2
Profit and loss as per appropriation account, £34,400. 3s. 3d.; less interim dividend, paid on March 20, 1894, £8,836. 19s.	25,563	4	3
	£695,891	12	9
Cr.	£	s.	d.
Cost of establishing the business, goodwill, remaining patents, etc., as per last balance-sheet	242,244	3	2
Further expenditure therefrom	19,711	12	11
	261,955	16	1
Amount of B shares of this Company, issued as per contra	117,820	0	0
	379,775	16	1
Shares in La Compagnie Générale des Lampes Incandescentes	30,489	8	3
Manchester Edison Swan Company, Limited, £100,000 B shares at nominal cost	12,000	0	0
Freehold property	40,912	9	9
Plant and stock	127,382	12	5
Debtors	40,970	17	9
Investment National Telephone Company, Limited, 5 per cent. non-cumulative third preference shares at cost	25,000	0	0
Cash at bankers and in hand	39,360	8	6
	£695,891	12	9

STATEMENT SHOWING THE PROPOSED APPROPRIATION OF PROFITS.

Dr.	£	s.	d.
Payment due on 4½ per cent. debenture stock for the nine months ended June 30, 1894	3,375	0	0
Payment of an interim dividend as follows: 5 per cent. per annum on the "A" shares for the half-year ended December 31, 1893	8,836	19	0
7 per cent. per annum for the half-year ended June 30, 1894	12,371	14	7
Reserve fund	9,816	9	8
	£34,400	3	3
Cr.	£	s.	d.
Balance of profit for current year to June 30, 1894	34,400	3	3
	£34,400	3	3

Mr. John Staats Forbes, who occupied the chair, stated that the meeting was rather an interesting one, as marking a new departure, as it was from October 1 last that the united business came into operation. The report showed that the companies had now been fused completely, and the balance sheet showed the first results of the united concerns. The Company were also now in open competition, owing to the lapse of the patent, with many keen rivals, and it was prudent for them to follow the example of ordinary traders and keep a good deal of information to themselves. It was not expedient to state where their business was, or how the profits were made. The accounts revealed something, but only the general results. The present position of affairs had been anticipated at the general meeting last year, when the speaker had warned them what would be the result of the expiry of the patent. The cost of the patent had largely come back in the shape of dividends. There was a great difference in the prices of lamps comparing 2s. 9d. and 1s.,

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and at the same time the cost of construction and management did not diminish. They kept a large stock, and that was a protection to the Company, for there were so many gradations of lamps that a complete stock of all kinds was necessary to secure customers. They had had to lay themselves out for this, and consequently had a great advantage over small manufacturers. In fact, the small manufacturer had to lock up so much capital in stock that he could hardly live on the manufacture. The value of their stock on June 30 was £87,768, as compared with £63,349 the previous year, an increase which was partly due to what they had taken over from the other company. Mr. Forbes then ran over the various items in the accounts printed above, and stated that during a portion of the year the Company had been still protected, the amount of the benefit being between £16,000 and £17,000. They were not afraid of competition, notwithstanding the eagerness with which lamps were pressed on the market at the expiry of the patent, and even in anticipation thereof. They had sold about the same number as before, though of course there was a marked reduction in the profits, but they had a character as well as a lamp. The valuation of the stock had been reduced, and stood well within its value, being taken as the cost of production less a discount. Their cost of producing was such that they did not fear competitors and the quality was maintained. What they had to lose by the reduction in price they hoped to make up by future increased sale. They had a good sound commercial business which had a good future before it. It might be prudent further on to apply some of the profits to redemption of capital, but that was not a pressing matter. With respect to their holding in La Compagnie Générale des Lampes Incandescentes they could cease to be partners next year, and it might be better to be free to sell all over Europe than being tied down by the agreement with the foreign company. Mr. Forbes then moved the adoption of the report.

Major S. Flood-Page seconded the motion, which was agreed to.

On the motion of **Mr. Forbes**, seconded by **Major Flood-Page**, it was agreed to declare a dividend on the A shares of the Company, of 2s. 1¾d. per share on the 89,261 ordinary shares, £3 paid; of 3s. 6⅝d. per share on the 5,000 £5 fully paid shares allotted to the Edison Electric Light Company, Limited; and of 3s. 1¾d. per share on the 12,139 £5 fully-paid shares allotted to the Swan United Electric Light Company, Limited; being, together with the interim dividend paid on March 20, 1894, 6 per cent. in respect of the year ended June 30, 1894.

Mr. Forbes stated that steps would be taken to get a quotation as soon as the old company had been wound up and an apportionment of the shares made.

On the motion of **Major Flood Page**, seconded by the **Earl of Lichfield**, Mr. Forbes was re-elected a director. Messrs. Welton, Jones, and Co., were re elected auditors.

DIRECT UNITED STATES CABLE COMPANY, LIMITED.

The thirty-fourth ordinary general meeting was held on Tuesday at Winchester House, Sir John Pender, M.P., presiding.

The **Chairman**, in moving the adoption of the report, said the revenue for the half-year ended June 30 last, after deducting outpayments, amounted in round figures to £34,843, and the working expenses required £18,750, leaving £16,093 as the net profit, making, with the £3,080 brought forward from the previous half-year, a total of £19,173. A final dividend of 2s. per share was proposed, making, with the three interim dividends paid, a total distribution of 2⅝ per cent. for the year, or £31,872. 15s. After transferring £6,000 to the reserve fund account, which now stood at £281,551. 3s. 7d., the balance of £1,031. 17s. 2d. was proposed to be carried forward. The depression prevailing six months ago still existed, but past experience told them that after a storm came a calm, and with a calm fine weather and brighter times. He had no doubt that would prove to be their experience in the Atlantic system.

Mr. E. M. Underdown, Q.C., seconded the resolution, which was adopted.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY.

The half-yearly meeting of this Company was held on Tuesday at the offices in Old Broad-street. **Admiral Sir George Richards**, who presided, said there was really no business to transact. A dividend of 10 per cent. had been declared for the half-year, or 12s. per share. The Company had done a good deal of work during the half-year, and had every reason to hope that the Directors would be able to give a good report at the end of the year.

COMPANIES' REPORTS.

CITY AND SOUTH LONDON RAILWAY COMPANY.

Directors: Charles Grey Mott, Esq (chairman), Harrow Weald, Middlesex; Charles Seymour Grenfell, Esq., Elibank, Taplow; Sampson Hanbury, Esq., Wyvenhoe Park, near Colchester; S. Barclay Heward, Esq., 96, Ashley-gardens, Westminster; Edwin Tate, Esq., 21, Mincing-lane, London, E.C.

Report of the directors, with abstract of accounts for the half-year ending June 30, 1894, to be submitted to the half-yearly ordinary general meeting of the Company, to be held at Winchester House, Old Broad-street, E.C., on Wednesday, August 1, 1894, at 3 p.m.

The receipts from all sources, for the past half-year have amounted to £24,294. 17s. 6d., and the cost of working has been £14,990. 3s. 2d., leaving a profit of £9,304. 14s. 4d. Inclusive of the balance brought forward from December 31 last, the net revenue account shows an aggregate total of £10,368. 8s. 2d. After making provision for the debenture and debenture stock interest, a balance remains available for dividend of £6,295. 17s. 10d. Out of this sum your directors recommend that the full dividend of 5 per cent. per annum be paid on the preference shares, and that a dividend at the rate of 1 per cent. per annum be paid upon the consolidated ordinary stock, leaving a balance of £1,335. 17s. 10d. to be carried forward to the next account. The following table shows the number of passengers, exclusive of season-ticket holders, carried since the opening of the railway in each half-year:

Half-year ended	Number of passengers (exclusive of season ticket holders.)	Receipts (including season tickets).
Dec. 31, 1890 (11 days)	165,000	£1,568 3 9
June 30, 1891	2,412,343	19,403 6 9
Dec. 31, 1891	2,749,055	19,798 16 6
June 30, 1892	2,813,162	20,931 4 2
Dec. 31, 1892	3,117,602	22,002 17 5
June 30, 1893	3,146,656	22,458 6 9
Dec. 31, 1893	3,093,351	22,067 14 10
June 30, 1894	3,383,154	23,564 10 6
Total since the opening of the line	20,880,323	£151,795 0 8

Your Directors have great satisfaction in stating that the increased traffic has been carried punctually, and free from accident of any kind. The closing of the Oval for football militated against the traffic for the first three months of the half-year, but subsequently there has been a satisfactory increase. The actual cost of working the line for the past half-year has been somewhat less than for the corresponding period last year, but your Directors regret that the local rates again show a marked increase. The locomotives, rolling-stock, generating, and other plant have been maintained in thorough working order and repair, as certified by the engineer. The alterations at the City terminus are complete, and the additional accommodation thus obtained is a great convenience, especially on occasions when the traffic is heavy. The parcels office and left luggage room are in operation, and promise to be a remunerative source of revenue. During the half year £8,200 of the terminable mortgage debenture bonds have been paid off and reissued as debenture stock, or preference shares, at a premium. Your Directors have instructed their engineer to make experiments with the view of substituting motors on the train itself in place of the present separate locomotive, with the object of adding an additional coach to each train. Should this change prove practicable, the number of passengers capable of being carried will be considerably augmented.

Dr. Revenue Account.	£	s.	d.
Maintenance of way, works, and stations	563	2	11
Locomotive and generating power	5,893	14	1
Carriage repairs	391	8	2
Traffic expenses	5,755	1	2
General charges	1,691	11	5
Passenger duty	5	8	7
Law charges	12	10	0
Rates and taxes	677	6	10
	£14,990	3	2
Balance carried to net revenue account	9,304	14	4
	£24,294	17	6
Cr.	£	s.	d.
By Passengers (3,383,154)	22,824	14	0
Season tickets (348)	739	16	6
	£23,564	10	6
Parcels, etc.	34	12	6
	£23,599	3	0
Transfer fees	18	5	0
Rent of property net	578	15	6
Sundry receipts	98	14	0
	£24,294	17	6

Dr. General Balance-Sheet.	£	s.	d.
Balance from net revenue account	6,295	17	10
Unpaid interest and dividends	135	6	7
Interest payable or accruing and provided for	1,380	14	0
Construction reserve	2,005	8	11
Sundry outstanding accounts	5,752	15	8
Loan account	1,000	0	0
	£16,570	3	0
Cr.	£	s.	d.
Cash at bankers, current accounts, £1,441. 17s. 5d.; and cash on deposit at interest, £5,000	6,441	17	5
Cash in hand	457	17	3
	£6,899	14	8
General stores—stock of materials on hand	3,448	13	6
Sundry outstanding accounts	287	0	7
Balance from capital account	5,934	14	3
	£16,570	3	0

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CONTRACTS FOR ELECTRICAL PLANT.

CONTRACTS OPEN.

York Town (Surrey).—The Lighting Inspectors desire by the 31st inst. tenders for lighting the street lamps for ensuing season—Specifications may be obtained from Mr. George W. Mason, secretary, York Town.

Nelson.—The tenders invited for the wiring and fittings in connection with the new technical school are to be sent in by the 30th inst. Plans and particulars may be obtained on payment of £1. 1s. by applying to Messrs. Holtom and Fox, architects, Dewsbury.

London.—The tenders required by the London County Council for boilers and fittings, steam and exhaust piping, surface condensers, and air-pumps for the station to be erected for the electric lighting of the embankment are to be addressed to the Clerk of the County Council by the 31st inst.

Hull.—The Corporation invite tenders for two steel Cornish boilers, 10ft. 6in. by 5ft. 3in., delivered on their seats in the basement of the Hull Town Hall. Forms of tender and other particulars may be obtained at the borough engineer's office. Tenders are to addressed to the deputy chairman of the Property Committee, and delivered at the town clerk's office not later than August 1.

Great Yarmouth.—Tenders are invited for repairing, painting, distempering, and other work at the School of Art, and for installing the electric light therein. Plans and specifications may be obtained at the office of Mr. J. W. Cockrill, borough surveyor, Town Hall, Great Yarmouth. Tenders, to be separate for the repairing works and electric light installation, are to be delivered at the office of Mr. T. M. Baker, town clerk, by 31st inst.

London.—The London County Council invite by Tuesday next tenders for the supply of engines, dynamos, motors, switchboards, and other electrical appliances required for the electric light installation for the Victoria-embankment and Waterloo and Westminster Bridges. The drawings may be inspected, and specification, bills of quantities, form of tender, and other particulars obtained at the Engineer's Department, County Hall, Spring-gardens, S.W., on payment of £2. Tenders are to be addressed to the Clerk of the London County Council, Spring-gardens, S.W.

Edinburgh.—The Corporation of Edinburgh invite tenders for the following work: Contract No. 13, supply and erection of Willans engines, alternators, etc.; No. 14, switchboard, instruments, and connectors; No. 15 arc lamps; No. 16, Ferranti rectifiers for arc lighting; No. 17, insulated concentric cable. Copies of the specifications can be obtained on application from the resident electrical engineer, City Chambers, Edinburgh. All information will be supplied by Prof. A. B. W. Kennedy, at 14, Old Queen-street, Westminster, S.W. Tenders must be received in Edinburgh not later than 30th inst. for contract No. 15 (arc lamps), or on August 6 for contracts Nos. 13, 14, 16, and 17.

RESULTS OF TENDERS.

Carshalton.—The tender of the Croydon Commercial Gas Company has been accepted, at £3. 2s. 1d. per lamp, for the lighting of this district with gas for 12 months.

Rochdale.—The tender of the Oldham Boiler Works Company, Limited, of Oldham, has been accepted for the supply of two steel Lancashire boilers for the Health Committee of the Corporation.

Maidstone.—Messrs. Laing, Wharton, and Down's tender has been accepted by the Town Council for the installation of the electric light at the technical schools. The amount of the tender is £1,143.

Ayr.—The Electric Lighting Committee of the burgh of Ayr have decided to place the contracts for the plant required for their new electricity works with the undermentioned firms:

Penman and Co., boiler house plant	£1,541
Siemens Bros and Co., Limited, engine-house plant	5,940
J. Fowler and Co., Limited, Leeds, switchboard	437
Callenders Bitumen Company, Limited, cables and culverts	1,842
Swinburne and Co., Limited, transformers and boxes	420
J. Fowler and Co., Limited, arc lamps and posts	476
S. Z. de Ferranti, Limited, meters	590
Carrick and Ritchie, overhead crane	192

BUSINESS NOTES.

Aberystwith.—The terrace at Aberystwith will soon be lighted by electric light.

Edison and Swan Company's Dividend.—The dividend warrants will be posted on August 3.

Exeter.—The new wing of the Museum, now in course of construction, is to be lighted electrically.

Western and Brazilian Telegraph Company.—The receipts for the week ended July 20 were £2,238.

Eccles.—The Electric Lighting Committee of the Town Council are still seeking information on electric lighting matters.

Forfar.—The Town Council have resolved to oppose the application of the Northern Electric Supply Company for electric lighting powers.

Broadstairs (Kent).—The Broadstairs and St. Peter's Local Board intend to oppose the application of the Brush Company for a provisional order.

Coventry.—Out of a loan for £40,000 which the Town Council are advertising for, £20,000 is to be devoted to electric lighting.

Fleetwood.—The Tradesmen's Association have passed a resolution pressing the Commissioners to carry out their electric lighting scheme promptly.

Lavatory Lighting.—The underground lavatory now being erected in Southwark-street for the St. Saviour's Board of Works is to be lighted by electricity.

Coatbridge.—The Town Council have empowered the Lighting Committee to spend £58 by way of experiment in lighting the streets with electric arc lamps.

St. James's and Pall Mall Company.—The share transfer-books of the St. James's and Pall Mall Electric Light Company, Limited, are closed to August 8.

Harrow.—The clerk has reported to the Local Board that a Bill confirming provisional orders regarding electric lighting has passed both Houses of Parliament.

Ipswich.—The lunatic asylum of the Suffolk Joint Committee is to be lighted electrically. The expenditure on the installation is estimated at between £200 and £300.

Clerkenwell.—The Vestry have received a letter from the County of London Electric Lighting Company giving notice that they are about to lay conduits for electric conductors in the parish.

Barnet.—Mr. Potter, of Mr. Joel's firm has written to the Local Board, stating that he hoped shortly to sell the lamp columns in the Board's yard, as he had received a business enquiry about them.

Metropolitan Electric Supply Company, Limited.—Letters of regret for the issue of £150,000 4½ per cent. first mortgage debenture stock have been posted, and allotment letters were posted on Wednesday.

Hackney.—The Vestry of West Hackney have resolved to apply for the necessary faculty for modernising the interior of the church, and also for lighting it by electricity. The proposed work is estimated to cost £2,000.

Fareham.—A noisy public meeting has been held at Fareham, at which a resolution has been passed deprecating the conduct of the Local Board in determing the purchase of the works without consulting competent authorities.

Notice of Removal.—The Edison and Swan United Electric Light Company announce that on and after August 27 the offices will be removed to the new premises, Ediswan-buildings, 36 and 37, Queen-street, Cannon-street, E.C.

New Offices.—The Telegraph Manufacturing Company, Limited, of Helsby, near Warrington, and of 11, Queen Victoria-street, E.C., have opened new offices at 2, Parsonage, Manchester, where stocks are kept of their manufactures.

Westminster Corporation Dividend.—The Board of the Westminster Electric Supply Corporation have declared an interim dividend at the rate of 4 per cent. per annum for the half-year ending June 30 last, payable on September 1 next.

Anglo-American Telegraph Company.—The Directors recommend a quarterly interim dividend of 10s. per cent. on the ordinary stock, carrying forward £1,173. They state that the new cable between Ireland and Newfoundland is in process of being laid.

Spanish Telephone Company, Limited.—This Company has been registered with a capital of £16 000 in £10 shares to acquire from A. Ruffer and Sons all the share capital now issued of and in the Compañia Peninsular di Telefonos for the sum of £32,000.

Dublin.—It appears that on certain property called St. Sepulchre's Estate, and including lands in Earlsfort-terrace and in the vicinity of Adelaide-road, it is proposed to erect houses, with suitable offices and outbuildings, to be lighted by electricity.

"Victor" Metallic Joints.—We are informed that the Admiralty have for the tenth time given the contract for the supply of "Victor" metallic joints, and other asbestos goods for use in the navy, to the United Asbestos Company, Limited, of Dock House, Billiter-street, E.C.

Bedford.—The Bedford Electric Light Company, Limited, have given notice to the Urban Sanitary Authority of their intention to apply for a provisional order to supply electric energy in the borough. The Mayor and others are to confer with Mr. Jessop, the secretary of the company, on the subject.

Shoreditch.—The Electric Lighting Committee of the Vestry have recommended the appointment of Messrs. Kincaid, Waller, and Manville as consulting engineers in connection with the electric lighting scheme, at a commission of 3 per cent. on the amount of the tender accepted on the original specification.

City and South London Railway.—The receipts of the company for the week ended July 22 were £839, against £764 for the corresponding week of 1893, or an increase of £75. The total receipts for the current period of the present half-year amount to £2,600, as against £2,609 in the corresponding period of 1893.

Bournemouth.—The Town Council, in connection with the recent application of the Council asking the electric supply company for estimate of the cost of lighting the winter garden for a lengthened period, have received a letter from the company asking for further particulars, and these the surveyor has been instructed to forward.

E. and E. Taylor, Limited.—This Company has been registered with a capital of £5,000 in £10 shares to acquire and carry on the business of hydraulic and electrical engineers, general iron-founders, and lift and revolving shutter makers, hitherto carried on by E. and E. Taylor at Moorgate-street, E.C., and Brady-street Ironworks, E.

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Science Master.—A master is required for next term at Queen Mary's High School, Walsall, able to teach all the usual branches of science for the South Kensington and University local examinations. The salary offered is £120, non-resident. Applications, with copies of testimonials, must be sent to the headmaster not later than August 1.

Devonport.—The town clerk read letters to the Town Council at a recent meeting from two electric lighting companies, in which they intimated their intention of applying to Parliament for a provisional order empowering them to introduce the electric light into Devonport. The letters were referred to the Highways and Streets Committee.

Stafford.—It is stated that as a result of recent experiments in the electric decomposition of brine for the production of bleaching powder and other substances, a company is being formed to establish the industry on a commercial basis The promoters are said to be in treaty for the purchase of land adjoining the Stafford Salt Company's new works at Baswich.

J. Mills and Sons —This Company has been registered, with a capital of £25,000, to acquire and carry on the business of W. J. H Ryder, now carried on at Newcastle, Walker Gate, and elsewhere, under the style of John Mills and Sons, and to continue the trades of brass founders and finishers, coppersmiths, metallurgists, and electrical and mechanical engineers.

Tottenham.— The General Purposes Committee have recommended the Board to decline to give consent to the application of the Tottenham and Edmonton Electric Light and Power Company for a provisional order to light part of Tottenham by electricity, and have recommended that it be referred to a committee of the Board to apply for a provisional order.

Hull.—Mr. A H. Gibbings has reported to the Electric Lighting Committee of the Town Council, stating that the demand on the central station will probably be greater this year than the supply. He consequently suggests that engines and dynamos for further 600 h p. should be procured, at a cost of about £4,500. The question is to receive further consideration. There are now 176 consumers of current.

Liverpool Overhead Railway Company, Limited.—The Directors have resolved to recommend dividends at the rate of 5 per cent. per annum on preference shares and 1 per cent. per annum on the ordinary shares of this Company, less income tax, carrying forward £1,010. The traffic receipts for the week ended 22nd inst. amounted to £1,034, as compared with £740 in the corresponding week of last year.

Newmarket.—It was mentioned to the Local Board on the 16th inst. that the British Electric Light Company, who have obtained a provisional order to enable them to supply the electric light, had written to say they intended applying to the Board of Trade for leave to extend the time for making the necessary deposit until December 23. The Local Board did not deem it necessary to take any action in the matter.

Cardiff —The Free Library Committee met on Tuesday when the question of lighting the new library was considered, and it was decided that a committee should be authorised to consult Mr. Massey as an expert in this work. It was decided to ask the Lighting Committee of the Corporation to include the free library in their inspection with the object of finding the cost of lighting the building by means of electricity.

Mill-Lighting.—Messrs. Bennett and Druce, of Preston, have received instructions from Mr. Edward Barlow, of Radcliffe, for a complete installation of electric light in his mills. The dynamo will be driven off the main mill engine, and about 300 incandescent lamps will be installed. This firm are also installing a gas-engine and dynamo for 250 lights in the premises of the Preston Industrial Co-operative Society's premises.

Wray Electrical Engineering Company, Limited.—This Company has been registered, with a capital of £10,000 in £1 shares, to acquire the goodwill of the business of electrical engineers carried on at Bradford and elsewhere under the style of the Wray Electrical Engineering Company. Messrs. Joseph A. Jessop and Cecil Wray are to be managing directors for a term not exceeding two years. The registered office is at Soho Works, Thornton-road, Bradford.

Church Lighting, etc.—The contract for the electric lighting of Bexhill Church has been placed in the hands of Messrs. Drake and Gorham. The plant will comprise a Crossley "Otto" gas-engine, an Elwell-Parker dynamo, and D.P. battery. The number of lights will be about 50. The entire reconstruction, rewiring, and additions at Mr. Bruno Schroder's installation at Kensington Court has been entrusted to the firm, as well as that of Mr. Harris's house at 18, Montague-square.

Marten Hale and Co.—Mr. F. Marten Hale, whose name will be remembered as the general manager of the late Sphincter Hose and Engineering Company, has secured new patents for an improved method of armouring hoses, and has formed a company, of which he is the managing director, for the purpose of working these patents. The style of the company is F. Marten Hale and Co, Limited, and their registered offices and works are in Emerson-street, Southwark, London, S.E.

Sevenoaks.—A letter has been read at a meeting of the Local Board from the secretary of the Holloway Electricity Supply Company, Limited, giving notice of intended application for a provisional order to supply electricity in the Sevenoaks Local Board district. Having read the letter, the Clerk stated that there was no necessity for immediate action in the matter, as notice of opposition could be given any time before Christmas. It was resolved, therefore, to leave the question in abeyance.

Appointment of Receiver.—The case of the Halifax and Huddersfield Union Banking Company, Limited, against Messrs. Andrews and Preece has come before Mr. Justice Chitty on a motion by the plaintiffs, as debenture-holders of the defendant company, for the appointment of a receiver and manager of the company, which carries on business as electrical engineers at Bradford. Mr. Justice Chitty. the defendant consenting, appointed Mr. James Duff, chartered accountant, Halifax, as receiver and manager of the defendant company's business.

"Medical Battery" Company.—Application was made to Mr. Justice Williams on Wednesday to sanction an arrangement for reconstruction. A new company was to be formed to take over the assets and liabilities of the old company. Mr. Justice Vaughan Williams said he must be satisfied that the business to be carried on was a proper one. and only sanctioned the scheme subject to the memorandum of association being altered so as to provide that electrical treatment and the sale of electrical belts should be controlled by a duly qualified medical assistant.

Llandudno.—The Victoria Palace Company have received permission from the Improvement Commissioners to lay down an inch pipe for supplying gas to a gas engine required for driving a dynamo. Mr. R. Bellis, solicitor to the Llandudno Electric Supply Company, Limited, has written to the Commissioners that it was their intention to apply to the Board of Trade for a provisional order empowering them to supply Llandudno with electricity for private or public purposes. The communication was referred to the Water and Gas Committee without discussion.

Mansion Lighting —Yester House, the seat of the Marquis of Tweeddale, is being fitted throughout with the electric light, water power being used to drive the dynamo. The latter will be situated at the mains, about half a mile distant from the mansion, to which connection will be made by means of an underground cable. There will be a battery of accumulators for maintaining the lights when the dynamo is not running, and altogether some 300 incandescent lamps will be employed. The installation is being carried out by Messrs. A. A. C. Swinton and Co., of Westminster.

Electric Bells.—The Fire Brigade Committee of the London County Council reported on Tuesday that the contract for the maintenance of electric bells belonging to the Brigade will expire early next month, and that they proposed to invite alternative tenders for the maintenance for one or three years As time does not admit of tenderers making themselves acquainted with the condition of the bells and submitting tenders before the recess, the committee have accordingly authorised the chief engineer to arrange for the work to be done by workmen directly employed by the Council until the new contract is entered into.

Collier Audible Telephone Syndicate.—The petition for the compulsory winding-up of this Company was disposed of last week in the Winding-Up Court before Justice Vaughan Williams. The Company was formed for the purpose of working a certain patent, and in March, 1892, entered into agreements by which in effect it transferred its undertaking to another company called the Collier-Marr Telephone Company, subsequently going into voluntary liquidation. The present petitioners, Messrs. W. Shepherd and Sons, were creditors, and on the ground that the voluntary liquidation had been going on for over two years without a satisfactory result, asked for a compulsory order. His Lordship made the order.

Wreck-Raising Company.—The British Wreck-raising and Salvage Company, Limited, has been formed for the purpose of undertaking the salvage of all descriptions of sunken, stranded, and disabled vessels. The capital is £100,000 in 20,000 ordinary shares of £5 each. The prospectus states that the principle of raising sunken vessels by means of pontoons or camels has been shown to be the most practicable and successful that can be adopted. The Company intends to build four camels, which will be fitted with steel masts and derricks capable of lifting the heaviest weights, such as the heavy guns of men-of-war, marine boilers, engines, etc., also with arc and submarine lights for working at night.

Welded Iron and Steel Pipes.—Our attention has been directed by Mr. John Spencer, of the Globe Tube Works, Wednesbury, to his welded iron and steel socket and spigot pipes. These tubes, which are mainly employed for gas and water services, may also be used as conduits for electrical cables and wires, compressed-air and oil main pipe lines. The spigot and socket tubes, which are made from 2in. to 6in. diameter can be fixed by the workmen accustomed to the old lead and yarn joint; and as they can be made about half the weight of cast-iron pipes, and in lengths more than double those now common, the cost of freight and of jointing is thus about half that of the old pipes, and there is no loss by breakage in transit.

Waterloo and City Railway.—The report of the Directors states that the agreement between the Company and the London and South-Western Railway Company, which was sanctioned by the shareholders in February last, has received the approval of the Railway Commissioners, and the Board of Trade have given the necessary certificate for the payment of interest on capital during the construction of the railway, in accordance with the Company's Act of 1893. The contract for the construction of the railway from the Mansion House to Cross-street, Waterloo Station, has been let to responsible contractors, who commenced operations on June 18 last. The terminal stations in the City and at Waterloo will form the subject of separate contracts.

Globe Telegraph and Trust —The net revenue of the Company for the year, after deduction of expenses, amounts to £185,076 13s. 9d., and makes, with the balance of £1,304, 17s. 9d. brought

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forward, a total of £186,381. 11s. 6d. From this amount there has been distributed the sum of £125,955. 16s. 1d. in interim dividends, leaving an available balance of £60,425. 15s. 5d. The Directors recommend the payment of a final dividend for the year of 3s. per share on the preference shares, and of 3s. 9d. per share on the ordinary shares, making, with the previous distributions, a total dividend for the year of 6 per cent., less income tax, upon the preference, and 4½ per cent. net (against 4½ per cent. for the preceding year) upon the ordinary shares, and carrying forward a balance of £527. 2s. 4d.

Taunton.—The lighting of St. James's Church has just undergone an entire remodelling. The arc lamps which have been in use for the past 7½ years, are now replaced by 55 incandescent lamps, arranged in 12 clusters of four each, suspended from the crown of the arches in the nave and chancel, the remaining seven lamps being arranged as a corona between the choir and the altar and suspended from the chancel roof. The lamps are of 32 c.p. each, and the electroliers are of wrought iron specially designed to suit the architecture of the church. The whole of the arrangements have been planned and carried out by Mr. F. M. Newton, of the Newton Electrical Engineering Works, Rowbarton. The wrought-iron fittings were made by Messrs. Lea, Sons, and Co., Shrewsbury. The power is supplied from the Corporation electric light works by means of a 40 h.p. transformer, made at the Newton works.

Maidstone.—The Electric Lighting Committee of the Local Board have reported as follows: "That they have been for a long time in negotiation with the Electric Construction Company with a view of arranging a transfer of your provisional order to that company, but they have now received a communication from the company which makes it clear to your committee that it will be impossible to come to terms which would be satisfactory to your Board. Your committee therefore recommend that an advertisement be inserted in the leading electrical papers to the effect that no satisfactory arrangement having been come to for transferring the order, your authority are still open to receive and consider offers." Mr. Barker, as chairman of the committee, moved the adoption of the report, and said it was a standing disgrace to think that Maidstone stood still while every other town in England went forward. Mr. Tootell seconded the motion, which was adopted.

Bath.—At a meeting of the Surveying Committee, Alderman Sturges brought forward the recommendation of the Lighting Committee, that the Authority oppose the application by the Bath Electric Light Company to the Board of Trade for a provisional order which would enable them to extend their area of supply to the whole city, and to have entire control over the supply of electric light in the city for 21 years. He said at the end of the present term of seven years under the license the Authority might wish to become the owners of the electric light undertaking. The report was adopted unanimously The Local Government Board have sanctioned the borrowing by the Town Council of £24,650 additional capital for electric lighting. This will enable them to clear off existing liabilities and to make a few extensions. For example, the proposal to light the Cathedral and St. Mary Redcliffe by electricity will be made possible by extending the mains in those directions.

Electric Lighting at Ealing.—The buildings of the Local Board's central electric lighting station at Ealing, which are being erected to the design and under the superintendence of Messrs, Bramwell and Harris, of 5, Great George-street, Westminster, are approaching completion. The contractors for the buildings are Messrs. Wilkinson Bros. The machinery and boiler contracts are held by Messrs. Siemens Bros. and by Messrs. James Watt and Co. respectively, while the mains are being laid by the Callender Bitumen Company. All branches of the work are now so far advanced that the supply of current is expected to commence early in September, and the official opening day has been fixed for the 29th of that month. During the month of October the Local Board propose to hold an electrical exhibition in the Victoria Hall or other suitable place, so that customers may have an opportunity of seeing the uses to which electricity can be put for lighting and other purposes.

Newcastle.—A special committee of the Corporation relative to the municipal authorities undertaking the provision of electricity for the city met on Tuesday. At the last meeting of the Council the sum of £200 was voted for the purpose of employing an expert to give the Council full information as to the cost of producing electric light for the city. Several names of experts were mentioned, and as the city engineer will be in London at the latter end of this week, it was resolved that he should make further enquiries into the matter, and submit his information to a meeting of the above committee to be specially called. The meeting had under further consideration the desirability of approaching the present two electric companies in this city, with a view, if they were disposed to sell, to open negotiations, and this, it was also agreed, should be reported on at the next meeting. The new Masonic Hall to be erected at the Pilgrim-street corner of High Bridge, is to lighted with the electric light.

The New "Hercules" Belt Fastener.—Messrs. Honeywood, Austin, and Co., of 69. St. Thomas's-road, Finsbury Park, N., have sent us a sample of their new "Hercules" belt fastener. This type of fastener is intended for use on any width of band, and for double and cotton belting. It has been designed to meet the requirements for all classes of machinery, including dynamos, and is made of a pliable metal which enables it to give freely on any size pulley, and is particularly suitable for high speeds. The makers claim that these fasteners will effect a saving of expense in bands; that owing to its pliability the fastener will travel quite smoothly over any size of pulley; and that the plates, having ribs on the underside, reduce to a minimum all cutting tendencies and strain that would otherwise come on the holes. It is further claimed that the "Hercules" belt fastener is the only fastener that can be successfully used for both over and under running, and that it will ensure a perfectly steady light on dynamos.

Highland and Agricultural Society.—The annual show of this society is being held at Aberdeen this week. Messrs. Robey and Co., Lincoln, have a 6-h.p patent portable engine driving one of Sayer's patent dynamos to provide electric lighting for the stand. Mr. Alexander Guild, Aberdeen, shows specimens of his "Geob" gas-engines, and a petroleum-engine. Messrs. Crossley Bros. exhibit a large 7-h.p. nominal portable oil-engine, a four-horse oil-engine, and a couple of their Otto gas-engines. Tangyes, Limited, Birmingham, exhibit their Otto gas-engines and a petroleum-engine, which are adapted for driving dynamos. Bickerton's patent "National" gas-engines are shown at work by the National Gas-Engine Company, Ashton-under-Lyne; and the Campbell Gas-Engine Company, Halifax, have in operation several of their oil and gas engines. "Trusty" oil-engines are shown by Messrs. Weyman and Hitchcock, Guildford. Messrs. Robert Stephenson and Co., Newcastle-on-Tyne, exhibit a "Rocket" oil-engine.

Recovery of Gold.—Mr. Justice Romer is hearing in the Chancery Division the action brought by the Cassell Gold Extracting Company, Limited, against the Cyanide Gold Recovery Syndicate, Limited. The plaintiffs are the registered owners of letters patent, granted in 1887 to Messrs. McArthur and Forrest for "improvements in obtaining gold and silver ores and other compounds." This patented process is said to have been largely used. The defendants' process, which is alleged to have infringed the plaintiffs' patent, consists in treating the powdered ore or compound with a solution containing cyanogen, or a cyanide, or a cyanogen-yielding substance, and that is said to be substantially identical with the process covered by the plaintiffs' specification. The defendants deny the allegation of infringement, claiming that under their system the recovery of gold is effected not by the dissolving action of cyanide of potassium, but by something which has not before been employed—namely, electrical action. It is further contended that having regard to the state of public knowledge at the date of the plaintiffs' specification, the patent is bad for want of novelty.

Chili Telephone Company, Limited.—The report for the year ending March 31 states that the small addition to the tariff made towards the close of 1893 caused some subscribers to withdraw, but others have taken their places, so that the aggregate in all centres was 3,987 at the end of the period under review, or only 37 less than at the beginning of the 12 months. By this increase of rates the revenue has been augmented, notwithstanding the smaller number of subscribers, by 55,527dol., the total income being 504,188dol. against 448,661dol. for the previous year. The further depreciation in the sterling value of the currency in which the Company is paid—from 18d. per dollar to about 14d.—has, however, destroyed all benefit from this increase of revenue. It has also increased the outgoings—many more dollars having to be given for the same services—hence the net income was 179,652dol, against 184,673dol., a decrease of 5,021dol. In sterling the diminution of net income is more marked, being at 13 96d. per dollar £10,448, against at 18d. £13,850, or £3 402 down. From this sum of £10 448 are deducted the interest on debentures and other expenditure in London, amounting to £4,943, which varies little from the aggregate of similar items in the previous year. The loss by the reduction of exchange in the sterling value of the liquid assets and liabilities in Chili amounted to £1,979, being less by £1,616. The net profit of the whole business was £3,528, as compared with £5,393, a diminution of £1,865. This net profit of £3,528 has been added to the reserve fund. An ordinary general meeting of the Company will be held at Winchester House on Tuesday next, at 11.30 in the forenoon, for the purpose of receiving the report of the directors and statement of accounts.

Arundel.—The Duke of Norfolk is rebuilding Arundel Castle, which is to be lighted electrically. The supply station has been erected in the New-road, at the top of Poor House-hill, near the entrance to the castle gardens. The building has a total frontage of 92ft., with a depth of 48ft., and is 36ft. high. It comprises boiler-house, engine room, accumulator-room, and fitting shop. In the boiler-house, which is 45ft. by 31ft., are three Galloway steel boilers, 18ft. long by 6ft. 6in. diameter. The engine-house is 36ft. by 24ft. There are three 90-h.p. vertical inverted compound steam-engines, and to each is coupled direct a specially compounded self-regulating six-pole dynamo, capable of working up to 400 amperes. The accumulator-room is 31ft. long and 18ft. wide, and contains two sets of storage batteries, each consisting of 62 cells, and together capable of feeding 260 lamps of 16 c.p. for 10 hours. Low-tension current is employed. The current is led to the castle by two pairs of cables. When the lighting of the castle by electricity was first considered, each contractor was asked to propose his own plan for the most effective internal service. The contractors were called upon to present their own schemes for internal lighting, and to stand or fall by them. When all the plans had been received they were entrusted to Mr. W. H. Preece, and his award was accepted. The building and the general arrangements of the plant have been carried out according to the designs of Mr. A. F. Phillips, C.E., of 31, Great George-street, Westminster, Mr. Gisbert Kapp, of 31, Parliament-street, acting as consulting electrical engineer. Mr. A. Bard, C.E., has acted as the resident engineer. The contractors for the build-

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ings were Messrs. Read, Blight, and Co. The whole machinery and electrical plant has been supplied and fixed by the Brush Electrical Engineering Company, Limited, London, under the superintendence of their engineer, Mr. W. Geipel, who has also laid the cables and carried out the wiring of the castle. Mr. J. E Sayers has been in charge of the electrical section, and Mr. J. W Donnet in charge of the mechanical department at the generating station.

PROVISIONAL PATENTS, 1894.

JULY 16.

13652. **Improvements in electric switches.** Charles Esson, Montpelier House, Blackheath, London.

13700. **Improvements in telephone switchboard mechanism.** John Edward Kingsbury, 24, Southampton-buildings, Chancery-lane, London. (The Western Electric Company, United States.)

13706. **An improved shade for electric lighting and like purposes.** Albert Henry Entwistle, Henry Joseph Stephens, and Arthur Dubber, 97, Newgate-street, London.

JULY 17.

13728. **A combined pole and lamp-post for supporting overhead wires or cables for electric tramways or railways, telegraph, telephone, and other wires or cables.** Alfred Dickinson, Birmingham-road, Darlaston.

13747. **An improved electrical coupling or terminal.** William Henry Stevenson, 61, Vicarage-road, Willesden, London.

13749. **Improvements in electric signalling apparatus.** Charles Arthur Allison 52, Chancery-lane, London. (The Standard Electric Signal Company, United States) (Complete specification.)

13750. **Improvements in electric signalling apparatus.** Charles Arthur Allison, 52, Chancery-lane, London. (The Standard Electric Signal Company, United States.) (Complete specification.)

13751. **Improvements in electric signalling apparatus.** Charles Arthur Allison, 52, Chancery-lane, London. (The Standard Electric Signal Company, United States) (Complete specification.)

13756. **Improvements in or connected with electrolytic cells and diaphragms therefor.** Charles Nelson Waite, 47, Lincoln's-inn-fields, London. (Complete specification.)

13762. **Improvements in and relating to electric railways.** Charles Daniel Jenney, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

13765. **Improvements in and relating to electric railways.** Edward Hibberd Johnson and Robert Lundell, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

13771. **Improvements in and relating to electric railways.** Eduard Lachmann, 45, Southampton-buildings, Chancery-lane, London.

13791. **Improvements in or appertaining to incandescent electric lamps.** William Lloyd Wynn Williams and George Herbert Morgan, 6, Lord-street, Liverpool.

13794. **Improvements in electric conduits and conductors therefor.** John Washington Eisenhuth, Rudolph Herman, and Emile Marie Herman, 6, Lord-street, Liverpool. (Complete specification.)

JULY 18.

13836. **Improvements in apparatus employed in the evolution and collection of hydrogen and oxygen gases by electrolysis.** Charles John Yarnold, 64, Upper Tulse-hill, Brixton, London.

13871. **Improvements in or relating to electrical transformers or converters.** James Anderson Kelman, sen, Pinners Hall, Great Winchester-street, London. (James Anderson Kelman, jun., United States.)

13872. **Improvements in and relating to electric railways.** Gustave Vermeire, 45, Southampton-buildings, Chancery-lane, London.

JULY 19.

13900. **An improvements in multiplex telephony.** Abner Mulholland Rosebrugh, 107, Mutual-street, Toronto, Canada. (Date applied for under Patents, etc., Act, 1883, sec. 103, January 6, 1894, being date of application in United States.)

13903. **Improvements in magnetic lock or apparatus for opening the locks of safety lamps by magnets only.** Charles Ellah Stallybrass, 4, Dock-chambers, Cardiff. (Complete specification.)

JULY 20.

13983. **Improvements in apparatus for driving air propelling and exhausting ventilators electrically.** Joseph Wad dington, 8, Quality-court, Chancery-lane, London.

13993. **New or improved electric light regulator.** Augustus Hamilton Johnston, 33, Chancery-lane, London

13995. **Improvements in or relating to electric railways.** William Phillips Thompson, 6, Lord-street, Liverpool. (James Francis McLaughlin, United States.) (Complete specification.)

JULY 21.

14029. **Improvements in prepayment mechanism applicable to gas, electricity, and like meters.** Stephen Simpson, Albert Works, Mansfield, Notts.

14065. **Improved electric fuse head for use in blasting.** William Albert Malson, Tom Malson, Sidney Richard Malson, and Emmanuel Smith, 54, Fleet-street, London.

14069. **Improvements in electrical governors for water-wheels.** Carl Schurz English, 18, Buckingham-street, Strand, London. (Date applied for under Patents, etc, Act, 1883, sec. 103, December 23, 1893, being date of application in United States.) (Complete specification.)

14080. **Improvements in incandescent electric lamps.** George Frederick Redfern, 4, South-street, Finsbury, London. (Carl Schwabe, Germany.)

SPECIFICATIONS PUBLISHED.

1893.

6677. **Railway electrical signalling devices.** Grimes.

13779. **Telephone circuits.** Möller.

14000. **Electricity meters.** De Ferranti.

14003. **Electric circuit closing devices.** Goldston.

14481. **Ammeters and voltmeters.** Moy.

14997. **Electric contacts for telegraphic vibrators.** Edwards. (La Cour.)

15074 **Electric coupling.** Cooper and others.

15355. **Electric battery.** Pyne and Thompson.

1894.

5253. **Producing and utilising electricity.** Wise. (Lewis.)

5254. **Producing and utilising electricity.** Wise. (Lewis.)

6482. **Telephonic systems.** Moreau and Munier.

8599 **Electric arc lamps.** McKeown.

9362. **Electric alarm clocks.** Bromhead. (Beuner.)

9968 **Arresting motion of electrically-propelled mechanisms.** Sperry.

10045. **Electric motors, etc.** Ormsby and Banister.

10169. **Secondary battery plates.** Blot.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	5	5¼-5½
Bournemouth Electric Company	—	—
Brighton and Hove Company Original	100	210-215
—— "A" Ordinary	—	162-166
Brush Company, Ordinary	3	2¾-3
—— Nom. Cum, 6 per cent. Pref.	2	2¼-2½
—— 4½ Debenture Stock	100	110-113
Charing Cross and Strand	5	4¼-5¼
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	12½-13
—— 6 per cent. Cumulative Pref.	10	14-14½
—— 5 per cent. Debenture Stock	115	128-130
City and South London Railway, Consolidated Ordinary	100	36-38
—— Debenture Stock	100	119-121
—— 5 per cent. Pref. Shares	10	12¾-13¼
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2¾-3
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	95-100
Electric Construction, Limited	2	¼-¾
—— 6 per cent. Debentures	—	87-92
—— 7 per cent. Cumulative Pref.	2	1¼-1¾
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1-1¼
Elmore's French Company	2	¼-½
Elmore's Wire Company	2	¾-1
Fowler-Waring Cables	5	¼-1¼
W. T. Henley's Telegraph Works, Ordinary	10	7-8
House-to-House Company, Ordinary	5	1-1¼
—— 7 per cent. Preference	5	5¼-5¾
India Rubber and Gutta Percha Works	10	22-24
—— 4½ per cent. Debentures	100	103-105
International Okonite, Ordinary	10	1-2
Kensington and Knightsbridge	5	4¾-5¼
—— 6 per cent. Pref.	—	6¼-6¾
Liverpool Electric Supply, Ordinary	5	6¼-6¾
—— Pref.	—	—
Liverpool Overhead Railway	10	8¼-8¾
—— Pref.	10	13-13½
—— 4 per cent. Mortgage Debentures of £100	100	111-113
London Electric	5	¾-1¼
Metropolitan Electric Supply	10	8¼-9
—— 5 per cent. Reg. Debentures, 1-10,000 in Bonds of £10, £20, and £40	—	—
National Telephone, Ordinary	5	4¾-5¼
—— 6 per cent. Cum. First Pref.	10	14¾-15¼
—— 6 per cent. Cum. Second Pref.	10	14-15
—— 5 per cent. Nom. Cum. Third Pref	5	5¼-5¾
—— 4½ per cent. Deb. Stock	—	109-112
Notting Hill Company	10	4¼-5¼
Oriental and Electric Company, £1 shares	1	¾-1¼
—— £5 Shares	—	6-6½
—— £4½ shares	—	5-5½
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7-7½
—— 7 per cent. Pref.	5	8¼-9
Swan United	—	—
Telegraph Construction and Maintenance	12	40-42
—— 5 per cent. Bonds	100	102-105
Westminster Electric Supply, Ordinary	5	6¼-6¾
Yorkshire House-to-House	4½	4¼-4¾

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NOTES.

Burgdorf (Hanover).—It is proposed to establish a central electric light station here.

Telephony at Bruchsal.—Good progress is being made in establishing a telephone system here.

British Association.—The annual meeting of the association commences at Oxford on Wednesday next.

Electric Lighting in Magdeburg.—Tenders are invited by the Municipality for the electric lighting of the town. They are to be sent in by October 31.

Simbach-on-the-Inn.—Mr. Hellmansberger, rope-maker, intends to introduce the electric light here. The work will be carried out by Mr. Leitl, of Neuölting.

Electric Traction at Belgrade.—An electric tramway, about 3½ miles in length, constructed by a French company, has been opened between Belgrade and Topscheider.

Electric Transmission at Remscheid. — The Electric Street Tramway Company are experimentally putting up an electric motor in a local works for driving machinery.

Electric Lighting at Arad.—The local authorities of this Hungarian town have approved of an agreement with Messrs. Ganz and Co. for the introduction of the electric light.

Nice.—The electric lighting of Nice is, to a certain extent, at last an accomplished fact. It is at present restricted to the Place Masséna, Avenue de la Gare, and adjacent streets.

Electric Traction at Gmunden.—A 90 years' concession has been given by the Austrian Government to Messrs. Stern and Hafferl, of Vienna, for an electric railway at Gmunden.

Electricity at Mannheim.—Circulars have been addressed to industrial firms by the Municipality in order to ascertain what the probable demand will be for current for light and power purposes.

Hospital-Lighting.—The new fever hospital being erected at Shooter's Hill for the Metropolitan Asylums Board is to be lighted throughout by electricity. The architect is Mr. T. W. Aldwinckle.

Electric Traction in Madrid.—The Madrid Tramway Company have decided to introduce electric traction on their lines according to the plans of the Allgemeine Elektricitäts Gesellschaft of Berlin.

Obituary.—The death is announced of Sir George R. Prescott, Bart. The deceased was chairman of Callender's Bitumen, Telegraph, and Waterproof Company, and a director of the Chelsea Electricity Supply Company.

New Cable.—The Anglo-American Telegraph Company announce the completion of the laying of their new cable between Ireland and Newfoundland. This is the eighth cable this company has laid across the Atlantic.

Report on Dry Cells.—We have received a copy of a report on dry cells of the Obach and E.C.C. types by Prof. A. Jamieson, M.I.C.E., and published by Messrs. Siemens Bros. and Co., Limited. In a future issue we hope again to refer to this report.

Iron and Steel Institute.—The autumn meeting of the Iron and Steel Institute will this year be held in Brussels, under the presidency of Mr. E. Windsor Richards. The Brussels meeting will begin on Monday, August 20, and will end on Friday, August 24.

Periodic Variations of Alternating Currents.—MM. Hess and P. Janet are investigating the registration of periodic variations of alternating currents. Two preliminary notes on the subject have already been presented to the French Academy of Sciences.

Distribution of Electrical Energy by Alternating Currents.—In the article given in our last issue on this subject, a type-written error unfortunately escaped notice in regard to the "units to the £ capital.' The figure given was "1·00." This should be "3·46."

Station-Lighting.—The Midland Railway Company are extending their installation of the electric light at Leicester. For some time their offices in Leicester have been lighted by electricity, and extra plant has recently been laid down with a view of lighting up the goods yard.

Only the Subscriber.—A little storm has arisen in the German press in consequence of the rigorous application of an old regulation which prohibits a subscriber to a telephone exchange from allowing anyone not of his household to use the instrument. The withdrawal of the regulation is being asked for.

Electric Lighting at Graz.—Good progress is being made with the laying of the cables here, and the work in connection with the machinery buildings at the central station in the Steyergasse is also making headway. It is expected that the inner portion of the town will receive current by December 1.

Electric Central Station at Goldberg.—The Municipality of this Silesian town are not disposed to run an electric light station on their own account, and in consequence Messrs. Schuckert and Co. propose to erect a central station for the supply of current for lighting and power purposes.

St. Martin's-le-Grand.—The large building in St. Martin's-le-Grand designed for the Administrative Department of the Post Office, is now so far advanced that it is hoped that the transfer will be made before the New Year. The electricians of the Post Office are now fitting the building with the electric light.

Telegraphy in Asia.—The construction of the telegraph line between Burma and China is being proceeded with. The Bombay, Baroda, and Central India Railway Company has asked for a third telegraph wire on the Godhra-Rutlam from Anand to Rutlam, and for a fourth wire between Bombay and Anand.

Imperial Institute.—A special exhibition of submarine telegraph instruments and appliances, connecting the building with various parts of the world, is now on view. The instruments are shown in operation from 5 p.m. to 10.30 p.m., and models of cables and cable-laying ships, museum of deep-sea curiosities, etc., are also exhibited.

Search-Lights.—The Trinity House, Hull, has given notice that the War Department proposes to experiment with the electric search-light at Paull Battery (on the east shore of the River Humber, and about three miles below Hull) between the hours of 8 p.m. and midnight on certain days from the present time to September 26.

Stellingen-Langenfelde.—The Municipality have been considering the question of lighting the streets electrically for some time, but have not come to a definite conclusion as they are afraid of the expense. They now intend to inspect the central station at Wesselburen, where two twin motors are worked by generator gas.

Heiligenstadt.—The municipal authorities are considering the question of lighting the town electrically. The Dirks Cement Works have announced that they are

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prepared to lay down a central electric light station. The Municipality have decided to postpone the matter until estimates are obtained as to the probable cost.

Association of Municipal Engineers.—As mentioned in our issue of the 20th ult., the members of this association will hold a meeting in Brussels, commencing on Thursday, the 16th inst. Various visits have been arranged, including the Brussels central electric light station and electric cars, the Antwerp Exhibition, and the Antwerp hydro-electric works.

The Department of Science and Art.—The forty first report of the Department of Science and Art of the Committee of Council on Education has been issued. It is mentioned that the additions to the machinery and inventions division at South Kensington during the past year included Cowper's original writing telegraph and Shallenberger's electric meter.

Western Australia.—The Governor (Sir William Robinson), in opening the Parliament of Western Australia last week, stated that among the objects which the Ministers had in view were the construction of railways and the erection of telegraphs. Among the works to be undertaken were the extension of the telegraph system, and the improvement of lighthouses on the coast.

West Hartlepool.—The tenth annual report of Mr. J. W. Brown, A.M.I.C.E, borough engineer to the Corporation of West Hartlepool, mentions that sanction has been given by the Council to the tramway company for operating the tramcars by electric power on the overhead trolley system, and that a provisional order has been obtained by the Council enabling it to supply electricity.

Laundry and Sanitary Exhibition.—An opportunity for electrical firms to demonstrate the applications of electric lighting and heating will be afforded by the second annual laundry and sanitary exhibition, which wil be held at the Royal Agricultural Hall, N., from Wednesday, November 7, to November 17. Enquiries are to be sent to Messrs. Cordingley and Co., 39 and 40, Shoe-lane, E.C.

Junior Engineering Society.—The summer excursion of this society will be to Cardiff and district, commencing on Saturday, the 18th inst., and terminating on 25th idem. Visits to various works, including the Cardiff electric light works, have been arranged, and the rooms of the South Wales Institute of Engineers, Park-place, will be available for the use of the members during their stay in Cardiff.

Up-to-Date Continental Journalism.—In our issue of July 27 we gave a description of the working of the Chemnitz central electric light station. Since then a German contemporary dated two days later—namely, July 29—calmly informs its readers, in fine Irish bull style, that it may be anticipated that current will be supplied from the station towards the end of last May or the beginning of last June.

Alternating-Current Plant.—As an instance of the rapid development of the use of alternating currents, a French contemporary, *Electricité*, publishes in its issue of 12th ult. a remarkable list of installations carried out on this system during the past few months by Messrs. Brown, Boveri, and Co. These cases, numbering 31, not only concern plant for lighting, but also for the transmission of power for use in various industrial works.

The Waterloo-City Railway.—Work is proceeding on the south side of the River Thames, near Blackfriars Bridge, where piles are being driven into the bed of the river. This pile driving is the commencement of the new underground electric railway between the City and Waterloo. It is intended to sink caissons in the bed of the river at this point, and then to drive a tunnel in two directions—the one going to the Mansion House and the other to Waterloo Station.

Northern Society of Electrical Engineers.—A number of members of this society who have paid a visit to Belgium, have just returned from what has proved to be a most enjoyable and instructive excursion to the Antwerp Exhibition. The members, through the courtesy of the directors, visited the Rue du Chantier station of the Compagnie Hydro-Electrique Anversoise, and some of the members who visited Brussels had the good fortune to inspect the central station in that city.

Detection of Liquor Frauds.—The French Chamber of Deputies has placed at the disposal of the Académie des Sciences the sum of £2,000, which is to be awarded to the inventor who succeeds in devising a simple and sure method of determining fraud practised in the production of alcoholic liquor for human consumption. *Electricité* asks whether the knowledge of electrical conductivity, coupled with that of density, is not a sufficient means if the liquor experimented on is brought to the temperature of melting ice.

The Prevention of Smoke.—The Prefect of the Seine, at the request of the Paris Municipality, has appointed a commission to institute a competition among engineers and inventors for the purpose of bringing to light the best means to be adopted for the prevention of smoke from steam-boilers. At the termination of the competition prizes will be awarded to the best three appliances or systems. The methods to be tested are those for firing boiler furnaces with coal without the emission of smoke.

The Gilgit Road Telegraphs.—The new telegraph offices on Gilgit road are now open. After Mr. Olpherts had inspected and reported on the favourable condition of the line over the Tragbal and Burzil Passes, Gurais was opened, and then Minimarg. The Bunji Astor and Gilgit offices, formerly on the line of communication *viâ* Skardu, will shortly be taken over and worked by members of the Imperial Telegraphs—sent up from Bombay, Calcutta, and othe. places, specially selected to stand the severe winter and to effect the speedy restoration of communication in case it gets interrupted.

Personal.—A few personal friends of Mr. J. Rance, jun., presented to him on Monday a pair of binocular glasses and a pocket compass prior to his leaving for the Transvaal to erect plant for the electrical transmission of power, on behalf of Messrs. Johnson and Phillips, for the Sheba Gold Mining Company. Mr. A. Grundy, late manager and director of Bailey and Grundy (London), Limited, has been appointed electrical engineer to the Battersea Polytechnic Institute. Mr. E. Arnold, the chief engineer of the Oerlikon Works, has been appointed professor of electricity at the Technical High School, Karlsruhe. Mr. W. H. Massey is one of the English jurors at the Antwerp Exhibition.

Electric Lighting at Ballarat.—According to the *Melbourne Age*, arrangements have been completed by the Railway Department with the Ballarat Supply Syndicate for the lighting of the local stations and embankment with electricity. The Government will, it is computed, save about £300 per year by the introduction of the new light as a substitute for gas, which costs about £40 per month. It is understood that the electric light will be in use at the stations before the expiration of three months. Steps will also be taken shortly with the view of illuminating the post and telegraph offices and other public buildings with electricity, and it is probable that the same light will ere

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long also be introduced at the mechanics' institute. Among those who have promised to accord the Supply Syndicate support are a number of the leading shopkeepers in Sturt-street and other principal thoroughfares in the city.

Laying of New Mains.—The Westminster Electric Supply Corporation intend to lay mains in Smith-square, North-street, Church-street, Tufton-street, and Romney-street; in Berwick-street and St. Leonard-street, and Hindon-street west side; in Moreton-place, Moreton-terrace, and Moreton-street West; on the east side of Strutton-ground and the north side of Great Peter-street; and across South-street. The Kensington and Knightsbridge Electric Lighting Company are about to place underground mains across Cromwell road, and in Gloucester-road and Southwell-gardens. The Notting Hill Electric Lighting Company propose to lay mains and construct street boxes in Phillimore-gardens, Kensington-road, Melbury-road and Holland-park-road, and Pembridge-villas. The St. James and Pall Mall Electric Light Company intend to lay mains in Burlington-gardens, Bond-street, and Clifford-street.

Electrical Engineering Leaflets.—Our contemporary the *Electrical Engineer* of New York has commenced the publication of a series of leaflets on electrical engineering matters, by Prof. E. J. Houston, Ph.D., and Mr. A. E. Kennelly, F.R.A.S. These leaflets, which contain the underlying principles of electricity and magnetism, are issued in three grades: (1) elementary, suited to the study of electrical artisans, wiremen, and to elementary students; (2) intermediate, for students in high schools or colleges, and those beginning the study of electrical engineering; (3) advanced, for students taking technical courses in electrical engineering. The leaflets will be issued in 35 weekly parts, and there will be three leaflets each week—namely, elementary, intermediary, and advanced. Each leaflet consists of eight pages, of small octavo size, illustrated by diagrams and drawings. The first leaflets issued deal with electrical effects, E.M.F., and resistances.

The Douglas Electric Tramway.—The Douglas and Laxey electric tramway has been formally opened to public traffic. A number of ladies and gentlemen (among whom were Mr. A. Bruce and Dr. Farrell, directors of the Isle of Man Tramways and Electric Power Company, Limited; Dr. Hopkinson; Mr. F. Saunderson, C.E., the company's engineer; and Mr. J. Aldworth, manager) travelled from Douglas to Laxey by special car, the distance of eight miles along the cliff being traversed in a little over half an hour. It appears from a statement made by Mr. Nelson that during the week ending July 25 the earnings on the electric tramway were £276, the number of cars running 32, number of miles run 1,698⅔, and number of passengers 22,105. The Government inspection of the line took place on Friday, and Colonel Rich, inspector of railways, and Major Cardew, Government electrician, after travelling over the line and making observations, expressed themselves entirely satisfied with it.

The Pacific Cable Question.—In connection with the recent dispute regarding the reported intention of Great Britain to annex Neckar Island, a barren islet lying under the Tropic of Cancer to the north-west of the Sandwich Islands, an allegation was made, says a Reuter's cablegram from Melbourne, that the intentions of the British Government to annex the island were revealed by the Hon. R. Reid, Victorian Minister of Defence, the Hawaiian Government being thus enabled to forestall the hoisting of the Union Jack. Mr. Reid now denies having revealed the intentions of Great Britain, and states that the entire episode was due to Sir Sandford Fleming, the Canadian engineer, having sent a man to charter a steamer at Honolulu for the purpose of seizing Neckar as a station for the proposed Pacific cable, on the chance that the Home Government would recognise the action. The Hawaiian Government, however, obtained information of this plan, and took steps to prevent its execution.

Electrical Steam Attachment for Launches.—Our attention has been directed to an electrical steam attachment for the propulsion of boats without any alterations in the hull of the boat being rendered necessary. This arrangement has been devised by Mr. E. A. McLachlan, of 55, Brighton-road, Stoke Newington, N., who informs us that by its adoption any existing sailing or rowing boat can be converted into an electric launch without destroying its original character. The stern attachment, which is detachable, is fixed in the place of the ordinary rudder, and the motive power is obtained from accumulators placed under the seats. The large pair-oared rowing skiff, "Richmond Lock," which is equipped with this attachment, can be seen on the Thames. A boat fitted on this method is in operation on the canal at the Chinese water carnival now in full swing at the Agricultural Hall, Islington, where it is carrying passengers. Mr. McLachlan states that the electrical equipment can be supplied to any boat at about one half the cost of an ordinary electric lamp.

Electricity in Mining.—In the course of his presidential address before the British Society of Mining Students, at the annual meeting held on Wednesday in the lecture-hall of the South Wales Institute of Engineers, Park-place, Cardiff, Mr. Frank Brain, M.E., A.M.I.C.E., said that there was no doubt that electricity was the coming power in mines. In the colliery he was connected with they had three electric pumps working underground, and he could speak with confidence of their utility. His company were also putting down a system of underground main tail haulage worked by electricity. Electric coal-cutters were at work in many parts of the country, and scarcely a week passed in which they did not hear of some new electric plant in mines. It was their duty to apply themselves to the discovery and application of every means to the prevention of accidents in mines. Last year there were over 1,000 lives lost by mining accidents, and although this compared favourably with years gone by there was still room for improvement, and they must put into practice what they learned so as to minimise these dangers.

The Nottingham Central Station.—The municipal electricity works at Nottingham will, judging from a hasty inspection a week ago, soon be completed and set in operation. Plans of the buildings have already been reproduced in this journal, together with a preliminary outline of the steam and generating plant. As Mr. Talbot, the electrical engineer to the Corporation, remarked, the Town Council have been fortunate in securing the central site, constituted by the location of the generating station in Wollaton and Talbot streets, close to the Theatre Royal, Market-street, and the Market-place. As far as the generating station is concerned, it may be mentioned that three large Lancashire boilers are already in position, together with the Siemens dynamos and Willans engines, whilst the main switchboard is about completed. A battery of E.P.S. cells now being installed will serve partly as regulators and partly for the public supply when the demand for light is low in the small hours. The distributing mains have already been laid in the compulsory area. The capacity of the station, which is expected to be set in operation in September, in time for Goose Fair, is 10,000 lamps.

City and Guilds of London Institute.—We are glad to learn that the council of this institute has conferred the fellowship of the institute upon

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Dr. W. E. Sumpner, who, it will be remembered, was awarded the diploma of associate of the institute in 1887, and has since contributed to the advancement of the electrical industry by many original and valuable researches. The council have also conferred the diploma of associate upon the following matriculated students who have this year successfully completed the full course of instruction at the Central Technical College: in applied physics and electrical engineering—M. A. Abrahamson, J. R. J. Bowden, P. J. C. Day, R. A. Fullerton, A. F. Harris, H. C. Leake, A. E. Mayes, W. F. S. Mentheth, M. J. P. O'Gorman, L. L. Robinson, J. Severs, A. K. Taylor, J. A. W. Ward, and R. J. C. Wood; in civil and mechanical engineering—N. Abbott, B. S. Aldis, C. L. Bushell, R. B. Carter, A. O. Cautley, A. C. Hall, A. Hallett, J. H. James, C. Lightfoot, H. G. Lloyd, F. Maeers, B. T. Stubbs, and W. Thomas; and in applied chemistry—A. M. Crighton, A. Marshall, and E. W. S. Schwabe.

Telephony.—A correspondent writing to a Dundee paper from Broughty Ferry says: "I had an interesting experience this afternoon. A friend rang me up by telephone at my house in Broughty Ferry from the Highland Show Yard in Aberdeen, and whilst he was speaking to me he said: 'Wait a minute; I can't hear what you are saying on account of a pipe band which is passing the telephone booth.' I instantly replied: 'I was just hoping you would stop for a minute, as I wanted to hear the band.' The wire was fortunately in very good order to-day, and not only did I hear the pipe music, but I distinctly heard the tramp of the men as they walked past. The tune they were playing was 'The Barren Rocks of Aden,' and it was a most interesting experience to hear pipe music and 'the tramp of armed men' over 150 miles of wire. I have repeatedly before heard by telephone a common eight-day clock striking and piano music at a distance of over 100 miles, and have heard a watch ticking at a distance of about a mile, but I have never until to-day had the pleasure of hearing over the telephone music played in the open air at a distance of considerably over 100 miles."

Iron Ships and Lightning.—Adverting to the "Note" in our last issue concerning a peculiar accident at the Norfolk Navy Yard, the following letter received by Rear-Admiral J. A. Fisher, C.B., from Lord Kelvin will prove interesting. Lord Kelvin says: "With reference to the recent report of a lightning discharge in Norfolk Dockyard, U.S.A., by which two men were killed, it is proved by that accident that to secure against danger to men working under a ship in dry dock there ought to be a thorough metallic connection, by wire rope or otherwise, between several points of the ship's iron, such as bollards, ringbolts, etc., and iron pipes leading to the water outside the dry dock. Similar precautions ought to be taken in respect to the frames of ships on the stocks in the course of building, although we have, so far as I know, never heard of an accident from lightning happening to men at work in the building of ships. An iron ship simply resting on wooden blocks, and without any connection by metal with the water of docks, or river, or sea in the neighbourhood, is certainly dangerous to persons standing on the ground and touching any part of the iron hull during a thunderstorm." It is stated that precautions of this character will be adopted in all the Government dockyards.

Life Buoy with Electric Light.—The Allgemeine Elektricitäts Gesellschaft, of Berlin, send us particulars of a life buoy for use on board ship, which is fitted with an electric lamp so as to be visible at night in the water. The floating apparatus is made of waterproof linen, and is sufficient to bear the weight of three persons in the water, life belts being attached to the buoy. Inside the canvas buoy is a double wooden box containing an accumulator with gelatine material, and it is capable of feeding an incandescent lamp for six hours. The incandescent lamp surmounts the floating buoy in a strong wire frame, and is further protected by an outer strong glass globe. When the apparatus is hanging on board ship, the weight of the lower portion automatically switches off the current, but as soon as the buoy is released and dropped into the water four powerful springs switch the current on. The accumulator will last for two months before requiring to be recharged, so that the apparatus can be employed on board ships where there is no dynamo. The apparatus weighs about a hundredweight, but the accumulator can be made smaller with, of course, a corresponding decrease in the duration of the light. These accumulators with gelatine filling do not suffer from the motion of the ship, or from the fall into the water.

Technical Scholarships.—The Technical Education Board of the London County Council announce that they will be prepared early in October to award not more than five senior county scholarships of the annual value of £60, in addition to the payment of college fees, tenable for three years, and subject to annual renewal. The scholarships are intended to provide the means of obtaining advanced technical training in a university, university college, or technical institute of university rank for students (young men or women) of exceptional ability, who would otherwise find it impossible to secure such training. Candidates must, as a rule, be under 19 years of age on September 1, 1894, but the Board is prepared to consider very special cases in which the candidates are above that age. The scholarships are offered with the view of encouraging the study of science or art, with special reference to industrial requirements, and will be tenable at such institutions giving appropriate instruction within the statutory definition of technical education as may be selected by the scholars and approved by the Board. No candidate will be eligible whose parents enjoy an income from all sources of more than £400 per annum. The county scholarships are awarded under the Technical Instruction Act of 1891, which enables a local authority to provide scholarships for "students ordinarily resident in the district of the local authority." It is therefore essential that candidates should be ordinarily resident within the administrative county of London, including the county of the city of London.

The Transvaal.—With reference to our "Notes" of June 29 and of 27th ult., we learn from the *Elektrotechnischer Anzeiger*, of Berlin, that Messrs. Siemens and Halske are now only waiting for the permission of the Transvaal Government to proceed with the work of establishing a central power station at Witwatersrand. A number of mining companies appear to have agreed to take a portion of their power from the company, and within a circumference which will give the concern vitality. According to the plans which have been drawn up, the station will be erected on the Brakpan Farm, near the coal mines of the same name, and to commence with the station will have a capacity of 3,000 h.p., of which 2,000 h.p. will be delivered to the mines. The district proposed to be served at present covers a distance of 27 miles. The representative of Messrs. Siemens and Halske estimates that the average price on the Randt for 1 h.p. is £56. 10s. per annum, exclusive of interest and depreciation, whereas the company intend to furnish electrically 1 h.p. per year for £45, supplying the electromotors free of charge. There are at present in use on the Randt about 20,000 h.p., so that

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there is plenty of room for expansion of the station if the 3,000-h.p. installation give good results. It was at first intended to utilise the water power of the Crocodile River, but after further consideration this idea was abandoned as it might have given rise to difficulties in times of drought. The use of water power would have enabled the price per horse-power to have been reduced, but only to a slight extent, as according to a provisional agreement with the colliery owners the coal can be obtained for the station at a low price. The capital of the electric company to be formed is to be £300,000, of which £250,000 are to be devoted to the installation and motors, £25,000 will be paid in shares for the concession and expenses, and £25,000 will be held in reserve.

A Gas View of Electric Lighting.—The statements made by Mr. James M'Gilchrist in his presidential address delivered before the North British Association of Gas Managers in Glasgow last week, show that he is not aware of the progress being made in electric lighting, as the following quotation demonstrates: "Since I last addressed you, in 1881, electric lighting has had a good trial, and were it not for the high cost, it would, I believe, become popular. It is still the rich man's light, and, I fear, can never be anything else. As a gas manufacturer I have had experience of supplying a mansion with gas for illuminating purposes, and of subsequently supplying a gas-engine in the same house to generate electricity—I much prefer the latter occupation, because the account for gas is fully 100 per cent. greater. The first cost and wear and tear on electrical plant is so great that it is impossible to produce the light cheaply. It appears, from calculations that I have made, that the bare cost of storing electricity (without adding manufacturing charges) is equal to the cost of gas delivered on the consumer's premises. Under these circumstances, many and great improvements must be made on electrical plant before electricity can be taken seriously as a rival to gas in point of expense. The Corporation of Glasgow have spent thousands of pounds experimenting on electrical street-lighting, and but a few pounds experimenting with the Welsbach system of lighting with gas. These systems will, I hope, be examined by you while resident in the city. The annual cost of the Welsbach light may be put down at 15s.; the electric light at £20 per lamp." The best answer to the question of cost of the electric light is to be found in the rapid adoption of this illuminant and the preference shown towards it in different parts of the country, and in the erection of new and extension of existing central stations; but where is there much work proceeding in this direction in the case of gas? Moreover, the comparison of a Welsbach light at 15s. per annum with an arc lamp at £20 yearly, is, to say the least, not only amusing, but misleading.

Locomotion in London.—The Public Health and Housing Committee of the London County Council reported on Tuesday that they had had under consideration the best means to be adopted for giving effect to the resolutions passed by the Council, to the effect that the committee should consider and report on the best means of obtaining information on the question of locomotion in London, including railways, tramways, omnibuses, and steamboats, and that, subject to an estimate being submitted to the Council, a sum not exceeding £500 should be expended upon an enquiry on the question of locomotion in London, and that it be referred to the Finance Committee to consider whether this sum should be charged against the £1,000 which the Council is entitled to expend on enquiries under the London County Council's General Powers Act, 1893. In carrying out the above instruction the committee consider that the first step to be taken is the collection of statistics relating to the actual present means of transit, and they think that such statistics, so far as concern omnibuses, tramways, and steamboats, can best be obtained by personal enquiry. The statistical officer estimates that the services of four assistants for eight weeks will be required for the purpose, at a cost of £2. 2s. per week each. Some maps and books would also be required at a cost of about £10, making a total expenditure of about £80. With regard to the question of railways, the committee have been in communication with Mr. J. H. Greathead, and have ascertained that he is willing to report on the whole question of railways in London, and especially as to the cost of constructing railways and the best routes and most reasonable fares, for a fee of 250 guineas. The committee consider the amount asked to be reasonable, and they recommend therefore that the committee be authorised to engage the services of four assistants in the statistical department for a period of eight weeks at £2. 2s. per week each to obtain statistics as to the means of transit provision by omnibuses, tramways, and steamboats in London; and that Mr. Greathead be employed to prepare a report, for the fee of 250 guineas, on the whole question of railways in London.

The Government and Telephony.—The agreement between the Government and the National Telephone Company is not yet ready, but members of the House of Commons continue to keep the matter before Parliament. In this connection Mr. H. S. Foster asked the Postmaster-General a few days ago whether his attention had been called to the fact that the chairman of the National Telephone Company, at the annual meeting of that company, stated that they had come to an agreement with the Post Office, which could now be submitted to the House of Commons for confirmation; whether such agreement had been entered into; and, if so, on what date, and when it would be submitted to the House for confirmation; and whether he could state what opportunity would be afforded to the House for considering the agreement. In reply, Mr. A. Morley stated that an agreement had at last been arrived at between the National Telephone Company and the Post Office, but until the approval of the company had been formally conveyed to him, and the sanction of the Treasury obtained, he would not be in a position to lay the draft agreement on the table of the House. He thought it right to add that some questions connected with companies controlled by the National Company must first be settled, but he had no reason to apprehend that this would involve serious difficulty or delay. In answer to the last paragraph, he pointed out that the agreement did not require the confirmation of Parliament, and he was therefore not aware that any special opportunity for its consideration would be necessary, but the subject was one which could in due course be raised on the telegraph estimates. Mr. Labouchere asked whether the promise given was not that a discussion should be taken before the agreement was signed. Mr. Henniker Heaton asked whether the right hon. gentleman would undertake that the question should not be considered at the end of the session, but should be rather postponed. Mr. A. Morley could not give such an undertaking. The general feeling was that there would be sufficient time to come to a decision. With respect to the question of the member for Northampton, he had distinctly stated that this agreement should be discussed before it was signed. But it was merely a formal confirmation of the agreement signed by the late Government and submitted to the House of Commons at that time. Practically there was no alteration in the agreement, which would be laid on the table in due course.

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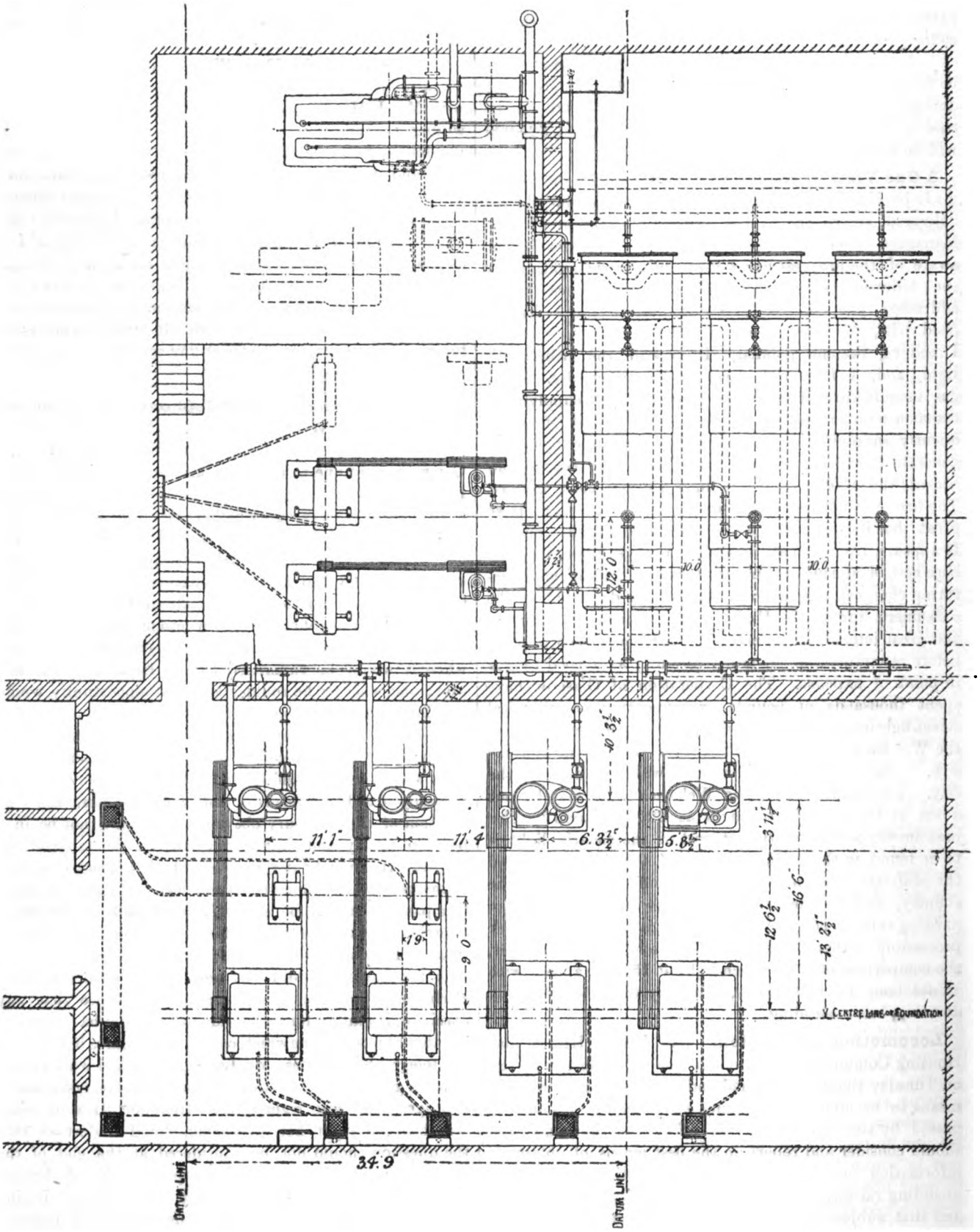
THE MUNICIPAL ELECTRIC LIGHT STATION AT HANLEY.

General Remarks.

A town of the straggling nature which is characteristic of Hanley, well known for its manufactures in china, tiles, and earthenware goods, is precisely the district where one would expect the high-pressure alternating-current system to be adopted for electric lighting; and what is more to the point, this method has been introduced. The Hanley Town Council thoroughly believe in municipalisation, and their belief in electric lighting has taken form in the electricity works which, as we announced in our last issue, were set in operation on Thursday, July 26. Hanley—with its numerous kilns and chimneys belching forth volumes of smoke day and night, its somewhat hilly character, and the few blast furnaces in the outskirts—is not a prepossessing town; but it is one in which the electric light should prove of great value. Mr.



Hanley Central Electric Light Station—General Plan of Main Engine and Alternator House, Arc Light and Condenser Room, and Boiler House.

Joseph Lobley, M.I.C.E. (the borough engineer), is to be congratulated on the able supervision exercised by him in the carrying out of the electricity works, in conjunction with Mr. George Cottam (the electrical engineer to the Corporation), and under the general control of the Electric Lighting Sub-Committee—the chairman of which is Alderman J.

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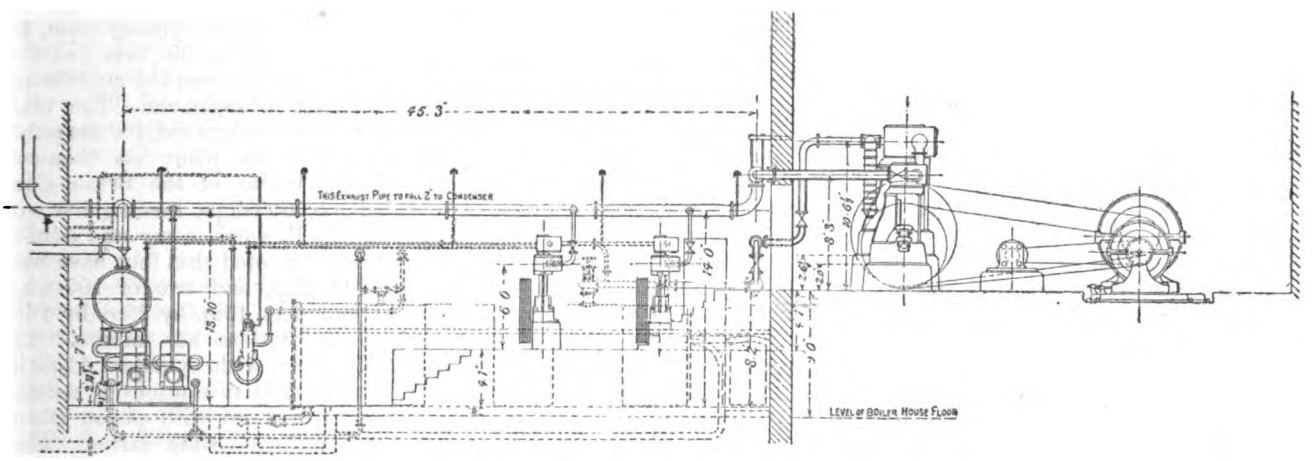
Shirley, and the other members are: Councillor A. Wood (vice-chairman), Alderman Hammersley (mayor), Aldermen Charlesworth, Cooke, Hampton, and Ridgway, and Councillors Coates, Huntbach, Palmer, and Turner.

The plans of the station buildings were prepared by Mr. Lobley, whilst the general design and equipment of the station have been carried out by the Brush Electrical Engineering Company, under the control of Mr. W. Geipel (their superintending engineer), assisted by Mr. S. A. Mahood, as resident engineer.

Historical.

The subject of electric lighting first came under the consideration of the Corporation as long ago as in 1882, but the matter dropped. Subsequently Mr. Lobley paid a visit to the United States, and from the experience gained there he came to the conclusion that the alternating-current system was the most suitable for Hanley. This method he recommended the Corporation through the Electric Lighting Committee to adopt, and after investigating existing systems the members of the committee urged the Council to introduce electrical distribution at low pressure, with generation at high pressure by alternating currents. The Corporation, having obtained a provisional order in 1891, decided to adopt the system recommended, and to borrow £21,000 for the purpose of carrying out the undertaking. Tenders were invited for the execution of the work, and in September, 1892, that of the Brush Electrical Engineering Company, at £15,760, was accepted, and a contract was also entered into with Mr. Cornelius Cornes, of London, for the erection of the station buildings. The work of erection of the station was commenced in August 18, 1893, and was practically completed in April last; a partial supply of light began in that month, and regular evening running was started on May 26.



Hanley Central Electric Light Station—Side Elevation of Condenser and Boiler Houses, Arc Light Room, and Main Engine and Alternator House.

Official Opening of the Station.

The formal inauguration of the electricity works took place, as already mentioned, on Thursday of last week, when, at the invitation of the Town Council, a large number of guests assembled at the station.

Alderman J. Shirley mentioned that the number of applications for light had been 70, and that requests for a supply of current for 2,675 lamps for private lighting and for the equivalent of 2,000 lamps for public illumination had been received, the latter including the lighting of the free library, museum, school of art, and public baths, whilst other public buildings are to be similarly illuminated. In other words, 93 per cent. of the total output of the station has already been taken up.

Mr. W. Geipel and Mr. W. M. Mordey followed with some well-chosen remarks, the former urging the necessity o getting a day load, and suggesting the profitable utilisation of alternating-current motors for ventilating and other purposes in the district. Due acknowledgement was made of the courteous treatment meted out to the Brush Company's officials by the Mayor and the Electric Lighting Committee, and of the valuable assistance rendered by Mr. Lobley and Mr. Cottam.

Mr. Edwin J. Hammersley (the mayor) made an appropriate speech. It was mentioned that the British Gaslight Company, which supplies Hanley with gas, had reduced the price of gas per thousand from 3s. 3d. to 3s. in consequence of the Town Council going in for the electric light, and now that the electricity works were completed the company had made a further rebate—namely, to 2s. 9d. per thousand. That reduction, it was stated, was due to anticipated competition of the electric light, and would never have been granted if it had not been for the municipalisation of the electric light undertaking. The Mayor then proceeded to switch on the current to the town lamps.

Subsequent Proceedings.

Subsequently a party of the guests assembled in the Mayor's parlour at the Town Hall, where light refreshments were partaken of and various toasts given and responded to. Some very happy remarks were made by various speakers. Mr. Lobley, for instance, suggested that in order to utilise the current in the daytime a cable should be laid to the sewerage works for the operation of electric motors for pumping purposes, that electric power should be employed for any extensions there necessary, and that the stone-breaker should be operated by electric power. A capital suggestion, Mr. Lobley. The representatives of the electrical Press present, who were obliged to withdraw shortly before eleven, were informed the following day that the proceedings did not terminate until 3 a.m.

The enterprising Corporation of Hanley have dispensed with the services of a consulting engineer in the initiation and completion of the undertaking, and have trusted to the judgment of the Electric Lighting Committee and of the borough engineer for guidance both from a commercial and a technical standpoint. The fact must, however, not be overlooked that considerable assistance has been rendered by Mr. Cottam, and by the Brush Company's staff, one of whom informed our representative that the exclusion of a consulting engineer had resulted in a saving of 30 per cent. on the total capital expenditure.

The Boiler-house.

The buildings forming the generating station (a plan and side elevation of which are annexed) have been erected on the bank of the canal and adjoining Bethesda-road, there being ample space for future extensions, which, taking into consideration the fact that nearly the whole of the present output of the generating plant has been taken up, will soon have to be carried out. The buildings may be divided into the boiler-house, arc light room, and general engine and dynamo house. The peculiar conditions of the site have rendered it necessary to construct the boiler and arc light houses at a much lower level than that of the engine and dynamo room; for instance, a large amount of carbonaceous matter had to be removed from where the boilers have been erected. The boiler-house and the arc light and condenser house are each 50ft. long by 30ft. 4in. wide, whilst the engine and dynamo room is 67ft. 3in. long by 35ft. wide.

The boilers, which were furnished by Mr. J. Thompson, of Ettingshall Boiler Works, Wolverhampton, are of the Lancashire type; they are three in number, each being 28ft. long by 7ft. in diameter. The boilers have an evaporative capacity of about 15,000lb. of water per

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hour, or, say, 750 h.p. They are made throughout from Siemens mild steel, and built upon the most modern practice. The circular rings of the shells have two rings of rivets, and the longitudinal seams have six lines of rivets; the end plates are also double riveted to the shell angles, and their system is carried out to the connection of the flues to the end plates. The flues contain tubes which are welded at their connection to the flues. The boilers are equipped with high-class fittings, the feed-water connection being in duplicate, and the internal arrangement of tubes for distributing the water is made to the design of the borough electrical engineer. They are constructed for 140lb. working pressure, and the hydraulic test pressure applied was 250lb. per square inch. The maker, it may be mentioned, has had his works equipped with modern tools for the special construction of boilers for heavy pressures. The boilers are fitted with mechanical stokers.

These stokers were supplied by Mr. Thomas Cass, of Hope Foundry, St. George's street, Bolton. The "Cass" smokeless coking stoker is a strong, simple, and durable machine, consisting of a large hopper arranged in front of the boiler, and holding about 10cwt. of slack. The stream of coal falling on the bars is pushed by a pusher plate, and is carried by the action of moving bars under a firebrick arch into the furnace, which ignites the surface of the coal some 5in. thick as it passes through. The moving bars carry the fuel and fire bodily forward along 6ft. of grate bar; then arriving at the end of the bars, the fuel is finally consumed, and the clinkers and ashes fall into a pit at the back, and are there cleaned out twice a day, according to the quantity of ashes. The attendant has only to keep the hoppers full of coal, regulate the feed, and keep clean at the back, whilst the stoker does the rest. The bars are all fitted with steel blocks, as also the tappets which work the bars, so as to prevent wearing away, as would be the case with cast iron. Thus the bars are very durable. The bars run on rollers, which cause the machine to run very easily. Mr. Cass informs us that some hundreds of these stokers have been fitted to the principal mills and works in Lancashire and other places. The machines are driven with a $^{9}/_{16}$ rope, and it is not necessary to drill a single hole in the boiler to apply this type of stoker, this being a great advantage.

The close proximity of the canal allows of the coal being brought to the station at about 7s. 6d. per ton, the coal being taken direct from barges on to a platform, from which it is conveyed by chutes into the stokers. At present only two boilers are required for supplying the necessary steam. The practice of constructing the main steam-piping in the form of a ring has been followed out in this station. The main steam-pipe, which is of wrought iron, 6in. in diameter, is provided with valves which are so arranged that any section may be isolated. The branches to the main engines are 4in. and 3in. The valves are of the parallel slide type, so that when open the steam has a straight passage through. The exhaust piping, which is of cast iron, ranging from 9in. downwards, opens into the condensers or direct to the atmosphere, as may be desired. An automatic relief valve is arranged on the pipe which opens the exhaust to the atmosphere in the event of a stoppage of the condensing plant, whilst a valve is also provided for shutting off the condenser when necessary.

The condensing plant, which is contained in the arc light room, is arranged so that it can be readily extended along with the engines. At present there is one surface condenser of 1,000 square feet cooling surface, and the cooling water is taken from the canal. The air and circulating pumps, which are horizontal, are of the Raworth type, and are fixed on a common bedplate, and are driven by a pair of compound cylinders; whilst a heavy flywheel is provided to enable the steam to be cut off and used expansively. The principal feed pumps are driven from a rocking shaft by the same engine as the air and circulating pumps. The pump rods are attached to blocks which slide in slotted levers, by means of which the stroke may be varied as required. The feed water is taken from the hot-well under the air-pump. In addition, there is a wall feed pump, supplied as a stand-by arranged to pump from the cold-water supply direct or from a tank which is heated by exhaust steam. This pump is equal in capacity to the full power of all the boilers.

Public Lighting.

The arc lighting plant, from which the principal streets are lighted by means of 30 Brush arc lamps arranged on ornamental posts, is operated from machines independently of the private supply, to which reference is made below. It is intended to light the by-streets by incandescent lamps, which are cut in by means of Lobley's patent automatic switch when the arc light circuits are started, so that the whole of the streets are lighted simultaneously by merely switching on at the generating station. The generators comprise two Brush series dynamos, each capable of developing 125,000 watts at eight amperes, running at 900 revolutions per minute. They are 25-light machines, which are rope driven by two vertical tandem type of Raworth compound engines, having cylinders 6in. by 10in. by 8in. stroke, running at 200 revolutions a minute. The engines are fitted with steam stop-valves, continuous lubricating arrangements, grooved flywheels, and Acme governors. The arc light circuit switchboard, which is of polished oak fitted with hook and stirrup connections for two dynamos and one circuit, is also equipped with an ammeter, provision being made on the board for extensions. The arc light main consists of a cable which is highly insulated with vulcanised rubber, protected by prepared tape, compounded and drawn into cast-iron pipes. Geipel's patent telescopic street boxes, constructed entirely of cast iron, are used for these mains.

Main Engine and Alternator Room.

Coming now to the main engine and dynamo room, the dimensions of which are given above, the first point to attract attention is the short drive between the engines and alternators, making a compact arrangement. The plant here is, as will have already been understood, for the public supply of light and the whole of the plant has been constructed at the Loughborough Works of the Brush Company, the total capacity being 5,000 lamps. Dealing first with the engines, which are of the Raworth compound double-acting vertical type, it is to be noted that four have been laid down—two are of 200 i.h.p. and two of 100 i.h.p. The larger engines have cylinders 15in. by 25in. by 16in. stroke, and run at 167 revolutions per minute. The smaller engines, which are fitted with cylinders 11in. by 18in. by 12in. stroke, run at 200 revolutions a minute. The high-pressure cylinders are fitted with piston valves, and the low-pressure with ordinary slide valves. They are controlled by a flywheel governor, acting on the high-pressure valve. The governor is fitted with Raworth's patent adjustment for altering the speed whilst running, and for dividing the load as required between the various machines running in parallel. The low-pressure slide valves are provided with Hackworth gear for varying the cut-off in the low-pressure cylinder whilst running, so that the engines may be operated with the best results for any load.

There are installed four alternators corresponding to the engines, which drive them by means of eight separate cotton ropes. Of the alternators, which are of the well-known Mordey-Victoria type, two are driven at 430 revolutions per minute, and have a capacity of 100 kilowatts each, whilst the other two run at 600 revolutions, and have a capacity of 50 kilowatts each, the pressure being in each case 2,000 volts. The armatures are stationary, as is customary in this type of machine, whilst the field magnets revolve. The lubrication of the bearings is automatic, being effected by means of small pumps, which keep up a constant circulation of oil. These alternators, it will be remembered, work perfectly in parallel irrespective of size.

The exciting plant comprises two Brush-Victoria dynamos, each having an output of 10,000 watts, and capable of exciting all the alternators. These machines are driven by short belts direct from pulleys keyed to the shafts of the two smaller alternators.

We must not omit to mention that the engine and dynamo room is fitted with an overhead hand travelling crane, supplied by a local firm, Messrs. J. Warner and Son, of the Phœnix Foundry, Hanley. This crane, which

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is capable of lifting a load of 10 tons, has the following motions : (1) longitudinal travelling ; (2) transverse travelling; (3) lifting and lowering. All these motions are effected by hand from below by means of endless chains or ropes. The main longitudinal travelling carriage is constructed of two steel girders, is of sufficient strength to safely carry a load of 10 tons in the centre, and has rails firmly secured to the top for cross travelling carriage. The end frames or carriages for carrying the main girders are of cast iron, and are firmly secured to girders and fitted with large travelling wheels from 20in. to 24in. diameter having double flanges to prevent the crane from running off the rails. It is fitted with spur gearing and shafting connecting each side together, and is provided with two large size chain pulleys, etc., for working longitudinal travelling from either side of the building. The main travelling carriage runs upon iron rails of strong section securely fastened to timber sleepers. The crab and cross travelling carriage are of strong make having sides of cast iron constructed to work inside the main steel girders, and are provided with travelling wheels about 9in. diameter with large chain pulleys. The crab has a strong double-purchase lifting gear ; all the wheels are cast of hematite iron ; the shafts are of best wrought iron, and are fitted with catch gear for sustaining the load ; also powerful brake gear, these with hoisting motions all being worked from below. Messrs. Warner and Son inform us that the crane was erected prior to the completion of the building, and that it was used by the Brush Company to fix the engines and machinery.

The Switchboard Arrangements.

The unit system of switchboard arrangement, introduced by the Brush Electrical Engineering Company, has been carried out in this station. Each exciter has a switchboard arranged for running the exciter in parallel on to the exciter omnibus bars. Platinoid resistances wound on bars of slate with a sliding contact are used in the shunt circuit for regulating the pressure of the exciters, and through them of the whole station. The station voltmeter is placed near these resistances. Each alternator has arranged opposite to it a board equipped with double-pole high-tension fuses and switches for connecting the machine to the station omnibus bars, also an alternate-current ammeter, a voltmeter, and an ammeter on the field circuit. There is also a small plug connecting the alternator to the synchroniser. The synchroniser-board contains two synchronisers and lamps, together with double-pole switches for connecting the synchroniser to the station omnibus bars. It also carries the main station ammeter, and the main station recording meter, which is of the Shallenberger type. After passing through this board from the alternators the omnibus mains proceed to the circuit boards, of which at present there are two. Each is fitted with an ammeter and double-pole high-tension switch and fuse. The method allows of the addition of any number of exciters, alternators, circuits, and their corresponding boards, without interfering with the existing arrangements.

The Distributing System.

The distribution of current is effected by means of low-tension distributing mains at 100 volts pressure from the transformer sub-stations, which are situated at convenient points in the town. There are 14 sub-stations, most of which consist of underground brick chambers, 7ft. long, 4ft. 9in. wide, and 6ft. 6in. deep. One of these transformer stations is erected at the Town Hall, which has not yet been electrically lighted. The distributing mains, which are laid on the Callender solid system, consist of a pair of copper cables of 100 per cent. conductivity, insulated with vulcanised bitumen, and laid in a cast-iron trough, run in solid with refined bitumen. The case is covered by a cast-iron lid laid over the bitumen. The high-pressure feeder mains, which were supplied by Messrs. W. T. Glover and Co., comprise concentric copper cables of 100 per cent. conductivity, highly insulated with vulcanised rubber and tape; they are braided with tarred hemp yarn, and compounded, and are drawn into cast-iron socket pipes, 2in. diameter, coated inside and out with preservative compound. Suitable draw-boxes are, of course, provided at intervals. The high-pressure joints are of the Raworth-Geipel type, which have many advantages over the ordinary vulcanised rubber joints; the joints, being mechanical, are easily made, and can be inspected by merely lifting off the cover, whilst the cable can easily be disconnected for testing purposes. The transformer-chambers contain Mordey Victoria transformers of 18-kilowatt capacity, two or three converters being arranged in each sub-station.

The generating station is lighted by both direct and alternating current lamps, the former being arranged on the town circuit, and the latter on transformers connected across the alternating-current mains. The extent of the lighting so far comprises the compulsory area, and mains have been laid for the supply of current in the following streets : Albion-street, Marsh-street, Newhall-street, Old Hall-street, and all the principal streets and squares within these boundaries; also in Lichfield-street, Vine-street, and other streets on the way to the generating station. As already mentioned, the free library, museum, school of art, and public baths are lighted by electricity, and the other public buildings are to be lighted in the same manner. Several tradesmen's shops and houses have also adopted electrical illumination, and others are about to follow their example. The charge for current is 6d. per unit ; and, altogether, the central station reflects credit on all who have been associated in the bringing of the undertaking to a successful issue.

A NEW ELECTRIC CRANE.

The most suitable type of electric crane for general service would appear still to be a matter of considerable dispute, since each maker or designer claims for his efforts the highest point of economy and efficiency. Probably the true principle underlying these appliances will be found to vary in accordance with the special conditions under which they operate in each case, and no general rule of design can be drawn up for all purposes.

The firm of H. Bollinckx, however, has given considerable time and attention to the study of the question, and has come to the conclusion that certain definite principles may be laid down as applying to the design of electric cranes, at any rate so far as the overhead traveller type is concerned. Whether this conclusion is reliable or sound, must be decided after considering the results of these investigations by Messrs. Bollinckx—who are tolerably well known on the Continent for their engineering work. They conclude, first, that continuous—rather than three-phase or ordinary alternating—currents should be employed for the purpose, if only because lighting and other power transmissions may be effected from the same electric generator, or source of energy. Moreover, they consider that the speed of the crane motors may be varied more easily and with greater precision—a detail of some importance in foundry work when dealing with delicate moulds. The motors may likewise be reversed without employing special precautions or the use of brakes.

In the second place, they consider that a separate motor should be employed for each movement of the overhead crane : a greater mechanical simplicity is thereby attained from the absence of clutches, since the motors run either way indifferently. Thirdly, the current should be collected by means of soft metal contact-pieces easily replaced and renewed : and these should be placed *underneath* the conducting wires, so that the latter may rest freely upon their insulating supports. Since the longitudinal traverse of these cranes usually reaches 100ft. or 200ft., it is advisable to reduce the weight strain in the conductors as much as possible ; and this is best effected by the above plan, because the conductors are not supported from soldered joints as in the case of trolley wires, but simply rest upon the insulators, from which they are raised by the contact-pieces as they pass along.

It is advisable, in the next place, to arrange all the operations which regulate the separate motors, so that as a single lever is moved round in one direction or another it starts, stops, and reverses its respective motor, and regulates the speed as may be desired. Finally, a speed-reducing gear, which consists of a worm and worm wheel,

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should be used wherever possible, since the entire arrangement may be more easily boxed up and shielded from dust, etc. Moreover, the use of ball bearings to take up the end thrust of the worms becomes practicable, and much friction is thereby saved, especially as the gear is run in an oil bath. These are the chief points brought forward by Messrs. Bollinckx to advocate and explain the special characteristics of the design they now submit.

The annexed illustrations, from the *Revue Industrielle*, show some details of a 15-ton overhead travelling crane constructed on these principles by Messrs. Bollinckx for use in a foundry. The three electric motors employed respectively for longitudinal and horizontal traverses, and for lifting, are all made by the Henrion factory; that marked B drives by means of worm gear and two bevel pinions a cross-shaft, which carries a train of gearing connected with two of the traveller wheels, and so propels it along the gantry rails. At D is the motor for effecting the cross traverse through spur gears that drive an idle shaft carrying other and similar gears connected to the winch carriage. This motor is geared to the first train of spur wheels by means of a compressed leather pinion, so that easy and noiseless working may be secured. The third motor, C, operates the lifting winch by means of worm gear and spur wheels connected to a chain barrel. In this case, and in the first mentioned, the motor is attached to the worm by means of a Raffard flexible coupling. The smaller illustrations—Figs. 2 and 3—show the details of gearing, and also a section through the worm and worm wheel, in which may be seen the arrangement of ball bearings employed, as also the oil bath in which the gear works, and the general system of lubrication.

The longitudinal traverse of this crane is about 65ft. per minute, and the cross traverse 28ft. A speed of 10ft. per minute is attainable in lifting weights up to eight tons, and from 5ft. to 6ft. with a weight not exceeding 15 tons. Within these limits any desired speed may be used, as the revolutions of the motors are variable up to a speed of 1,200 per minute, by using resistances. For lifting heavier weights than those above named a greater speed-reducing gear is provided, as shown at N; this can be thrown in by a lever which moves the worm wheel spindle, H H. The conductors are shown at the side of the crane frame.

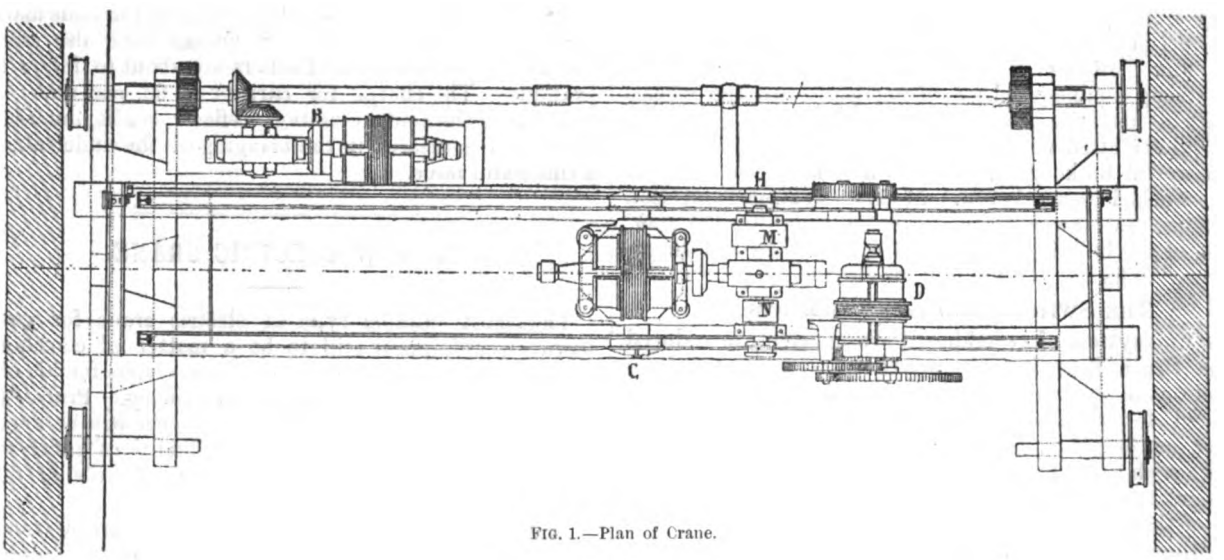

FIG. 1.—Plan of Crane.

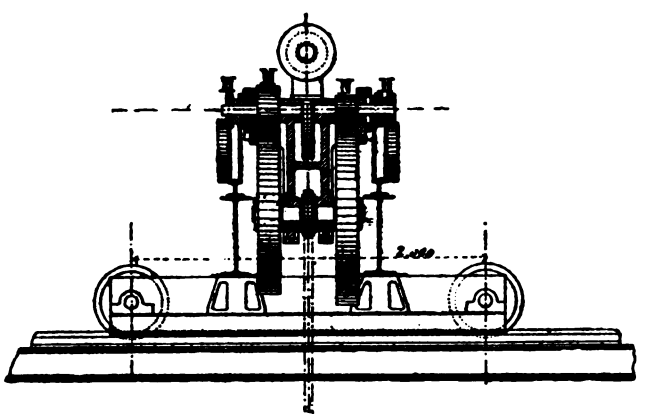

FIG. 2.—Cross-Section of Winch.

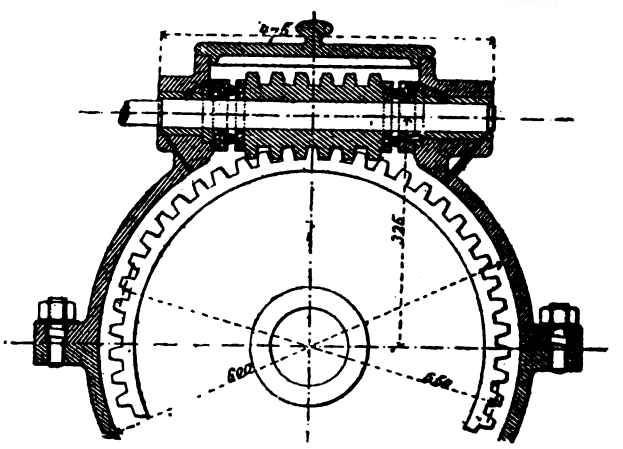

FIG. 3.—Section of Worm Gear and Case.

PHYSICAL UNITS.

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(Continued from page 92.)

MAGNETIC UNITS.

§ 48. The unit *magnetic pole*, *m*, is defined in exactly the same manner as the unit quantity of electrostatic electricity was defined in § 39. The analogue to electrostatic inductive capacity is magnetic inductive capacity, generally called magnetic permeability and denoted by μ. Hence the dimensional formula for strength of magnetic pole is

$$[m] = [F . \mu . L^2]^{\frac{1}{2}};$$
$$= [L^{3/2} M^{\frac{1}{2}} T^{-1} \mu^{\frac{1}{2}}].$$

§ 49. Magnetic *surface density*, σ^1, *intensity of magnetic field*, H, and *magnetic potential*, V, are defined similar to the corresponding quantities in electrostatics in § 40, § 42, and § 43 respectively, and hence their dimensional formulæ are:

$$[\sigma^1] = [L^{-\frac{1}{2}} M^{\frac{1}{2}} T^{-1} \mu^{\frac{1}{2}}];$$
$$[H] = [L^{-\frac{1}{2}} M^{\frac{1}{2}} T^{-1} \mu^{-\frac{1}{2}}];$$
$$[V] = [L^{\frac{1}{2}} M^{\frac{1}{2}} T^{-1} \mu^{-\frac{1}{2}}].$$

§ 50. The *moment* of a magnet, M, is the strength of either pole into the distance between the poles. Hence its dimensional formula is

$$[M] = [m . L];$$
$$= [L^{\frac{5}{2}} M^{\frac{1}{2}} T^{-1} \mu^{\frac{1}{2}}].$$

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If a bar magnet is placed in a uniform field of force, it experiences a couple tending to set it with the lines joining its poles in the direction of the force of the field. When the magnet is so placed that the line joining its poles is at right angles to the direction of the lines of force of the field, the couple is equal to the product of the magnetic moment into the strength of the field. Hence

$$[M] = [G \cdot H^{-1}];$$
$$= [L^2 M T^{-2} \times L^{\frac{1}{2}} M^{-\frac{1}{2}} T \mu^{\frac{1}{2}}];$$
$$= [L^{\frac{5}{2}} M^{\frac{1}{2}} T^{-1} \mu^{\frac{1}{2}}].$$

§ 51. *Intensity of magnetisation*, I, of an uniformly magnetised magnet is measured by its magnetic moment divided by its volume. Hence its dimensional formula is

$$[I] = [L^{\frac{5}{2}} M^{\frac{1}{2}} T^{-1} \mu^{\frac{1}{2}} \times L^{-3}];$$
$$= [L^{-\frac{1}{2}} M^{\frac{1}{2}} T^{-1} \mu^{\frac{1}{2}}].$$

This is equal to the surface distribution of the magnetism over the ends of the bar, and its dimensional formula is therefore the same as that of magnetic surface density.

§ 52. Magnetic *susceptibility*, κ, is the ratio of the intensity of magnetisation to the magnetising force. Its dimensional formula, therefore, is

$$[\kappa] = L^{-\frac{1}{2}} M^{\frac{1}{2}} T^{-1} \mu^{\frac{1}{2}} \times L^{\frac{1}{2}} M^{-\frac{1}{2}} T \mu^{\frac{1}{2}}];$$
$$= [\mu].$$

§ 53. *Magnetic induction*, B, is proved to be equal to the resultant of H and $4\pi I$. If the substance be isotropic and has no magnetism except what exists on account of the magnetising force, H, then

$$B = H + 4\pi I;$$
$$= H(I + 4\pi\kappa);$$
$$= H\mu.$$

The dimensional formula for magnetic induction is therefore

$$[B] = [L^{-\frac{1}{2}} M^{\frac{1}{2}} T^{-1} \mu^{\frac{1}{2}} \times \mu];$$
$$= [L^{-\frac{1}{2}} M^{\frac{1}{2}} T^{-1} \mu^{\frac{1}{2}}],$$

the same as that of intensity of magnetisation.

§ 54. These magnetic quantities may now be put into a tabulated form for convenience of reference.

Name.	Symbol.	Relation to other quantities.	Dimensions in L M T μ
Quantity of magnetism Magnetic pole	m	$\sqrt{\text{force} \times (\text{distance})^2 \times \mu}$	$L^{\frac{3}{2}} M^{\frac{1}{2}} T^{-1} \mu^{\frac{1}{2}}$
Magnetic surface density	σ^1	magnetic pole ÷ area	$L^{-\frac{1}{2}} M^{\frac{1}{2}} T^{-1} \mu^{\frac{1}{2}}$
Intensity of magnetic field ..... Magnetic force.....	H	force ÷ strength of pole	$L^{-\frac{1}{2}} M^{\frac{1}{2}} T^{-1} \mu^{-\frac{1}{2}}$
Magnetic potential ...	V	work ÷ strength of pole	$L^{\frac{1}{2}} M^{\frac{1}{2}} T^{-1} \mu^{-\frac{1}{2}}$
Magnetic moment ...	M	strength of pole × distance.	$L^{\frac{5}{2}} M^{\frac{1}{2}} T^{-1} \mu^{\frac{1}{2}}$
Intensity of magnetisation	I	moment ÷ volume	$L^{-\frac{1}{2}} M^{\frac{1}{2}} T^{-1} \mu^{\frac{1}{2}}$
Magnetic induction...	B	magnetic force × permeability	
Magnetic permeability	μ	—	μ
Magnetic susceptibility	κ	intensity of magnetisation ÷ magnetising force	

(To be continued.)

NOTES ON ELECTRIC TRAMWAYS IN THE UNITED STATES AND CANADA.*

BY H. D. WILKINSON, MEMBER.

(Concluded from page 102.)

I have here copies of two Bills which have recently passed the House of Representatives, authorising an extension of tramways in the city of Washington, in which the system of underground conduit I have just described is to be used. The section of the Act incorporating the Washington Traction Company which refers to the system reads as follows: Sec. 2. "That the motor power shall be the underground electric, such as is now in use on the U-street branch of the Rock Creek Railway, on all of its road east of Rock Creek, while the overhead trolley shall be used upon that part of the route north-west of Rock Creek until such territory shall be built up and the District Commissioners shall deem it proper that the wires shall be placed underground." The other Act empowers the Brightwood Railway Company of this city to extend their lines within the city, using the above system. It has been proposed to use synchronous, two-phase, or three-phase motors for tramcars, chiefly with a view to economy in the transmission of energy, but also with the object of avoiding electrolytic troubles. There are advantages to be considered in the use of alternating currents, but it would involve the carrying of line and return close together in the neighbourhood of telephone lines. A tramcar fitted with a three-phase motor, said to be the first one so fitted, was exhibited by Messrs. Siemens and Halske in the electricity building at the World's Fair. The motor was four-pole, of 20 h.p. nominal, but capable of working up to 60 h.p. at 500 to 600 volts and 1,400 revolutions. The reduction gear was enclosed in oil.

I now come to some points in power house plant. Most of the stations I visited had large cross or tandem compound horizontal condensing engines, the average units being of 500 h.p., driving 200-kilowatt generators by belts. These were usually compound machines, to give 500 volts on open circuit to 550 on full load, and had the intermediate connection taken from the brushes to the switchboard for coupling machines in parallel. In allowing for "drop" a good deal depends upon the site of the power house. In the heart of a city, where there are a large number of pedestrians and vehicles, the cars must of necessity travel at slow speed, and do not, therefore, require the full pressure, while in the suburbs speed is a matter of importance for business men coming into and leaving the city; and in Cincinnati it was particularly necessary to keep the pressure up, owing to the hilly nature of the suburbs. The power houses, I found, were built in the suburbs in situations most suitable to deliver highest pressure where most required. Short circuits being of very frequent occurrence, magnetic cut-outs were placed on the feeder and dynamo mains at the switchboard, and in some cases on the machines as well. With built-up fly-wheels of the ordinary type, it is well known that the maximum linear speed of the rim must not exceed a certain limit of, say, 6,000ft. per minute. Centrifugal force acting radially outwards tends to bend those portions of the rim lying between spokes, putting the outside of the rim in tension and the inside in compression. What the stresses due to bending actually are need not be gone into here, but it is evident that the safe factor between bending moment and circumferential tension of the rim rapidly diminishes as the limiting velocity is exceeded, and from this cause wheels occasionally fly to pieces without any previous warning. The large amount of energy stored in these 25ft. and 30ft. fly-wheels answered the purpose of keeping the volts up under sudden increases of load, but were somewhat a cause of anxiety when short-circuits came on. Either the magnetic cut-out did not act quickly enough and the inertia of the driving power kept the dynamo up to speed and forced it to a burn-out, or the engine raced to a dangerous extent on the quick withdrawal of full load Some instances of these came under my own observation. At the Hunt-street power house in Cincinnatti, where there are intermediate lines of countershafting between engines and dynamos, I noticed some repairs being effected, and was informed that seven pulleys on one line of countershafting had flown to pieces on the occasion of one main engine racing, and that the broken pulleys had smashed an equivalent number of dynamos which they were driving. I was then shown an ingenious arrangement that had since been added to the Corliss cut-off gear, in preparation for the next occasion of racing, by which steam could be instantly cut off the engines by pulling a cord which came over a pulley on the ceiling. These cords were dropped down at various points in the station, so that a man, say at the switchboard, could instantly stop any engine. Pulling the cord released a weighted lever, which moved a cam into such a position under the trip gear that steam was completely shut off

* This paper, which will be discussed before the Institution of Electrical Engineers, is taken from the *Journal* of the Institution.

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during the whole of the stroke. At the time of my visit to the Atlantic Avenue Street Railroad power house in Brooklyn, broken parts of one of the large fly-wheels, together with a generator, were just then being taken out through an opening in the station wall, which, with part of the roof, had been demolished by the flying pieces of a racing engine. The facts were fully reported in the American Press at the time, and the engineer in charge was highly spoken of for the manner in which he endeavoured to avert the catastrophe. On account of the uncertainty of cut-outs it was generally considered that the generators should be under-engined, thus allowing a margin for overload. I found, on the other hand, that some of the more recently planned power stations were equipped with direct-coupled plant; and the tendency of advanced practice in America, if one may take the plant at the World's Fair as an indication, was certainly towards direct driving. The General Electric Company, who completely equipped the very successful elevated electric railroad of three miles in extent through the Exposition grounds, used for the most part generators coupled both to horizontal and vertical engines; while the Westinghouse Electric Company supplied power to the moving sidewalk from a large dynamo taking the place of a fly-wheel between the high and low-pressure sides of a cross-compound horizontal engine. This company also exhibited a 160 h.p. generator direct-coupled to a Westinghouse high-speed engine, such as is regularly used in their power stations. I also saw well-arranged direct-driven sets in the power houses at Milwaukee and Cleveland. At the former place there was a very large Edison plant, with boilers on an upper floor and engines below. The engines were of 600 h.p., vertical, triple-expansion, condensing, each driving two 200-kilowatt generators. At Cleveland the power house of the Cleveland City Railway Company contained four vertical triple-expansion condensing engines, by the Globe Manufacturing Company of Cleveland, of 560 h.p., three driving two 190-kilowatt four-pole generators each, and one driving one six-pole generator; the maximum output of the station being 2,800 amperes at 500 volts. These engines were fitted with Joy's valve gear, controlled by a small centrifugal governor through the medium of a hydraulic valve. Dynamos were very carefully insulated from earth, in some cases by half an inch of sulphur under the rails, and in all cases by wood under the bed-plate, and where direct-coupled the coupling was insulated. This precaution is necessary where overhead wires are used, on account of lightning, to prevent a side flash between coils and framework. When a flash does pass by the machine, the damage is caused by the current of the machine following up the flash. The "magnetic blow-out" and "air-blast" arresters are being supplanted by Wurt's water-tank arrester, in which there is no spark gap. The well-known action of lightning in choosing to flash from coils to frame, instead of through magnet and armature coils to earth, on account of self-induction in the latter, is utilised in preventing its reaching the machine at all. Coils are placed in the line circuit—a sufficient number being in multiple to carry the current—and from these at intervals connections are tapped to carbon rods dipping into water in a tank. Lightning is checked by the induction of the coils, and discharges by the rods and water to earth. By the use of running water the normal loss from generators is reduced to a very small amount; and by using a small branch from the city water mains, with overflow pipe for this purpose, the additional advantage is gained of a good earth. I found that a good deal of power was tapped off the 500-volt tramway circuits for supplying private motors. On the Cleveland Electric Railway Company's system there was 350 h.p. taken off for this purpose, the motors varying in size from $\frac{1}{2}$ h.p. to 25 h.p. The tariff charged was 20s. per month per h.p. for 3 h.p. and over, or at the rate of 4d. per horse-power hour; the horse-power being averaged by a portable meter kept on the circuit for a given time.

Improvements have been made in the design of street car motors, their attachment to car trucks, and in decreasing their weight for a given output. Through the courtesy of the General Electric Company I am able to give a few particulars of their latest type of 25 h.p. motor, known as the "G.E. 800 Motor." This name is stated to be given to it on account of the drawbar pull exerted by the motor being 800lb. on ordinary street tracks, with 33in. car wheels, the usual single reduction gear, and rated current. The dead weight has been reduced to 1,450lb., or 730lb. below the former standard type of the same power—viz., the W.P. 50 (waterproof motor). Next to reducing the weight of the motor *per se* is the requirement of reducing dead weight on the axles and distributing it over the car. By the usual end suspension about half the weight is carried by the axle, and half by a cross-bar resting on springs; but by a new arrangement with side-bar suspension (Fig. 19), the whole of the weight is taken off the axle. The side-bar, B, takes the weight of the motor at the trunnion, E, and is itself supported by link bars bolted to the frame at the back (A), and by six springs in front at F, four of which take the weight, and two resist upward pressure. The wear and tear of the track is by these devices considerably reduced, and the running of the cars improved. The motor is enclosed in a cast-iron frame, in two parts hinged together, the same forming the field. There are two field coils, one in the upper and the other in the lower portion of the field; and, as these are wound to give similar poles, two additional consequent poles are formed between them, making a four-pole machine. The armature is cross-connected, so that only one pair of brushes is used; and these, with the upper field coil and armature leads, are fixed inside the upper half-frame and swing back with it. The iron of the field is of course to earth, and therefore special care is necessary to insulate the field coils; but the chance of a fault is minimised by coupling the coils to the earth return, in which case they can only vary by a few volts from the potential of the frame itself. The axle gear, which runs in an oil chamber, is arranged for a speed reduction of 4·78. The latest type of Westinghouse motor for street cars is built in a cast-iron horizontal frame, on which are hinged the upper and lower field magnets, so that the armature can be got at from above or below. There are four field poles, with as many coils. The armatures are drum-wound, each coil being wound on a former of the size of a quarter the circumference of the core, then taped, and slipped into its place between the teeth of the core. The wires composing the coil are laid so as to form a flat strip, which goes in edgewise between the teeth and lies flat at the ends of the drum, so economising space. The whole is then covered with waterproof material.

There are various types of "controllers," or combination switches, for putting the two motors on a car in series and parallel. The switch handle has from five to ten notches, giving different grades of speed. The first, or starting, position puts the motors in series through resistances; the succeeding steps reduce the resistances, shunt one motor out of circuit, and finally put both in parallel. There is also a side lever operating a cylinder of contacts for reversing the motors. I tried the experiment on one of these controllers of making the motors act as an electrical brake. Getting them first up to full speed, the controller was put back to starting position, current switched off, motors reversed, and then put in parallel again. The slight difference in excitation between the motors then caused one to act as a generator and drive the other, making a very powerful and quick-acting brake. A single switch might be employed which would effect these changes, and so prove an important aid to the mechanical brake in an emergency.

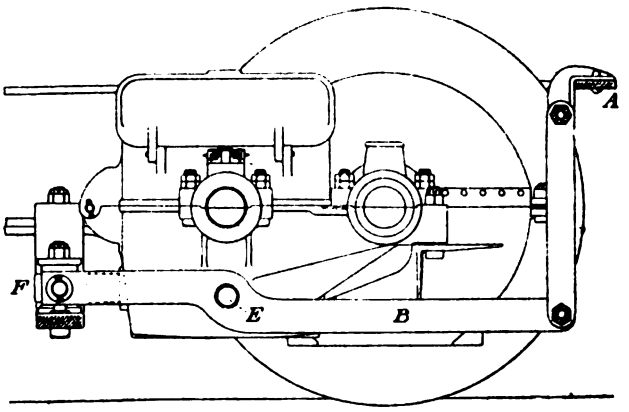

FIG. 19.—Side Suspension of Motor.

In Philadelphia I found very few streets with overhead wires, and learnt that an active policy had been pursued by the City Electrical Bureau towards the placing of all electric wires underground. One overhead trolley line was in operation, but the feeder cables were all in underground cement-lined conduits. Mr. D. R. Walker, chief of the Electrical Bureau, informed me that he, in company with the director of the Department of Public Safety, had examined into the systems of electric traction in other cities, with the view of employing the most suitable for the city of Philadelphia. He referred me to his report, which summed up as follows: "The overhead system of electric propulsion of street cars is, in my opinion, better fitted for small towns or villages, or to connect the same, or for the suburbs of a city such as our own; but when it comes to introduce electricity as a motive power in the heart of a large city, the circuits conveying the power for the same can, and should, be placed beneath the surface of the street. It has been effectually proven a success in Chicago, and is now being introduced to a large extent in Washington, D.C.; and any new privileges asked for in this direction should be granted only on condition that all the wires used for such a purpose should be placed underground. The only difference between the overhead and underground systems is in the matter of cost, which is but a secondary question when the safety and comfort of our people, and maintaining the beauties of our thoroughfares, are concerned. Again, a more reliable service can be maintained underground than overhead, as it would be free from interruptions caused by fire, falling of wires, or the action of the elements. The franchises so granted are immensely

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valuable, and while they are being issued the interests of the city should be taken into consideration, and provision made underground for its electrical systems and for the lighting of its highways."

I may mention incidentally that the city authorities use, or own and rent to private companies, about 25 miles out of the 150 miles of underground conduit laid. I refer here to conduits constructed for the reception of electric cables and feeders, not for tram-car propulsion. The wires owned by the city are for telegraph and telephonic communication from the City Hall to fire and police stations and street call boxes, of which there is a most complete system, and for the electric lighting of the streets. The city contracts with lighting companies to supply lamps and current only, posts and cables being erected and laid by the city. I was very much impressed with this imposing and beautiful city, and with the system of control exercised in the interest of the citizens over all electrical undertakings by the electrical bureau.

Of the 12,000 miles of tramway in the United States and Canada, about 7,200 miles are operated by electricity, and 3,500 miles by horses. In conclusion, I need only remark how well adapted electric traction is to the wants of the people. Following the ordinary highways, where business is done and people congregate and travel to and fro, tramways afford at once a means of locomotion that is readiest to hand with least trouble to the traveller. For short distances, people will not go out of their way to get on the railway, or climb steep staircases to elevated roads, provided that the street tramcars travel at a reasonable speed, with minimum delay. For the latter desideratum a modification of the American practice in cities of not stopping between "blocks" might be adopted, while for a reasonable speed we must look to other means of propulsion than horses. The cable system is very suitable in certain localities, such, for instance, as on straight and hilly roads, but the wear and tear of cable is enormous on curves. Steam is unsightly and obnoxious. Electricity affords at once rapid and noiseless travel, quick control, with small wear and tear, and the current can simultaneously be utilised for heating and lighting the cars. As a means of travel, I have not experienced in the States anything so pleasant as their well lighted and fast moving electric street cars; and I cherish the hope that ere long this public boon may be extensively put into action along the streets and lanes of our own country.

ELECTRIC POWER, HEATING, AND LIGHTING.*

BY G. BINSWANGER, M.I.E.E.

I feel confident that the invention of the electric motor will revolutionise the planning and building of our factories. At present our mills and factories for the most part are driven by steam power, and it is essential to bring the machines as near the source of power as possible, in order to avoid the cost and waste inherent in transmission by shafting and belting. No such consideration need affect the designing of our factories in the future. The power of the electric current can be transmitted easily, cheaply, and practically without loss through two wires; the motors can be placed directly near or upon the machines to be driven. Not only will the factory buildings themselves be constructed on different lines owing to this fact, but I look forward to an increase of home industry in which the several members of a family may be employed. From a social and economical point of view, this will prove a great advantage to many an industry and to many a community. It will, of course, receive due consideration in planning the construction of our workmen's dwellings. I look forward to the employment of electric motors in large public buildings, hotels, and in private houses.

I believe ventilation is an important question for architects, and one which has not yet found a definite solution. The usefulness of the electromotor in driving fans for ventilation has been again and again demonstrated and recognised. There can be no doubt that it will be employed largely for this purpose in the future, and will therefore have a considerable influence on the construction of buildings that require proper ventilation. At present lifts are only used in large buildings because the power required is costly, or requires room, or cannot be obtained conveniently. No doubt, with such a source of power as the electric current within the reach of private houses, we may look forward to seeing lifts, cranes, and other methods of mechanical conveyance introduced into smaller houses. I suppose the want of such mechanical conveyance is now influencing the construction of many a house. Why should the kitchen be near the dining-room if we can get our dishes sent into the room by merely pushing a button? Electric cranes have done good work in docks, and are much preferred to steam cranes. I think they will be largely employed in many of the operations necessary in the construction of buildings.

I will now refer to heating by electricity. Imagine a house built without flues, without chimneys, without hot-water pipes, and yet perfectly heated, perfectly ventilated, and with perfect cooking arrangements! Such a house could be built to-day if we call electricity to our aid. Many such houses, I doubt not, will be built within a not too distant period. Imagine the question of smoke abatement solved in this way! To heat the atmosphere in our rooms we make radiators or stoves; we can heat either by radiation or convection. Here is such a radiator, the heat produced in the wire resistance embedded in the cement is transmitted to an iron surface having many projections and blackened. It requires a current of 10 amperes at 100 volts to warm a room of about 3,000 cubic feet. This method of heating the atmosphere by electricity is still too young to predict the success of its ultimate employment, in preference to heating by coal or gas.

I do not purpose dilating upon the advantages of the electric light, its beauty, safety from fire, non-consumption of oxygen, its decorative uses, etc. All these have been dwelt upon so often. But may I seize the opportunity I now have of talking to architects to say a few words upon a subject in connection with electric lighting, a subject which, to my knowledge, has so far received but little ventilation before architects, to whom it must mean a good deal. This subject is: the wiring for the electric light. The method adopted in this and many other countries is to run two wires in wood casing, having two grooves in it. This method is a compromise between the electrical engineer and the fire insurance inspector; the third party who ought to have a voice in the matter has never been consulted—I mean the architect. I have heard many architects complain that this method is one which does not commend itself to them; it is difficult, and sometimes impossible to provide for it in new houses, and often disfigures the walls of existing buildings, to be installed with electric wires. By some it is looked upon as a necessary evil. I may affirm that this need not be so. We are not married to this system. I feel confident that a departure from present arrangements could be effected which would be appreciated both by the builder and the architect. I feel sure that the co-operation of the architect and electrical engineer will eventually produce such a modification as is felt to be desirable, and even necessary, by the electrical profession itself.

This brings me to say a few words about the education in matters electrical of an architect. Doubtless many a one is giving the subject his earnest consideration, but I think all architects should acquaint themselves with the elements of applied electricity. He ought to be familiar with the properties of wires, their carrying capacities, their resistances, and of materials used for insulating those wires necessary to fit them for use in electrical installations. A knowledge of these and similar subjects would be of considerable service to him in preparing his plans for our modern buildings, which will be all the better for being supplied with all the comforts and luxuries capable of being bestowed upon us by making electricity our servant.

I have so far refrained from referring to what would be the cost of employing the electric current for the purposes I have been speaking of. Doubtless, you will say, here lies the crux of the whole question. There can be no doubt that the operations can be performed, but they would be of little practical value, if their cost should be beyond your client's means. My reply to this is, that the cost is not excessive, or beyond the means of the moderately rich, even at the price at which the current is being generally sold, but there are indications and grounds sufficient at hand that may lead us to expect that one day electricity will also supply energy for light, power, and heat to the poor. The present ruling price is capable of being reduced, and the very fact of its being used for motive power and heating will necessarily bring down such price.

At present the average charge for current is 6d. per unit for lighting and 3d. per unit for other uses during the day. Mr. Crompton, in a paper on the cost of electricity, gives the actual works cost of current—that is, for coal and wages—at ½d. per unit. The rest of the cost, such as maintenance, interest on capital, and management, is in a measure governed by the load-factor, or the proportion to daily load compared with the capacity of the plant, and if this is large and well distributed, as it will be if heating, cooking, and motive power come to be used, the percentage of such extra cost to be charged in each unit will be small, and we may look forward to seeing electricity sold in our houses at or near 2d. per unit—a price at which electricity will be able to compete with coal or gas for light, as well as for power and heat, and be in many instances cheaper.

We may with confidence look forward to being able to obtain, at a not too distant period, cheap electric energy, concurrently with perfect and economical apparatus, for employing it for lighting, power, and heating. In view of this, architects will do well to contribute to the early and general adoption of electricity for such purposes, and thorough co-operation of architects and electrical engineers will, I feel confident, be of great value, and conducive to the furtherance of the objects which this Congress of Public Health has at heart.

* Abstract of paper read before the Engineering and Building Construction Section of the Congress of Public Health.

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REPAIR OF LAND-LAID CABLES.

We have always had a great appreciation of the work of submarine cable engineers and electricians. When properly done, their work can only be characterised as thorough, and those engaged in the newer developments of electricity have never sufficiently examined the accumulated knowledge of old cable workers. We are led somewhat to emphasise these conclusions from reading two able reports by Mr. Chas. Bright to the Silvertown Company—one on the repair of a land line, the other on the repair of a beach section of cable. The former has more interest to us than the latter, for electrical engineering is world-wide, and the burying of cables, electric light or otherwise, is as extensive. Telegraphists especially will be glad to know that the Silvertown Company has printed these reports, copies of which are to be found in various public libraries. But electric light cables, telegraph cables, and telephone cables have much in common when laid underground. They develop faults from various causes, and have to be repaired. These repairs are costly, and if the faults arise from neglect in manufacture, carelessness in laying, or being put into the wrong place, any information on these points is valuable. It is singular, for example, how persistent are certain mistakes in laying cables. It is known many a cable fault has been caused by the fraying of the cable hanging over a couple of rocky points, too little slack having been paid out to allow it to rest on the ocean bed. One would not expect faults of an exactly similar character to be found in trench-laid cables, but something very much of the same kind goes on, as was found in this repairing expedition. Not a fraying through motion, but a too little regard for the conformation of the ground; hence too great a strain at the bend of the cable through a valley trench. Then deterioration takes place through alternations of wet and dry, aided by a high temperature—three causes which may be found acting almost everywhere. In the particular case described the wind was the moving agent acting on a sandy soil. This, heaped up in one place and denuded in another, buried the cable deep under the surface in one place while leaving it near or quite at the surface in another, as well as putting an extra strain upon the cable from the accumulating weight of material at the ends of the bend. This report is exceedingly interesting reading, also, in that it discusses minutely every detail of the repairing operations, pointing out how wrong steps were taken in the original laying, and why these ultimately led to the development of faults. As yet electric light cables are in their infancy. They are in big towns laid in a different manner to the laying of this telegraph cable in Africa, but we are quite sure that electric light cables will from time to time develop faults, and have to be repaired. In fact, many of them have only during recent years been laid without that careful factory testing to which telegraph cables are continuously subjected, though it speaks volumes for the more prominent makers in saying that early in the

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industry they saw the necessity for such testing and subjected their manufacture to it, so that of late years the life history of a piece of electric light cable can be as easily ascertained as the life history of a piece of submarine cable. To the telegraph engineer these reports are of the greatest importance. They are the first, so far as we know, to exhaustively discuss the repair of land-line links in tropical climates. There seems to be no point overlooked. The type of cable, its insulation in particular places, the best depth at which it should be laid, jointing, etc., each and all are examined, and the reasons given for the adoption of the course pursued. We must congratulate Mr. Bright upon the admirable way in which he has presented these reports, and the Silvertown Company for having printed them and by placing them in various public libraries put them at the disposal of anyone who desires to consult them.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE SECOND ATLANTIC CABLE.

SIR,—Would you kindly tell me who laid the second Atlantic cable?

I used to be under the impression that Sir Charles Bright laid the first Atlantic cable, and that Sir Samuel Canning (as engineer-in-chief) was responsible for the laying of the second Atlantic. Lately, however, I have heard Sir James Anderson referred to so many times as being the person to whom we are indebted for it (as well as Cyrus Field for the first Atlantic) that I really don't know *what* to think. It is quite clear that some one man was in *charge* of the cable work, and I should much like to know who this really was.

The question has cropped up again recently in connection with the Eastern Telegraph Company's banquet at the Imperial Institute, when, according to the *Electrician* (which appears to have been the only electrical paper that was in a position to report the speeches)—the journal which, I understand, is the official mouthpiece of the "cable ring"—Sir John Pender seems to have said: "It was proved by our late colleague, Sir James Anderson, to be possible to pick up and repair a cable in 2,000 fathoms of water." On reading this in the *Times*, I thought it must be a mistake on the part of the reporter, so waited for the issue of the *Electrician* for verification—and got it. This would lead one to suppose that Sir James Anderson has been, at some time or another, placed in charge of a cable expedition—repairs, if not laying—and I should much like to know *which* one, if you can inform me.

Captain Anderson I have heard of as the gallant captain of the "Great Eastern" steamship—a very big ship, too, with several funnels, two paddle-boxes, and two screw propellers to be answerable for—but I did not know of Sir J. Anderson (afterwards the able manager of the Eastern Company) in the light of a cable engineer, and I should be glad to be further "posted up" in this subject if I am all afield.

Maybe it is hard for some people to realise that they are not, amongst themselves, responsible for *all* the cables laid—old as well as young.—Yours, etc.,

ENQUIRER.

Presentation.—The presentation of a handsome timepiece has been made to Mr. Burbey by the employés of Messrs. Burbey, Williamson, and Joseph on the occasion of his leaving the firm. Mr. Burbey being very popular with the employés, much enthusiasm prevailed, and the expression of good wishes for his future success were unanimous.

PRACTICAL NOTES ON DYNAMO CALCULATION.*
VIII.

BY ALFRED E. WIENER.

Experiments on the variation of the hysteretic loss per cycle as function of the temperature have been made by Dr. W. Kunz,† for the temperatures up to 800deg. C. They show that with rising temperature the hysteresis loss decreases according to a law expressed by the formula

$$H = a + b\,t,$$

where H = hysteresis loss per cycle, in ergs;
t = temperature, in centigrade degrees;
a and b = constants for the material, depending upon the temperature and on the maximal induction.

The decrease of the hysteretic loss, consequently, consists of two parts: one part, $b\,t$, which is proportional to the increase of the temperature, and another part, a, which becomes permanent, and seems to be due to a permanent change of the molecular structure, produced by heating. This latter part, in soft iron, is also proportional to the temperature, thus making the hysteretic loss of soft iron a linear function of the temperature, but is irregular in steel.

The curves in the latter case show a slightly ascending line to about 300deg. C., then change into a rapidly descending straight portion to about 600deg. C., when a second "knee" occurs, and the descension becomes more gradual.

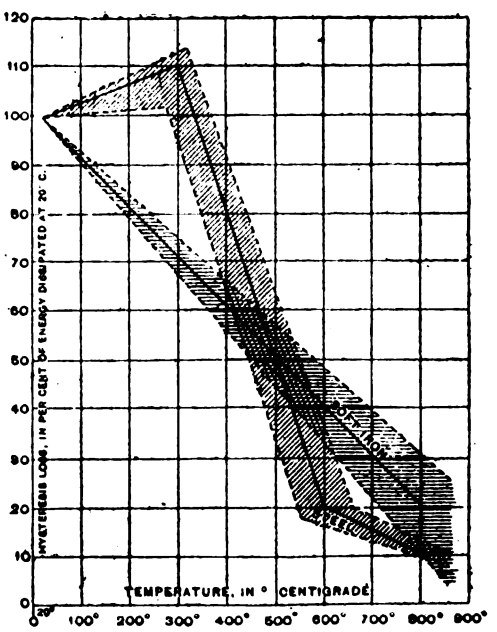

FIG. 15.

The writer has refigured all of Kunz's test results, basing the same upon the hysteresis loss at 20deg. C. as unity in every set of observations. In Fig. 15 dotted lines have then been drawn, enclosing all the values thus obtained for soft iron and for steel respectively, and two full lines, one for each quality of iron, are placed centrally in the planes bounded by the two sets of dotted lines, thus indicating the average values of the hysteretic losses, in per cent. of the energy loss at 20deg. C. Arranging the same in form of a table, the following law is obtained:

TABLE XXVI.—Variation of Hysteresis Loss with Temperature.

Temperature in centigrade degrees.	Energy dissipated by hysteresis in per cent. of hysteresis loss at 20deg. C.	
	Soft iron.	Steel.
20	100	100
100	90	103
200	80	106
300	70	110
400	60	80
500	50	50
600	40	20
700	30	15
800	20	10
20	70	40

* From the *Electrical World* (New York).

† Dr. W. Kunz, "Elektrotechn. Zeitschr.," vol. xv., page 194 (April 5, 1894); the *Electrical World*, xxiii., page 647 (May 12, 1894).

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The last row of this table, which give the hysteresis loss at 20deg. C., at the end of the test, shows that the energy required to overcome the hysteretic resistance is reduced to about 70 per cent. in case of soft iron, and to about 40 per cent. in case of steel, after having been subjected to magnetic cycles at high temperatures. Kunz further found that the hysteretic energy loss can thus be considerably reduced by repeatedly applying high temperatures while iron is under cyclic influence.

For soft iron a set of straight lines was obtained in this way, each following of which had a lower starting point, and descended less rapidly than the foregoing one, until, finally, after the fourth repetition of the heating process a stationary condition was reached.

For steel, already the second set of tests with the same sample did not show the characteristic form of the, at first ascending, then rapidly, and finally slowly, descending steel curve, but furnished a rapidly-descending straight line. For every further repetition the corresponding line becomes less inclined, and for the fifth test is parallel to the axis of abscissæ. Steel, therefore, after heating it but once as high as 800 deg. C., loses its characteristic properties, and with every further repetition becomes a softer, less carbonaceous iron.

c. Energy Dissipated by Eddy Currents.—From his experiments, Steinmetz also derived that the energy consumed in setting up induced currents in a body of iron increases with the square of the magnetic density, with the square of the frequency, and in direct proportion with the mass of the iron:

$$H_2 = \epsilon_1 \times B^2 \times N_1 \times M_1 ;$$

H_2 = energy dissipated by eddy currents in ergs;
B = density of lines of force per cm.^{2} of iron;
N_1 = frequency, in cycles per second, $= \frac{N}{60} \times P$;
M_1 = mass of iron, in cm.^{3};
ϵ_1 = constant, depending upon the thickness and the specific electric conductivity of the material:

$$\epsilon_1 = \frac{\pi^2}{6} \times \delta_1^2 \times \gamma_1 \times 10^{-9} = 1{\cdot}645 \times \delta_1^2 \times \gamma_1 \times 10^{-9}.$$

δ_1 = thickness in cm.;
γ_1 = specific conductivity in mhos.;
for iron, $\gamma_1 = 100{,}000$ mhos.;
for copper, $\gamma_1 = 700{,}000$ mhos.

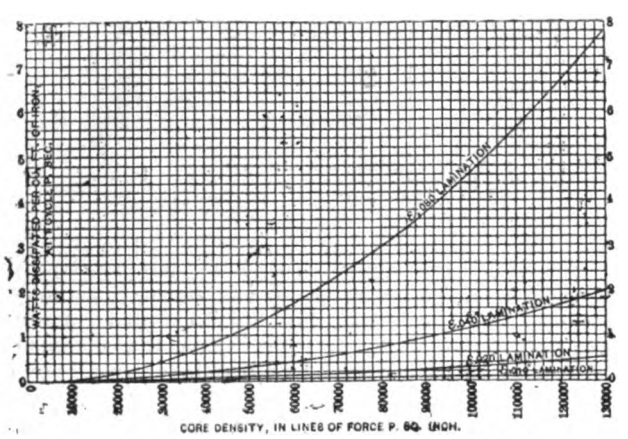

FIG. 16.

Inserting the value of ϵ_1, with reference to iron, into the above formula, and transforming into practical units, the eddy current loss in an armature, in watts, is obtained:

$$w_e = 10^{-7} \times 1{\cdot}645 \times (2{\cdot}54\,\delta)^2 \times 10^{-4} \times \left(\frac{\mathfrak{B}_a}{6{\cdot}45}\right)^2 \times N_1^2 \times$$

$$28{,}317 \times M\pi = 7{\cdot}22 \times 10^{-8} \times \delta^2 \times \mathfrak{B}^2{}_a \times N_1^2 \times M \quad . \quad (40)$$

δ = thickness of lamination, in inches;
$\mathfrak{B}_a$ = core density, in lines of force, per square inch;
N_1 = frequency, in cycles per second;
M = mass of iron, in cubic feet.

Uniting again $7{\cdot}22 \times 10^{-8} \times \delta^2 \times \mathfrak{B}^2{}_a$ into one factor, in this case the eddy current factor, ϵ, we have the simplified formula:

$$w_e = \epsilon_1 \times N_1^2 \times M \quad . \quad . \quad . \quad . \quad (41)$$

The values of ϵ for core densities from 10,000 to 125,000 lines per square inch, and for laminations of thickness, δ = ·010″, ·020″, ·040″, and ·080″, are given in Table XXVII.

TABLE XXVII.—Eddy Current Factors for Different Core Densities and for Various Laminations.

Magnetic density in armature core. Lines of force per sq. in.	Watts dissipated per cubic foot of iron at a frequency of 1 cycle per second. Thickn'ss of lamination, δ				Magnetic density in armature core. Lines of force per sq. in.	Watts dissipated per cubic foot of iron at a frequency of 1 cycle per second. Thickness of lamination, δ			
	·010″	·020″	·040″	·080″		·010″	·020″	·040″	·080″
10000	·0007	·003	·012	·046	66000	·0315	·126	·503	2·013
15000	·0016	·007	·026	·104	67000	·0325	·130	·519	2·075
20000	·0029	·012	·046	·185	68000	·0335	·134	·534	2·137
25000	·0045	·018	·072	·288	69000	·0345	·138	·550	2·200
30000	·0065	·026	·104	·416	70000	·0355	·142	·566	2·265
31000	0070	·028	·111	·444	71000	·0365	·146	·582	2·330
32000	·0074	·030	·118	·472	72000	·0375	·150	·599	2·896
33000	·0079	·032	·126	·503	73000	·0385	·154	·616	2·463
34000	·0084	·034	·134	·534	74000	·0396	·158	·633	2·530
35000	·0089	·036	·142	·567	75000	·0407	·163	·650	2·600
36000	·0094	·038	·150	.600	76000	·0418	·167	·668	2·670
37000	·0099	·040	·158	·633	77000	·0429	·171	·685	2·740
38000	·0104	·042	·167	·667	78000	·0440	·176	·703	2·810
39000	·0110	·044	·176	·703	79000	·0451	·180	·721	2·883
40000	·0116	·046	·185	·740	80000	·0462	·185	·740	2·958
41000	·0122	·049	·194	·777	81000	·0474	·190	·758	3·033
42000	·0128	·051	·204	.815	82000	·0486	·194	·777	3·108
43000	·0134	·054	·214	·855	83000	·0498	·199	·796	3·184
44000	·0140	·056	·224	·896	84000	0510	·204	·815	3·260
45000	0146	·059	·234	·937	35000	·0523	·209	·835	3·340
46000	·0153	·061	·245	·979	86000	·0535	·214	855	3·420
47000	·0160	·064	·256	1·022	87000	·0548	·219	·875	3·500
48000	·0167	·067	·267	1·066	88000	·0560	·224	·895	3·580
49000	·0174	·070	·278	1·110	89000	·0573	·229	·916	3·662
50000	·0181	·072	·289	1·155	90000	·0586	234	·937	3·745
51000	·0188	·075	·300	1·200	91000	·0599	·240	·958	3·830
52000	·0195	·078	·312	1·248	92000	·0612	·245	·979	3·915
53000	·0202	·081	·324	1·297	93000	0625	·250	1·000	4·000
54000	·0210	·984	·337	1·346	94000	·0638	·255	1·021	4·085
55000	·0218	·087	·349	1·397	95000	·0651	·261	1·043	4·170
56000	·0226	·091	·362	1·448	96000	·0665	·266	1·064	4·257
57000	·0234	·094	·375	1·500	97000	·0679	·272	1·086	4·345
58000	·0242	·097	·389	1·555	98000	·0693	·277	1·109	4·436
59000	·0251	·101	·403	1·610	99000	·0707	·283	1·132	4·528
60000	·0260	·104	·416	1·665	100000	·0722	·289	1·156	4·622
61000	·0269	·108	·430	1·720	105000	·0797	·319	1 274	5·095
62000	·0278	·111	·444	1·776	110000	·0875	·350	1·398	5·593
63000	·0287	.115	·458	1·833	115000	·0955	·382	1·528	6·113
64000	·0296	.118	·473	1·891	120000	·1040	·416	1·664	6 655
65000	·0305	·122	·486	1·951	125000	·1128	·451	1·806	7·222

Curves corresponding to the values of ϵ in the above table are plotted in Fig. 16.

TABLE XXVIII.—Specific Energy Dissipation in Armature Core.

Magnetic density. Gausses.	Lines of force per sq. in.	Hysteresis loss for sheet iron at frequency of one magnetic cycle per second (in watts). Per cm.^{3}	Per c. ft.	Per kg.	Per lb.	Eddy-current loes for 030″ (·075cm.) lamination, at one cycle per second proportional to frequency (in watts). Per cm.^{3}	Per c. ft.	Per kg.	Per lb.
2000	12900	·00007	1·98	·0091	·0041	0000004	·011	·000051	·000023
3000	19350	·00013	3·68	0140	·0077	0000009	·026	·000119	·000054
4000	25800	00020	5·75	·0265	0120	·0000016	·046	·000212	·000096
5000	32250	00029	8·20	·0378	·0171	·0000025	·071	·000327	·000148
6000	38700	00039	11·03	·0508	·0230	·0000036	·102	·000471	·000213
7000	45150	·00050	14·15	·0652	0295	0000049	·139	·000640	·000290
8000	51600	·00062	17·5	0806	·0365	0000064	·181	·000833	·000377
9000	58050	·00074	20·9	·0963	0436	·0000081	·229	·001054	·000478
10000	64500	·00087	24·6	·1133	0513	0000100	·283	·001308	·000590
11000	70950	·00102	28·3	·1303	0590	·0000121	·343	·001580	000715
12000	77400	·00118	33·1	·1524	·0690	0000144	·408	·001878	·000850
13000	83850	·00134	37·9	·1745	·0790	·0000169	·479	·002204	·000998
14000	90300	·00150	42·7	·1966	·0890	0000196	·555	·002553	·001157
15000	96750	·00168	47·5	·2193	·0990	0000225	·637	002923	·001328
16000	103200	·00187	52·9	·2440	·1103	·0000256	·725	·003340	·001512
17000	109650	·00206	58·3	·2680	·1212	·0000289	·818	·003770	001708
18000	116100	·00225	63·7	·2932	1328	·0000324	·917	004220	001911
19000	122550	·00246	69·6	·3200	·1450	·0000361	1·022	·004710	·002130
20000	129000	·00267	75·6	·3480	·1575	·0000400	1·133	·005225	·002362

(d) Total Energy Loss in Armature.—The total energy transformed into heat in the armature is the sum of the

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energies consumed by the winding, by hysteresis, and by eddy currents:

$$W_a = w_a + w_h + w_e \quad . \quad . \quad . \quad (42)$$

W_a = total watts absorbed in armature;
w_a = watts consumed by armature winding, formula (35);
w_h = watts consumed by hysteresis, formula (39);
w_e = watts consumed by eddy currents, formula (41).

For comparison, in the preceding Table XXVIII., the energy losses due to hysteresis and eddy currents, expressed in various units of the metric as well as the English system, are compiled.

17. *Radiating Surface of Armature.*—The radiating surface, or cooling surface, of an armature is that portion of its superficial area which is in direct contact with the surrounding air, and which consequently gives off the heat generated in the winding and in the iron core. It is evident that the shape and the construction of the armature and the arrangement of the field determine the size of this radiating portion of the armature surface. In drum armatures, for instance, only the external surface is liberating heat, while in ring armatures, according to design, either the external surface only, or any two or three sides of the cross-section, or even the entire superficial area, may act as cooling surface.

(*a*) *Radiating Surface of Drum Armatures.*—In drum armatures the dead portion of the winding forms two "heads" at the ends of the cylindrical body, and the external area, extending over the cylindrical part, as well as over these two conical heads, is the radiating surface of the armature. In order to calculate the cooling area of a drum armature, it is therefore necessary to first determine the size of the armature heads.

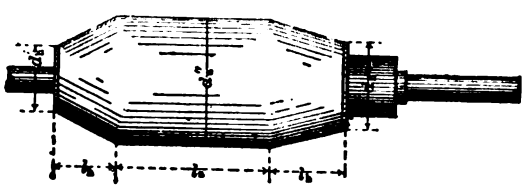

FIG. 17.

The length of the heads, l^h (Fig. 17), depends upon the diameter of the armature, the size of the shaft and the height of the winding space, and can be found from the empirical formula:

$$l_h = k_7 \times d_a'' + 2 \times h_a \quad . \quad . \quad . \quad . \quad (43)$$

where l_h = length of armature heads, in inches;
k_7 = constant, depending upon the size of the armature (see Table XXIX.);
d_a'' = external diameter of armature, in inches;
h_a = height of winding space, in inches.

The coefficient, k_7, in this formula varies with the slope of the head, and this, in turn, depends upon the ratio between the diameter of the armature and the thickness of the shaft. For in large machines the shaft bears a smaller proportion to the armature diameter than in small ones, and therefore in large armatures there is comparatively much more room between the shaft circumference and the body periphery than in small armatures, and since the diameter of the head must never exceed that of the armature itself, it is evident that the slope of the head is smaller, and consequently its relative length is larger in the smaller armatures. The following Table XXIX. gives the values of this coefficient for the various sizes of drum armatures:

TABLE XXIX.—Length of Heads in Drum Armatures.

External diameter of armature. d_a''.	Value of k_7.	Average length of heads. l_h. Inches.
Up to 6"	·60 to ·50	$l_h = ·55 \times d_a'' + 2\,h_a$
„ 12"	·55 to ·45	$= ·50 \times d_a'' + 2\,h_a$
„ 18"	·50 to ·40	$= ·45 \times d_a'' + 2\,h_a$
„ 24"	·45 to ·35	$= ·40 \times d_a'' + 2\,h_a$
„ 30"	·40 to ·30	$= ·35 \times d_a'' + 2\,h_a$

As to the diameters at the ends of the heads, that of the front head, d_h, at commutator end of armature, is generally made from $0·75\,d_a''$ to d_a'', while the diameter of the end washer of the back head, d_h, ranges in size from $0·5\,d_a''$ to $0·75\,d_a''$. Taking $d_h = 0·9\,d_a''$ as the average diameter of the front head, and $d_h = 0·6\,d_a''$ as that of the back head, Figs. 18 and 19, we obtain the following formula for the radiating surface of a drum armature:

$$O_a = d_a'' \times \pi \times \left(l_a + 1\tfrac{3}{4} \times \sqrt{l_h^2 + \left(\frac{d_a''}{8}\right)^2}\right),$$

or, approximately

$$O_a = d_a'' \times \pi \times (l_a + 1·8 \times l_h) \quad . \quad . \quad (44)$$

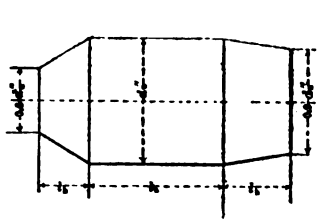

FIG. 18.

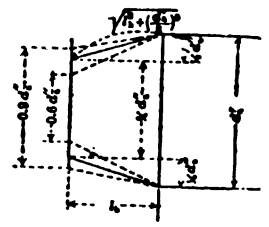

FIG. 19.

O_a = radiating surface of armature, in square inches;
d_a'' = external diameter of armature, in inches;
π = $d_a + 2 \times h_a$;
l_a = length of armature body, in inches, formula (12);
l_h = length of armature head, in inches, from formula (43).

(To be continued.)

ELECTRIC WELDING.*

BY BENJAMIN ALFRED DOBSON, MEMBER OF COUNCIL

EXPERIENCE IN ELECTRIC WELDING.

Practical everyday working for nearly three years of the process of welding by electric force enables the author to give certain indications and appreciations of the method considered as a practical workshop operation. During this period his firm has had two machines in operation, worked from the same generating dynamo, and employed on different classes of work: one is specially arranged for piecing bar iron and steel; and the other and smaller machine for special classes of work of a more delicate description, such as brazing and the piecing of clean-finished work, where the fire heat would have destroyed the quality of the work on the adjacent material. The statement made with regard to the requisite mechanical power placed great difficulties in the way at first, as it was found that this power had been much understated. Having something like 35 i.h.p. to spare on a certain engine, and understanding that 30 h.p. would be the utmost wanted in order to piece a 2in. round bar, the author determined to drive the dynamo from this engine, particularly as it was in close proximity to the smithy and stretching shed, where this piecing was previously effected by means of the ordinary smith's hearth. By this practical test it was found that not 30 h.p., but as much as 80 h.p. seemed to be required for the larger sizes; and until this was understood the engine was frequently stopped from want of steam, occasioning great loss and inconvenience. The company having control of the welding machine suggested that they should supply a semi-portable engine and boiler, and that this should be tried, with the option of purchase, after a certain length of time, if approved. This was agreed to, and a portable engine by Messrs. Marshall, of Gainsborough, capable of working up to 100 i.h.p. with 80lb. pressure, was supplied and placed at a distance of about 45 yards from the welding machine. This got over the difficulty of power, but was of course more expensive on the score of separate attendance and other cost. But even with this engine it was found that, when piecing the larger diameters—and as yet nothing over 2¼in. has been pieced—if the work was to be done within a reasonable time, the engine was seriously checked in speed. It was therefore with a view to be certain as to the basis of calculation for the necessary expenditure on driving power that the experiments which follow were conducted.

After some months' working with the portable engine, it was proved satisfactorily that the process was a practical one, and, so far as the results to the author's firm were concerned, a success. As considerable enlargements were about to be made to the establishment, a portion of a large dynamo-room for electric lighting purposes was set apart for the welding dynamo and exciter; the distance of the leads from the dynamo to the welding machine was approximately 100 yards. Having a quick-running vertical engine of the kind made by Messrs. Fleming and Ferguson, making 140 revolutions per minute,

* Abstract of paper read before the Institution of Mechanical Engineers.

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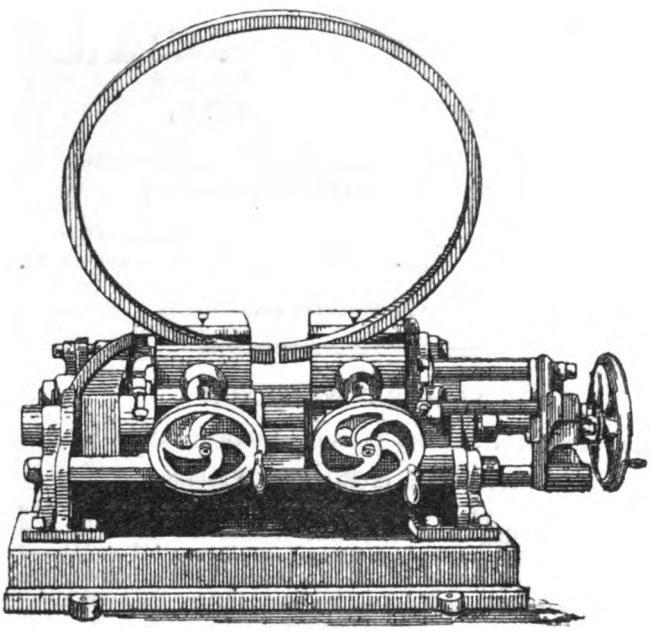
with an extra heavy flywheel and abundance of surplus power, the author has been able to work the larger diameters without affecting the steadiness of the arc lamps driven off the same engine; and as the load will vary 80 h.p. in the tenth of a second, this result speaks well for the arrangement of the engine and for its governing powers. The greatest variation in voltage of the lighting dynamos has been two volts.

Electric Welding Process.

The accompanying illustration shows the Elihu Thomson machine employed in welding a ring. The Thomson-Houston welding dynamo is an alternating-current machine. The field magnets project inwards from a cast-iron frame having six pole-pieces. Its speed is 1,000 revolutions per minute, and it gives at full load a current of 200 amperes at 300 volts, having a frequency of 100 complete alternations per second.



Welder with Hoop Ready to Weld.

The machine is excited from a continuous-current dynamo giving 40 amperes at a pressure of 110 volts. The large welder is capable of piecing iron or steel bars up to 2in. diameter. The primary coils consist of 41 turns of 0·452in. copper wire; these are coiled round an iron core formed of thin sheet-iron plates bolted together. The secondary circuit consists of a single massive copper tube 1¾in. diameter inside and 3¾in. outside, passing through the centre of the core, and connected at the two ends with massive castings 6¼in. broad by 3in. thick, which support the welding clamps; one clamp is kept stationary during the welding, and the other is movable. The pressure is obtained by a screw and hand wheel, forcing the movable clamp towards the fixed clamp.

Elihu Thomson Welding Process.

The heating effect of the passage of electric energy through a bar of any particular resistance is proportional, not to the amount of energy, but to the square of the current simply. In order, therefore, to obtain the greatest heating effect with a given amount of energy, it is advisable to use a very large current at a very small pressure. With this object an alternating current is employed in the Thomson process, and transformed down from something like 300 volts to one volt or even a fraction of a volt. The bar itself is held between two clamps of copper having a small resistance; and the portion of the bar to be heated for welding is that which lies between the two clamps, and which always has a much greater resistance than the clamps themselves or any other portion of the circuit. Even, therefore, if a solid bar be held between the two clamps, it becomes heated somewhere between the points at which it is held. If, however, as is the case for welding, the bar is not a solid one, but has a break in it at the point where it is to be welded together, then the greatest resistance in the circuit is at the surfaces of this break, where the contact is imperfect. Heat is developed here at once; and the surfaces being continuously pressed together by special apparatus, the metal as it softens is squeezed into closer contact, and eventually the two original separate pieces are thereby welded together.

Method of Working.

The method of working is somewhat on the following lines. The main carrying the current to supply the exciting coils of the alternator is conducted to the room in which the electric welder is placed. The main is attached to the terminal of a rheostat or resistance coil, and a return main is connected to the other terminal and is returned to the alternator, and from this another main is led back to the exciter. The rheostat now being in series with the exciting coils, governs the current of excitation, and thus controls the output of the alternator. A double-pole switch has one pole connected with the primary main leading to the primary coil of the electric welder, and the other pole connected with the exciting current main leading to the rheostat, so that this switch breaks the exciting circuit and also the primary circuit at the same time. When two pieces are ready to be welded, the double-pole switch is switched in, and the attendant adjusts the rheostat until the desired heat is obtained. The ordinary surfaces of bars, whether cut by shears or broken with the chisel and hammer, are found sufficiently uniform to permit of welding without further preparation. Should there be dirt or rust upon the surfaces, it is easily expelled when the metal is sufficiently soft to allow of the end pressure of the screw necessary to form union, and the dirt, scale, or oxide makes its way to the exterior.

In common practice at the author's works the following materials have been heated, and the undermentioned work has been performed. Welding of steel of every quality, iron of every description from crown to best roller iron and charcoal iron, steel and iron together, wrought iron and cast iron; different diameters of the same and different materials. Riveting in many varieties; work which previously had to be riveted cold, and which consequently left the strength of the parts uncertain, is now done easily, and certainly with the requisite heat. The piecing of countershafts and lathe spindles, where the question of exactness of length is of the utmost importance; screwing taps, rollers, and spindles broken in the neck bearings, and brazing of all descriptions have all been successfully treated. The alloys which have been tried have been done more for the purpose of experiment than for any useful end, and were not successful, owing to there not having been time to persevere sufficiently for ascertaining the precise temperatures and conditions under which the process could succeed.

Power Required for Electric Welding.

These tests have been confined to the welds required in everyday work, and have varied from ½in. steel and iron to 2in., as shown in Table I. The measurement of the alternating-current power supplied to the welding transformers is attended with some little difficulty, owing to the short space of time during which the current and E.M.F. are practically steady. As also every piece of iron varies in resistance, though cut from the same bar, the power registered is continually varying in the welding of bars of the same diameter. Another cause, accounting to some extent for the different powers obtained with the same size of shafting, is that the rheostat is not always worked from the same segment of the coils through the adding or deducting of the resistance, and consequently causes a greater or less excitation of the field of the alternator, thereby producing a greater or less E.M.F.

A Siemens electro-dynamometer was connected in series with the thick wire coil of a Siemens wattmeter, the latter being in series with the primary coil of the electric welder. Connected across the terminals of the welder was the thin wire coil of the wattmeter, in series with a non-inductive high resistance. A Siemens voltmeter for the measurement of alternating volts was also connected across the terminals of the welder. By this means the virtual volts and the virtual amperes were estimated with sufficient accuracy, and at the same moment a reading was taken from the wattmeter, giving the true watts absorbed in the transformer. At the time of taking the instrument readings indicator diagrams were taken from the engine, which afford a considerable check on the results obtained from the wattmeter. In order to estimate accurately the power taken for each weld, it is necessary to add the power required to excite the alternator and the power lost in transmission. For this purpose the resistance was measured of the mains supplying the current to the primary coil of the welder, and also the resistance of the mains carrying the exciting current; the former was 0·2 ohm, and the latter 2·6 ohms. The electrical horse-power given in Table I. is obtained from the true watts shown by the wattmeter, divided by 746, and the loss in the mains and in the exciting current is got by calculation; the loss in friction is the amount of power required to work engine, alternator, and exciter at no load.

Strength of Welds.

The following particulars are taken from Mr. Fish's draft paper, prepared for a former meeting of the institution, and, owing to the care with which the work seems to have been done, may be depended upon as correct. He says: "Twenty electric welds, bent hot, were bent through an average angle of 144deg. before cracking, Table II. In cold bending tests, however, the average with 20 pieces was only 66deg. before failure of the weld occurred. As a cause for this comparatively early failure, Sir Frederick Bramwell suggests the extreme localisation of heat in the electric welding process, and proposes annealing as a remedy. More recently a few welded bars, annealed either in the forge or by reheating a length of 5in. or

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6in. in the welding machine immediately after the swaging and working of the weld was completed, have been tested by bending cold under the steam-hammer. The results were much more favourable than those obtained by Mr. Kirkaldy, the average angle of bend at which failure occurred being about 130deg. In testing welds of smaller sizes, the writer has experienced but little difficulty in bending the bars, while cold, round their own diameter; and he suggests that in the Farnley welds failure in the bending tests was hastened by error in the method employed in making and finishing the weld, as well as by any possible effect due to the localisation of heat.

"In testing Bessemer steel welds Prof. Kennedy obtained the following results:

Diameter of bar	1·00	0·75	0·50 inch.
Average tensile strength of welded bar in percentage of unwelded	92	97·5	100 per cent.

The decrease in efficiency of weld with increase in diameter would seem to be due to a proportionately smaller butting pressure during the welding. A high percentage of strength at the weld, 80 per cent. or upwards, and probably more than would be required in any practical test of the metal, can be obtained with most of the hardest steels. Most metals that are commercially pure, and certain alloys, weld with little loss of strength, except that which may be due to the annealing effect of the process; this loss may amount possibly to a total of 10 or 15 per cent. Tests made by Prof. Silvanus P. Thompson and others show that the electrical conductivity at the weld is practically the same as that of the unwelded material. This result is possibly an index of the soundness and homogeneity of the electric weld."

Table I.—Power Expended in Electric Welding.

Work welded.	1894	Duration of current.	Electrical horse-power. Watts / 746	Loss in mains and in exciting.	Loss in friction.	Total.	Indicated horse-power.
	May	Sec.	e.h.p.	e.h.p.	e.h.p.	e.h.p.	i.h.p.
2in. wrought-iron bar.	24	243	59	10·8	18	87·8	—
Ditto. polished all over..... ...	25	256	55	10·8	18	83·8	—
2in. wrought-iron bar.	29	255	59	10·8	18	87·8	88
1⅛in. round iron bar. Average of 15 welds	16	57	17·7	6·3	18	42	42
Average of 7 welds	25	50	21	6·3	18	45·3	—
1in. steam-pipe, wrought iron	24	67	20·1	6·8	18	44·9	—
Ditto.	24	66	19	6·8	18	43 8	—
Ditto.	24	61	24·7	6·8	18	49·5	—
Ditto.	29	86	15	6 8	18	39·8	49
Ditto.	29	66½	25·5	6·8	18	50 3	49
1in. Bessemer steel shaft.....	23	64	22·3	8	18	48·3	—
Ditto.	24	65	22	8	18	48	—
Ditto.	29	62	23	8	18	49	49
Ditto.	29	54	27·6	7	18	52·6	51
¾in. Bessemer steel ...	24	37	15·5	6	18	39·5	36·5
Ditto.	24	38	15 2	6	18	39 2	36·5
Ditto.	29	50	17	6	18	41	48
Ditto.	29	54	15	6	18	39	43
½in. Bessemer steel ...	24	21	9 2	4·7	18	31 9	—
Ditto.	24	21	10·1	4·7	18	32 8	—
Ditto.	24	36	8	4·7	18	30·7	—
Ditto.	24	22	10·3	4·7	18	34	—
Ditto.	29	25	9 2	4·7	18	31·9	—
Ditto.	29	30	8	4 7	18	30·7	34

Table II.—Bending Tests of Electric and Hand Welded Round 1¼in. Bars of Farnley Iron. Electric Welds were Butt. Hand Welds were Scarf. Extracted from Messrs. Kirkaldy and Son's Report.

Welding.	Bent cold. Test No.	Angle of bend.	Effect of bending.	Bent hot. Test No.	Angle of bend.	Effect of bending.
	Y	Deg.		Y	Deg.	
Electric welded.	404	37	Broken	444	180	*Cracked
	406	65	Cracked	446	180	Uncracked
	408	65	Broken	448	160	Cracked
	410	34	Cracked	450	175	Cracked
	412	58	Broken	452	94	Cracked
	414	115	Broken	454	180	Uncracked
	416	65	Cracked	456	60	Cracked
	418	57	Cracked	458	180	Uncracked
	420	37	Broken	460	96	Cracked
	422	58	Broken	462	180	Uncracked
	424	58	Cracked	464	180	†Cracked
	426	50	Cracked	466	81	Cracked
	428	90	Cracked	468	163	Cracked
	430	150	Broken	470	98	Cracked
	432	95	Broken	472	180	Cracked
	434	59	Cracked	474	90	Cracked
	436	70	Cracked	476	120	Cracked
	438	35	Cracked	478	180	Uncracked
	440	55	Broken	480	180	Cracked
	442	64	Cracked	482	117	Cracked
	Mean of 20	66	—	Mean of 20	144	—
Hand welded.	640	60	Cracked	662	100	Cracked
	642	180	Uncracked	664	75	Cracked
	644	90	Cracked	666	180	†Cracked
	646	150	Cracked	668	180	†Cracked
	648	170	Cracked	670	180	†Cracked
	650	75	Cracked	672	180	†Cracked
	652	180	Crached	674	180	†Cracked
	654	180	Uncracked	676	90	Cracked
	656	180	Cracked	678	180	†Cracked
	658	180	Cracked	680	180	Uncracked
	660	70	Cracked	682	95	Cracked
	Mean of 11	138	—	Mean of 11	147	—

* Very slightly cracked; † Slightly cracked.

Conclusion.

The practical experiments made in the author's works show almost a better conclusion than the tests shown in published tables from the testing machine of the United States arsenal, for in bending cold here the weld has rarely given way. But in explanation of this it must be borne in mind that all the piecings of plain bars are here more or less swaged. It is well within the mark to state that there is not one out of 500 welds which turns out a failure or even defective. The question of cost, which of course is of importance to commercial engineers, has not been alluded to in detail. The author admits, however, that the payment of royalty, the cost of horse-power, and the depreciation which on electrical apparatus is heavy, together bring the cost considerably over the net cost of the ordinary smith's hearth work, while the actual payments in wages and so on are considerably less. The loss in weight of iron is about one-twentieth only. It may be taken that on straightforward welds the total cost will be between 10 and 15 per cent. more than the ordinary smith's work: whereas in delicate work and difficult operations, such as have been alluded to, the cost will probably be one-third of the smith's work. But the real advantage of the apparatus, at any rate as at present arranged, is not so much an economy as a method of securing an absolutely reliable result, and occasionally saving considerable expenditure by its special adaptability.

DESCRIPTION OF THE NEW ELECTRIC LIGHTING WORKS, MANCHESTER.*

BY DR. JOHN HOPKINSON, F.R.S., MEMBER OF COUNCIL.

The purpose of the present paper is merely to give a short description of the electric lighting works in Manchester, more particularly stating the minor points in which the arrangements differ from those most generally adopted. Although the differences from ordinary practice are small and comparatively unimportant, and involve nothing new in principle, a description of these works may be of interest on the occasion of the present meeting.

System of Distribution.

The system adopted is a direct continuous current, with five conductors supplying consumers at a pressure of 100 volts, the total pressure between the outer conductors being 400 volts. The conductors are partly bare copper in concrete culverts, and partly indiarubber insulated cables in cast-iron pipes. This arrangement of conductors is very similar to that which has been adopted in many other places, but is here carried out on a somewhat more extensive scale, the Portland-street culvert containing a total area of copper of 9¾ square inches. The sectional area of the three intermediate conductors is small—only ¼ square inch for each; whereas the total sectional area of the outer conductors in this case is no less than 4½ square inches. As might naturally be expected, such small intermediate conductors are in themselves inadequate to effect a perfect balance; the balance is therefore perfected by means of motor-generator machines fixed in outlying parts of the system. Each of these machines is wound with two circuits, so that the pair contains four circuits, each circuit being connected with two conductors of the five-wire system. The two

* Abstract of paper read before the Institution of Mechanical Engineers.

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machines being connected mechanically with each other by a coupling, any excess of current demanded from one section will be supplied by the circuit connected thereto, and the power required to effect this supply will be derived from one or more of the other circuits. As a compensating device this arrangement is found to work perfectly; it does not claim any originality, as it has been in use for some time in many places. Electricity can be supplied to consumers at four different pressures, according to their requirements.

Insulation.

The system of bare conductors has the disadvantage that the general insulation is poor; but this really causes no trouble, as it is a general small leak over the whole system, and does not tend to get worse. There is one curious fact in connection with this defective insulation; the insulation of the positive conductor is always good, while that of the negative is always bad. The fact has been generally known for some time, but the author did not realise its importance till he experienced it. Electrolysis will deposit upon the negative conductor hydrogen from the moisture on the insulators; hence this exceptionally defective insulation is not calculated to injure the conductor. The explanation, so far as the author is aware, was not known. The difference in insulation between the positive and negative conductors arises from electric osmosis, which may be explained as follows. Suppose two vessels containing water to communicate by a cotton wick, and two electrodes differing much in potential to dip into the two vessels, then it is found that water passes over continuously from the vessel into which the positive electrode dips to that into which the negative electrode dips. This fact has long been known to physicists as a laboratory experiment. Next, suppose two electrodes to be carried on porcelain insulators which dip into water, and the water to be maintained at earth potential, and the two electrodes to be one positive and the other negative, then if the current leaking from each electrode into the water be measured, it is found that the leak from the negative is many fold the leak from the positive; this experiment the author has himself tried. The action of bare conductors is the same upon a large scale. The main source for moisture is from the walls and floor of the culvert; this moisture will constantly creep over the porcelain insulators towards the negative conductor, but will creep away from the positive conductor, drying the neighbourhood of the latter and improving its insulation. With the five-wire system the troubles have been few, and all easily met; with the bare conductors there have been no troubles at all.

Switchboards.

The switchboards are very simple and compact. The feeders are connected to vertical bars, each feeder to one or other of a pair of bars through a single two-way switch at the bottom of the pair of bars. The pole of each dynamo machine is connected through a switch to a horizontal bar of its own; and the horizontal and vertical bars are connected to each other by removable screw plugs. Suppose feeder No. 1 is connected to machine A through the left-hand vertical bar, and that it is desired to change this feeder to machine B. For this purpose a screw plug is put in for connecting the horizontal bar of machine B to the right-hand bar of the feeder, and the switch is thrown over, so as to connect the feeder to the right-hand bar, and to disconnect it from the left-hand bar. The change is thus effected in a fraction of a second. The double switches at the end of the horizontal bars have to do with exchanging from one machine to another. A resistance of about three ohms is permanently interposed between the two sections of each switch, and one section is permanently connected to the conductor from the machine. On each bar is an ampere indicator, competent to show when the current is nil. Suppose it is desired to take work off machine C, and put in D in its place. First, the horizontal bar of D is connected by screw plugs to all the vertical bars through which C is working, and machine D is started running. Next, by the double switch machine D is connected to its horizontal bar through the resistance of three ohms. Then the indicator is watched, and as the speed of D rises the current passing back from the system of conductors through D will diminish; at the moment when it is nil the resistance is short-circuited by the same double switch, thereby connecting D direct to its bar. Machine C is now slowed down, and at the moment when its current is shown by its indicator to be nil it is switched out, and the change is completed. The machines may each be run at the pressures suited to the feeders with which they are connected.

On the five-wire distributor-board there are six sliding glass plates with holes through them, two holes in each plate, for ensuring that it shall be impossible to put plugs into wrong places, and for preventing thereby the serious consequences which would follow such a mistake.

Engines and Dynamos.

In the first instance six engines and six dynamos of about 100 h.p. each were put up, and also four engines and four dynamos of 400 h.p. each. The six smaller dynamos give nearly 600 amperes at a little over 100 volts; the four larger give 600 amperes at a little over 400 volts. The engines are all vertical compound condensing, and drive their respective dynamos by link belts carried under jockey pulleys. The jockey pulleys works in every respect as well as simple belts of adequate length, and the loss of power is increased to only a very small extent, if at all. Compared with ordinary belt driving, the saving in space is considerable. In comparison with high-speed direct driving there is the advantage of entire freedom as to speed both of engines and of dynamos, and there is less liability to vibration. On the other hand, high-speed engines takes less space, and the author thinks if single acting they make less noise. In his opinion there is no great balance of advantage in one system over the other.

The condensers are ejector condensers, the condensing water being lifted some 30ft. in order to give an adequate head. These condensers have been found effective, giving a vacuum of 25in., and they prove most convenient. The regulation of electric pressure is effected by adjustment of the governor whilst running. Two more engines and dynamos of 400 h.p., exactly like those already erected, have been ordered after the experience of last winter.

Boilers.

The boilers are of Lancashire type, 30ft. long and 8ft. diameter; at present they are six in number, and a seventh is now being added. They work at a pressure of 125lb. per square inch, and are fitted with mechanical stokers, and the water is heated by economisers. The steam-pipes, feed-pipes, valves, and economisers are all in duplicate. The boiler-house, 77ft. long by 70ft. wide, is covered from end to end by a steel water-tank, weighing about 160 tons, constructed in seven compartments, and holding 205,000 gallons of water. In addition to the engines already on order, there is room for eight more large engines and five additional boilers. Hitherto no accumulators have been used; but in the author's opinion the present reduced price of these and their increased durability justify their introduction into large stations as well as small. There will, of course, be no difficulty in adding them when it is desired.

Conclusion.

There are connected to the mains 18,600 incandescent lamps of 16 c.p., 250 arc lamps, and motors to the extent of 16 h.p. This is an encouraging result when it is remembered that a preliminary supply on the two-wire system was begun only just a year ago. The average price to the consumer up to March 31 was about 5½d. per unit.

In conclusion, the author wishes to express his thanks to three gentlemen who have contributed much to the substantial success of the undertaking—namely, to Alderman Lloyd Higginbottom, the able mechanical engineer and vice-chairman of the Electric Lighting Sub-Committee, for his constant advice in all matters, whether engineering or commercial; to Mr. Charles Hopkinson, who designed the buildings; and to Mr. C. H. Wordingham, formerly the author's assistant, and now engineer of the station. He has also been not a little indebted to some of those who have contracted for the work; but they are many, and it would be invidious to distinguish.

THE HISTORY OF WOODHOUSE AND RAWSON UNITED, LIMITED,

As Detailed in the Bankruptcy Court.

The public examination of the directors and officers of this Company was continued on Friday last before Mr. Registrar Hood at Bankruptcy-buildings, Carey-street, Lincoln's-inn.

Mr. H. G. Rawson stated, with reference to the evidence given at a former sitting, that Sir Rawson W. Rawson became aware of his son's (Mr. F. L Rawson's) connection with the Phœnix Trust in September, 1890. There was no suggestion that when Mr. F. L. Rawson surrendered 25 shares held by him in the trust to the United Company, pressure had been brought upon him; the act was purely a voluntary one.

Mr. Registrar Hood said that was his impression of the evidence.

Mr. F. L. Rawson, recalled, stated that in the balance-sheet of 1891 a sum of £2,640 was included as "surplus assets on the Kidsgrove purchase." An amount of £1,000 was included in respect of the same in 1890. These sums represented the value which was placed on the stock and plant at Kidsgrove by the manager of the business, beyond the valuation of the vendors. It now appeared that a report upon that branch was made by the auditors who prepared the balance-sheet, in which it was submitted that the sum ought not to be included. So far as witness was aware that report had never been before the directors, and it did not come to his knowledge until after the winding-up order. The report ought to have been laid before the Board.

Mr. Stutchbury, who acted as secretary of the Company at the date of the report, said that he had some recollection of seeing the report. No record of it was in the minutes. He could not say whether the report was brought to the notice of the Board.

By **Mr. Jenkins**: Witness did not suggest that the minutes had been tampered with. It was his duty to write out the minutes, but they were always revised and altered by the managing director

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and the chairman of the Company. Witness did not always look at the revised minutes. He did not suggest that any alterations were made in his minutes which would amount to misrepresentations as to what actually took place at the Board meetings

Mr. F. L. Rawson further stated he was certain that he did not see the report in October, 1891. In the printed balance-sheet which was laid before the shareholders on December 22, 1892, a sum of £17,784 was written off as loss on the Kidsgrove works. The report of the auditors showed a loss in 1891 of £11,000, and if the report had been received by witness it would have been laid before the directors. There was no reference to the losses at Kidsgrove in the directors' report to the shareholders in 1891, neither was there any statement that a profit had been made. At the meeting, the chairman (Sir Rawson W. Rawson) said that the directors hoped to establish a sound and profitable business, so that the shareholders could not have been led to believe that the Kidsgrove works had made a profit. On November 16 it was resolved to inform the managers of the various concerns that more care ought to be exercised in the Company's transactions, forwarding at the same time copies of the various accounts. The accounts showing the loss on the Kidsgrove business could not have been sent out because the directors were not aware of their existence. Questioned as to the Company's dealings with the Phœnix Trust, witness said that 25 founders' shares of £1 each were acquired. In the balance-sheet of 1891 they were valued at £15,000. Dividends and cash to the amount of £6,625 had been received from the trust, and shares in the Elmore companies were also transferred. The United Company had shared with the trust the profits derived from the promotion of companies. A profit of £5,600 was taken into the books of the Company in connection with the promotion of the French Elmore Company, the shares being subsequently sold for the like amount. A sum of £15,588 had been charged as profit in connection with the Elmore companies, and up to the present time only the £5,600 mentioned had been realised, the other shares not having been disposed of. One of the companies had been in existence for three years, and had not yet paid a dividend.

The **Official Receiver**: I think companies generally pay a dividend the first year.

Witness said that was not always the case. Out of a sum of £36,658 included as profit about £27,000 had not yet been realised.

The **Official Receiver**: Having regard to the large amount of profit made on paper, what explanation do you give for increasing the value of the shares in the Phœnix Trust from £25 to £15,000?

Witness said that when the Board was considering the value of these shares an offer had been made of £10,000 for the shares.

The **Registrar**: Who made the offer?

Witness said that Baron Grant was anxious to obtain shares in the trust, and offered £10,000 for them. The directors, however, thought that if the shares were worth £10,000 to Baron Grant they were certainly of more value to the Company, and therefore the offer was refused. An investigation was made into the position of the trust, and as to what the Company would receive in respect of their share of the assets if the trust was wound up It was ascertained that the Company's interest amounted to about £17,000, which was taken in the balance sheet at £15,000. This sum represented almost entirely Elmore securities, which witness believed to be of that value. With reference to the return of the dividend guarantee fund, witness stated that a rebate of £12,000 was allowed on £73,000, 18 months in advance, the balance being paid in debentures and cash. The Company had to borrow money at 7 per cent. interest to provide for the payment of the cash, the interest amounting altogether to £3,660. Witness next entered into an elaborate statement with reference to his justification for the inclusion of a profit of £35,000 in connection with the Epstein Company. He said that the United Company had expended £30,000 for the purpose of working out the patent. He did not consider that the profit was so large, having regard to the money and labour spent upon the patent. With reference to the sum of £37,000 included in the balance-sheet of 1891, witness denied that it was included with the idea of his receiving commission upon it.

Some further evidence having been given, the enquiry was adjourned until August 6.

THE ELECTRIC LIGHTING OF THE VICTORIA EMBANKMENT AND BRIDGES.

THE CAPITAL EXPENDITURE.

A report by the Highways Committee was presented to the London County Council on this subject on Tuesday. The committee stated that when they brought up a report to the Council in June, 1892, recommending the establishment of an electric installation for the lighting of the carriageway, footways, and parapet walls of the Victoria-embankment, they observed that they were advised that the capital expenditure would probably not exceed £10 000, while the cost of maintenance, including depreciation, repair, interest on capital, and ample provision for labour, would probably not exceed £2,000 per annum. The Council on June 28, 1892, adopted the recommendation, and at the same time instructed the committee to confer with the Bridges and Parks Committees respectively, and to report whether the plant could be established on a sufficient scale to enable Westminster and Waterloo Bridges and the embankment gardens to be lighted from the same source. The Council subsequently, on November 1 of that year, decided to seek parliamentary sanction for the carrying out of the installation for all these places, and powers were obtained for the purpose in the London County Council (General Powers) Act, 1893. The addition to the initial scheme submitted by the committee necessarily involved additional capital expenditure, and in the Council's Money Bill of 1893 £15,000 was provided for the purpose of establishing the installation.

In submitting their scheme on June 28, 1892, the committee stated that it was proposed that lamps of from 1,000 c.p. to 1,200 c.p. should be placed in the centre of the carriageway at about 50 yards from each other; that about 50 of these lamps would be required; and that the supply of electric light might be extended to the existing lamps on the parapet walls, and, where necessary, to those on the footways. A proposal then made to refer back this recommendation for further consideration, especially on the point of the distribution of the lamps, was not adopted by the Council; but on March 13, 1894, the views of the Council appear to have changed, for by resolution it expressed the opinion that it was undesirable to place any columns for the purpose of electric lighting along the centre of the embankment.

This resolution involved a reconsideration of the whole of the scheme; and the committee are now informed that instead of a total number of 108 lamps as originally anticipated, by the adoption of side lighting 136 will be required, an increase of more than 25 per cent. A further consequence of the resolution is that the cost of the buildings and of the boilers and machinery will also be more than anticipated. Moreover, the period for the repayment of loan has been reduced from 40 years, upon which the committee calculated as regards the more substantial part of the undertaking, to 25 years for the whole. The original and revised estimates for the installation for the embankment and the two bridges are as follow: capital cost for original estimate for 108 lamps, £15,000; revised estimate for 136 lamps, £20,000; the maintenance would be respectively £3,010 and £3,880.

The committee state that the cost of the gas lighting is about £1 800 a year, but in this amount nothing is included for interest on or repayment of loan, nor for depreciation with respect of gas lamps and mains, information as to which cannot be obtained. It is evident from the figures stated above, the committee observe, that any comparison of the relative cost of the electric light as against that of gas lighting is necessarily unfavourable to the former; but on the other hand they point out that the illuminating power of the electric light is so very much greater, and the importance to the community of a magnificent thoroughfare like the Victoria-embankment being properly and efficiently lighted is so obvious, that the extra expenditure appears to be fully justifiable.

The committee are assured that the revised estimate given above is fully adequate, and that, unless any special and unforeseen circumstances arise the Council will not have to be asked to incur any capital expenditure beyond the £20 000, the amount of the revised estimate. As above stated, the original estimate was £15,000, and it will be necessary to supplement this with a further sum of £5,000. The committee accordingly recommend that, subject to a supplemental estimate of £5,000 being submitted to the Council by the Finance Committee, the authorised capital expenditure in connection with the electric light installation for the Victoria-embankment and gardens and Waterloo and Westminster Bridges, be increased from £15,000 to £20,000. The consideration of this report was deferred by the County Council until next spring.

The Designs for Lamp Standards.

The Council, on July 10 last, instructed the committee to take the necessary measures for obtaining designs for the electric lamp standards to be erected on the Victoria-embankment, and to advise the Council what premium should be offered for the best design. Having given full consideration to the matter, they are of opinion that the premium should be 25 guineas. As soon as the Council have decided the amount of the premium, the committee will proceed to invite competitive designs, and they propose to consider later on the question as to what arrangements shall be made for carrying out the Council's resolution. They recommend, therefore, that £26. 5s. be the amount of the premium to be offered for the best design for electric lamp standards.

Generating Station Buildings.

The committee have considered the two tenders opened by the Council on July 10 last for the erection of the generating station buildings for the electric light installation. The lower is that of Messrs. Foster and Dicksee, who offer to do the work for the sum of £5,562, and the committee think that their tender should be accepted. They accordingly recommend that the tender of Messrs. Foster and Dicksee be accepted, that the solicitor be instructed to prepare a contract to give effect to the tender, and that the seal of the Council be attached to the contract when ready. This recommendation was also postponed until next spring.

Plant for Generating Station.

The Council on Tuesday opened the tenders received for the supply of engines, dynamos, switchboards, etc., and boilers, condensers, pumps, etc., required for the generating station. Owing to the delay which must necessarily occur in obtaining the designs for the lamp standards, and afterwards the requisite supply of standards according to the selected design, it will not be possible to fully light before next winter the embankment and gardens by means of the installation; but the committee are endeavouring to arrange for the electric lighting of the bridges and of the parapet wall of the embankment before that time. In order therefore that there may be no unnecessary delay in consequence of the vacation, the committee recommend that the tenders,

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which are given in another column, be referred to the Highways Committee with authority to accept the tenders which it may consider most advantageous to the Council, and to enter into contracts on behalf of the Council.

MAINS AND LAMPS.

The committee think it advisable that contracts should be entered into at as early a date as possible for the supply and laying of the mains, and for the supply of the electric lamps to be placed in the lanterns. They therefore recommend that the Highways Committee be authorised to invite tenders, and to enter into contracts on behalf of the Council for the supply and laying of the mains, and the supply of the electric lamps required for the installation.

THE CITY COMMISSION OF SEWERS AND TELEPHONE TUBES.

In our issue of 20th ult. we referred to the discussion which took place at a meeting of the City Commission of Sewers during that week on the subject of the telephone tubes laid down by the City of London Electric Lighting Company.

On Tuesday the matter again came up, when **Mr. Pannell** moved the following resolution, which stood on the agenda paper in his name: "That the resolution of this Court of July 25, 1893, agreeing to a recommendation of the Streets Committee, that the Commissioners only consent to the use for telephonic purposes of certain tubes laid by the City of London Electric Lighting Company, on a guarantee being given that telephones with double wires and all the latest improvements will be supplied to the citizens at a cost not exceeding £8 per annum, be rescinded." Mr. Pannell said he would not have brought forward the motion had it not been for a remark dropped at the last meeting by an hon. member which he thought was extremely pertinent. The member to whom he referred said no committee or section of the Commission could deal with any negotiations in regard to the question while the existing resolution appeared on the minutes of the Court. He (Mr. Pannell) agreed that the present position in which the Court was placed was a very undesirable one. The tubes which had been the subject of dispute were underground, and they represented a capital of between £80,000 and £100,000. The Commission had received an offer whereby the rates could be benefited, while it was possible also that the users of telephones would be the recipients of benefits, but as long as the present block existed the Court was simply playing into the hands of the National Telephone Company. That company, Mr. Pannell proceeded to observe, were wise enough to secure the new company which was started first and was called the New Telephone Company. The former company had indeed absorbed the latter together with the contract for the leasing of the tubes in question. He ventured to say that it was now most advisable to put an end to the present state of affairs, and this could be accomplished without any sacrifice on the part of the Commission. Mr. Pannell said he would not venture to suggest any form or arrangement by which the ratepayers might hereafter benefit, or by which the users of telephones in the City would reap an advantage, but it was only right that the Commission should have the means of carrying on negotiations in the future, and that the Court should be removed from the present difficult and impossible position. The object of his motion was simply to clear the ground, and in his opinion the ground should be cleared as speedily as possible.

Mr. Sayer having seconded the motion, and expressed his concurrence with the views of the mover,

Mr. Morton expressed his regret that the remark which he made at the last Court should have had the effect of inducing Mr. Pannell to place the present resolution on the agenda. He urged the Court to wait until the agreement between the Government and the National Telephone Company was placed, as it would be in a few days, on the table of the House of Commons. He declared that the whole secret of the business was that the electric lighting company sought to benefit by the present state of things, and he contended that the honour of the Commission was concerned in the present dispute.

Mr. Burmester, in protesting against Mr. Morton's imputations, remarked that it might be said that the hon. member held a brief for the telephone users. He agreed with him, however, that the honour of the Commission was involved, but it was concerned in the protection not of one section of the ratepayers but of the entire body.

Mr. McCarthy having expressed himself in favour of the motion,

Mr. C. T. Harris opposed the proposition. The Court could, he said, rescind the former resolution whenever a fair proposition was submitted to it. He was opposed to playing into the hands of the National Telephone Company as much as he was opposed to playing into the hands of the electric lighting company.

Mr. Alderman Green denounced the continuation of the present dog-in-the-manger policy, and contended that the time had arrived when the resolution in question should be rescinded.

Mr. Pannell, in reply, said if the resolution was carried, as he hoped it would be, by a two-thirds majority, and the National Telephone Company did not come to bid, another would soon be found to do so, and an end being put to a monopoly, cheaper telephone communication would be secured.

On a show of hands the motion was supported by 33 votes, and there were 16 against it. On a division the numbers were 32 for and 14 against.

The necessary majority having been obtained, the motion wa declared by the **Chairman** to have been carried.

COMPANIES' REPORTS.

LIVERPOOL OVERHEAD RAILWAY COMPANY.

Report of the directors and abstract of accounts for the half-year ending June 30, 1894, to be submitted to the twelfth half-yearly general meeting of the shareholders to be held at the Law Association Rooms, 14, Cook-street, Liverpool, on Tuesday, August 14, 1894, at 12 noon.

Directors: Sir William Bower Forwood, J.P., Ramleh, Blundellsands; James Barrow, Esq., J.P., 7, Beach-lawn, Waterloo; John Brancker, Esq., J.P., Green Bank, Wavertree; Harold Brocklebank, Esq., 20, Bixteth street, Liverpool; Richard Hobson, Esq., J P., 54, Brown's-buildings, Liverpool; Edward Lawrence, Esq., J.P., 5, Fenwick-street, Liverpool; George H. Robertson, Esq., K 35, Exchange-buildings, Liverpool. Engineers-in-chief: Sir Douglas Fox, M.I.C.E; J. H. Greathead, Esq., M.I.C.E. Engineer and manager: S. B. Cottrell, Esq., A.M.I.C.E., 31, James-street, Liverpool. Secretary: William H. Alexander, Esq., C.A., 24, North John-street, Liverpool.

In presenting the half-yearly statement of capital and revenue accounts to June 30, 1894, your directors have to report that the gross revenue receipts amount to £20,044. 7s. 6d. The number of passengers carried since the opening of the railway being as follows:

	From March 6 to June 30. 1893.	Half-year ending Dec. 31, 1893.	Half-year ending June 30, 1894.
First class	235,487	260,221	277,653
Second class	956,922	1,293,840	1,246,975
Workmen (special return tickets)	178,333	921,578	1,336,809
Total	1,370,742	2,475,639	2,861,437

During the past half-year 50,483 trains have been run, and 96 per cent. have been punctual. The northern extension was opened on April 30, and the traffic at the Seaforth Sands Station has been very satisfactory. An arrangement has been made with the Liverpool Tramway and Omnibus Company to run omnibuses to this station, connecting it with the surrounding districts, and generally to act as feeders to the railway. Two new stations have been opened this month at points where experience has shown it to be desirable to provide further accommodation—viz., at Nelson and Huskisson Docks—and a third will shortly be opened at Langton Dock.

Revenue Account.

The gross receipts from traffic amount to	£19,658 13 11	
Miscellaneous receipts	385 13 7	
	£20,044 7 6	
Less working expenses	14,947 5 6	
	£5,097 2 0	
From which deduct—		
Interest on debentures and calls paid in advance ..	2,639 7 7	
	£2,457 14 5	
Add balance brought forward from last year	2,598 7 1	
Leaving available for dividend the sum of	£5,056 1 6	

Out of this balance your directors recommend the declaration of dividends at the following rates (less income tax), payable on and after August 17—viz.: 5 per cent. per annum on preference shares, £2,170. 13s. 8d.; 1 per cent. per annum on ordinary shares, £1,875; total, £4,045. 13s. 8d.; leaving a balance of £1,010. 7s. 10d. to be carried forward to next half-year.

REVENUE ACCOUNT, HALF-YEAR ENDED JUNE 30, 1894.

Half-year ended Dec. 31, 1893.	Expenditure.	£ s. d.
£1,730 9 10	Maintenance of way, works, and stations (Abstract A)	1,870 1 5
4,089 17 2	Locomotive power (Abstract B) ...	3,179 11 6
	Repairs and renewals of carriages (Abstract C)	425 2 6
5,398 10 3	Traffic expenses (Abstract D)	6,276 1 7
1,375 10 7	General charges (Abstract E)	1,403 5 3
82 6 0	Law charges	289 4 10
1 12 6	Compensation	5 0 0
1,054 5 1	Rents, rates, and taxes	1,399 9 1
	Government duty	99 9 4
£13,732 11 7		£14,947 5 6
4,609 12 8	Balance carried to net revenue account	5,064 9 4
£18,342 4 1		£20,011 14 10

Half-year ended Dec. 31, 1893.	Receipts.	£ s. d.
£18,000 11 7	Passenger traffic	19,658 13 11
2 5 4	Parcels, etc.	3 5 3
333 14 8	Rents	328 0 8
5 12 6	Transfer fees	21 15 0
£18,342 4 1		£20,011 14 10

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Abstract A.—Maintenance of Way, Works, etc.

Half-year ended Dec. 31, 1893.				£	s.	d.
£15	0	0	Salaries, office expenses, and general superintendence	19	10	0
231	12	4	Maintenance and renewal of permanent way—wages, £309. 2s. 11d.;			
176	12	6	material, £130. 1s. 7d.	439	4	6
488	5	1	Repairs of structure and opening bridges	359	15	5
193	19	11	Repairs of stations and buildings	426	11	6
625	0	0	Provision for renewal of boilers and machinery at generating station	625	0	0
5·68			Miles maintained—double... 6·4			
£1,730	9	10		£1,870	1	5

Abstract B.—Locomotive Power.

Half-year ended Dec. 31, 1893.				£	s	d.
Cost under working agreement with the Electric Construction Company.			Running expenses—			
			Wages connected with the working of generating engines and motor	1,975	9	7
			Coal and coke	896	9	10
			Oil, tallow, and other stores	149	19	0
				3,021	18	5
			Repair and renewals—materials	157	13	1
£4,089	17	2		£3,179	11	6

Abstract C.—Repairs and Renewals of Carriages.

Half-year ended Dec. 31, 1893.				£	s.	d.
Covered by working agreement with the Electric Construction Company.			Carriages—			
			Wages	282	2	8
			Materials	142	19	10
				£455	2	6

Half-year ended Dec. 31, 1893.			Abstract D.—Traffic Expenses.	£	s.	d.
£4,038	12	6	Salaries and wages, etc.	4,681	9	4
1,017	13	6	Fuel, lighting, signalling, water, and general stores	969	2	7
67	19	3	Clothing	255	14	3
274	5	0	Printing, stationery, and tickets	369	15	5
£5,398	10	3		£6,276	1	7

Half-year ended Dec. 31, 1893.			Abstract E.—General Charges.	£	s.	d.
£350	0	0	Directors	350	0	0
52	10	0	Auditors	52	10	0
592	15	9	Salaries of secretary, general manager, and clerks	678	3	9
154	7	4	Office expenses of ditto	181	3	4
156	0	8	Advertising	17	10	0
69	6	10	Insurance	103	11	11
—			Travelling expenses	20	6	3
£1,375	10	7		£1,403	5	3

Dr. General Balance-sheet, June 30, 1894.	£	s.	d.
Net revenue account, balance at credit thereof	5,056	1	6
Interest payable or accruing, and provided for	2,754	7	6
Retention money	2,444	14	11
Sundry outstanding accounts	7,729	8	8
Renewal fund for boilers and machinery	1,250	0	0
	£19,234	12	7

Cr.	£	s.	d.
Capital account, balance at debit thereof	7,646	7	6
Cash in bank (current account) and in hand	4,862	13	0
Parliamentary deposit on extension railways authorised by Liverpool Overhead Railway Act, 1892, and interest thereon	5,506	3	11
Stock of stores and stationery	799	3	3
Sundry outstanding accounts	420	4	11
	£19,234	12	7

COMPANIES' MEETINGS.

CITY AND SOUTH LONDON RAILWAY COMPANY.

The twentieth ordinary general meeting of the shareholders was held at Winchester House on Wednesday, Mr. Charles Grey Mott presiding.

In moving the adoption of the report, which we printed in our last issue, the **Chairman** stated that during the past half-year they had carried 236,498 passengers more than in the corresponding period of last year, and the number of season-ticket holders had increased by 49. This increase had been carried with the usual perfect safety, and almost absolute punctuality. The increase had been obtained in spite of the fact that the Oval was shut for football matches during the first three months. They had now got the railway in all its main details into thorough working order, and the directors had turned their attention to smaller details in order to make the line draw better. The King William-street Station had been improved on the surface, and this expenditure was not only likely to be remunerative by making it more attractive to passengers, but also directly from the receipts of the new left-luggage office, which could be used not only by their own travellers, but also by the general public crossing London Bridge. They were also trying to improve the carriages, and had a new train running with more ease and with less noise. They were considering the question whether the locomotives could not be abolished, and motors on the trains themselves be substituted. This had been the first idea when the line was projected, but in deference to the views of the Board of Trade it had not been carried out. The suggested method would allow of an additional carriage being added to each train. They were trying experiments, but owing to the smallness of the tunnel and to other reasons it was dubious if the arrangement could be made. Turning to the accounts, it would be seen that during the half-year 8,200 of the terminable mortgage debenture bonds had been paid off and reissued as debenture stock, or preference shares, at a premium; and the loan of £22,000, to which reference was made at the last half-yearly meeting, had been repaid. The receipts from all sources for the six months had amounted to £24,294, and the cost of working had been £14,990, leaving a profit of £9,304. Inclusive of the balance brought forward from December 31 last, the net revenue account showed an aggregate total of £10,368. After making provision for the debenture and debenture stock interest, there remained a balance of £6,295 available for dividend. The total working expenses for the half-year had been reduced to 61·7 per cent., against 64 61 at that time last year. If they took into account the cost of working the lifts, which did not properly belong to a railway, the percentage worked out at about 52 per cent., which was considerably lower than that of many of the large English railways. The receipts per train mile had been 2s. 1½d., and the receipts per passenger 1·62d.—practically the same as in the corresponding half-year. The locomotive expenses per train mile had been 6·21d. against 6·48d. in 1893. Although the dividend was not as large as he would like to see, the Company was making steady, though not rapid, progress. There was not much hope of rapid progress, and they would have to be content with a slow movement upwards with the present materials at command, and no extension of the line.

Mr. Sampson Hanbury seconded the adoption of the report.

Mr. Drake said that it had been unquestionably demonstrated that electricity could be practically used for motive power, and also that the line was useful to South Londoners, but the remaining point still to be demonstrated was that it should return a fair interest to the ordinary shareholders. At present the traffic was throttled at King William-street. If they were once relieved there, and the original project carried out, there would be a reward to the people who had put money into the line.

Mr. Shepherd stated that there was no reference in the report to any extension of the line. A continuation to Moorgate-street was needed, and would be of benefit.

Mr. J. P. Court stated that every £400 of increase in the profits meant ¼ per cent. extra dividend on the ordinary stock. There should consequently be more economy in the general charges. The managerial expenses amounted to £3,000, and the whole management was on too magnificent a scale. This was not a railway, but a tramway with 3½ miles of line. The offices of manager and secretary could be combined, and result in an increase of ⅛ per cent. on the ordinary shares. He concluded by giving notice that at the next half-yearly meeting he would move the reduction of the directors' fees from £1,300 to £750 per annum.

Mr. Middleton said that it had been promised him at the last meeting that experiments would be made with motors on the carriages, and that the engineer would report on the effect. This was not forthcoming, and the shareholders were now met with the statement that experiments were to be made. The dividend might have been increased to 1½ per cent. by carrying less forward in the balance. As regarded the Moorgate-street extension, he considered that there should be no extension until at least 2 per cent. dividend was paid. More economical working was required, and the staff was far too large. Any extension should be carried out as a separate undertaking, and he would strenuously oppose the raising of debenture capital for such a scheme.

The **Chairman**, in reply, said that Mr. Middleton did not understand the working of a railway line like this or appreciate the difficulties. The speaker had from the first favoured motor cars, and they had given orders to two firms so as to expedite the matter. They had no plans yet for extension, but the completion of the line to Moorgate-street would result in an almost immediate increase of the dividend to 5 per cent.

The motion was then carried.

The **Chairman** moved, and **Mr. Greathead** seconded, the motion that 1 per cent. dividend be paid on the ordinary stock, which was agreed to.

MANCHESTER EDISON-SWAN COMPANY, LIMITED.

The twelfth ordinary general meeting of this Company was held on Monday at the Memorial Hall, Albert-square, Mr. V. K. Armitage, chairman of the Company, presiding.

The directors' report, which was taken as read, was as follows: "The net profit, including last year's balance, amounts to £1,508. 17s. 5d., which it is proposed to appropriate as follows: to writing off balance of loss on Williamson Electrical Engineering Company, £940. 0s. 1d.; to special depreciation owing to change of showrooms, £256. 5s. 6d.; to special depreciation on stock of lamps on

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expiration of patents, and to reduction in value of cables, £306. 11s. 5d.; balance to be carried forward, £6. 0s. 5d. The directors view the result of the year's trading as satisfactory, considering the depressed state of trade during the last 12 months, and the fact that the Company's monopoly of the lamp trade has now ceased They propose to write off the whole of the loss made on the Williamson Electrical Engineering Company, Limited, and the special depreciation shown above this year, and accordingly do not recommend the payment of a dividend."

The **Chairman**, in moving the adoption of the report, referred to the work that has been undertaken at Altrincham and Bowdon, and said he thought that from that installation the shareholders were justified in expecting a satisfactory financial result. He believed that in that and in other directions the future of the Company was hopeful.

Mr. F. B. Ross seconded the motion, which was adopted.

Mr. F. B. Ross and Mr. W. P. James Fawcus were re-elected directors.

ANGLO-AMERICAN TELEGRAPH COMPANY, LIMITED.

The ordinary half-yearly meeting was held last week at the Cannon street Hotel, the Marquis of Tweeddale presiding.

The **Chairman**, in moving the adoption of the report, stated that the traffic receipts for the half-year had been £130,094, showing a diminution of £16,791. They now had four cables across the Atlantic in first-class order, and they were all duplexed. The fifth cable, the French cable, they had not attempted to repair this year, nor did he think there was any probability of that repair being undertaken this year. The expenses of the new cable and of the repair of the 1874 cable had made serious inroads into their renewal funds, which would be reduced to about £530,000. The amount they proposed to set apart to this fund—£12,000 each half-year and the interest earned by the fund—was a minimum figure. Judgment had at length been given in their favour in the proceedings with regard to the Pouyer-Quertier cable. The judgment at any rate proved that their contention was correct, that the French company committed a serious breach of their agreement, but whether the result of the decision would be attended with any great financial benefit to the "pool" companies was doubtful, for it was impossible to express an opinion as to what view would be taken by the experts by whom the damages were to be assessed. No doubt they had heard with some dismay of the possibility of one or two more cables being laid in the Atlantic. It was said that the French were contemplating the laying of a new cable, but of this they possessed no reliable information. They had reason, however, to believe that the German Government contemplated giving a concession for a new cable from Germany to America. He only hoped that it would fall into the hands of those who had large interests in the "pool" companies, instead of into the hands of hostile competitors.

Mr. Francis A. Bevan (the deputy-chairman) seconded the motion, which was carried.

GLOBE TELEGRAPH AND TRUST COMPANY, LIMITED.

The ordinary general meeting was held last week at Winchester House, under the presidency of Sir John Pender, M.P.

The **Chairman**, in moving the adoption of the report and the payment of the dividends recommended, stated that the receipts for the year ended the 18th July, after paying all expenses, had been £185,057, as against £188,931 in the previous year. The object of the Globe Company was to equalise the dividends paid by the various telegraph companies in which they held investments, and this object, to a very large extent, had been attained. They were able to recommend the payment of a dividend on the ordinary shares of 4½ per cent. for the year, or ⅛ per cent. less than in the previous year. The dividend they were paying was still above the average, and taking their preference and ordinary shares in like quantities, they showed a return of 5¼ per cent. He then referred to the dividends which they had received from their investments in the Anglo American Telegraph Company, the Direct United States Cable Company, the Submarine Cables Trust, and the Telegraph Construction and Maintenance Company, and afterwards stated that the £62,000 which they had held in 6 per cent. debentures of the Direct Spanish Telegraph Company was paid off last May. The money had been since reinvested. With reference to the West Coast of America Company, now that the Transandine line was completed, they might possibly get some return from that company.

The **Marquis of Tweeddale** seconded the motion, which was adopted.

CHILI TELEPHONE COMPANY, LIMITED.

The annual general meeting was held on Tuesday at Winchester House, Mr. Thomas Greenwood presiding.

The **Chairman**, in moving the adoption of the report, said the year through which they had just passed had been the worst that the Company had seen, and he thought he might fairly add the worst it was likely to see. In consequence of the low price of the dollar, the Board had felt compelled to make a small addition to their tariff. This had had the effect of causing some of their subscribers to withdraw, but others had taken their places, so that the aggregate in all centres was, at the end of the year, only 37 less than at its commencement. Although they had been so long without a dividend, he felt their prospects were hopeful.

The **Hon. F. Ernest Allsopp** seconded the resolution, which was adopted.

CONTRACTS FOR ELECTRICAL PLANT.

CONTRACTS OPEN.

Maidstone.—The Town Council are still desirous of receiving particulars as to the terms on which a company or firm will undertake and carry out the powers granted by the Maidstone electric lighting order.

Cheshunt.—The Local Board invite tenders for the public lighting of the district by gas, oil, or otherwise. Specification, stating period of lighting and district to be lighted, may be seen at the office of Mr. S. Towlson, the surveyor to the Board, Turner's-hill, Cheshunt. Tenders are to be sent, addressed the Chairman, Cheshunt Local Board, St. Mary's Hall, Cheshunt, by the 6th inst.

St. Pancras.—The St. Pancras Vestry, as will be seen from our advertisement columns, invite tenders for the supply and laying of armoured cable mains. Specifications, schedules of quantities, general conditions, and plan of streets can be obtained at the offices of Prof. Henry Robinson, 13, Victoria-street, Westminster, on payment of 5s. Tenders must be sent in by 16th inst. to Mr. Albert E. Pycraft, chief clerk, Vestry Hall, Pancras-road, N.W.

RESULTS OF TENDERS.

West Ham.—The following tenders were received by the Corporation of West Ham for the electric lighting of the public hall and library at Canning Town :

	General lighting.	Extra power for blowing organ.	Extra for footlights on stage.	Total.
Fanshawe and Grant	£839 0 0	£60 0 0	£18 0 0	£917 0 0
H. F. Joel and Co.	896 0 0	114 16 0	45 0 0	1,055 16 0
Brush Electrical Engineering Company	916 0 0	144 0 0	15 0 0	1,075 0 0
Wenham and Waters	1,060 0 0	117 5 0	53 0 0	1,230 5 0
Fowler, Lancaster, and Co.	1,073 0 0	85 0 0	38 0 0	1,196 0 0
Raynes, Smith, and Co.	1,089 15 0	—	37 17 6	1,127 12 6
Harry South	1.110 0 0	*75 0 0	30 0 0	1,215 0 0
W. Mackie	1 130 0 0	†244 0 0	—	1,374 0 0
Fenton & Barnes	1 150 0 0	60 0 0	15 0 0	1,225 0 0
Laing, Wharton and Down	1,183 0 0	172 0 0	15 0 0	1,370 0 0
Verity and Sons	1,189 0 0	‡123 0 0	28 0 0	1,340 0 0
R. Barnett & Co.	1,200 0 0	100 1 6	45 0 0	1.345 1 6
Suter and Co.	1,213 0 0	30 0 0	12 10 0	1.261 10 0
Paterson and Cooper	1,232 0 0	—	25 0 0	1,257 0 0
Statter and Co., Limited	1,264 0 0	75 0 0	210 0 0	1,549 0 0
Strode and Co.	1,267 0 0	187 0 0	33 0 0	1,487 0 0
Crompton and Co.	1,298 0 0	220 0 0	66 0 0	1,584 0 0
British Electric Light Co.	1,323 0 0	110 0 0	15 0 0	1,448 0 0
Roger Dawson, Limited	1,339 0 0	—	30 0 0	1,369 0 0
Vaughan and Brown	1,340 0 0	66 0 0	23 0 0	1.429 0 0
C. A. Hemmingway	1,350 0 0	—	—	1,350 0 0
Holmes and Co.	1 375 0 0	136 10 0	25 0 0	1,536 10 0
P. Jones	1,376 7 9	30 0 0	17 1 0	1,423 8 9
J. C. Howell, Limited	1.378 0 0	—	61 0 0	1,439 0 0
Stone and Co.	1.384 0 0	146 10 0	31 0 0	1,561 10 0
R. A. Scott, Ltd.	1.398 0 0	85 10 0	25 0 0	1.508 10 0
Thames Ironworks Co.	1,440 0 0	79 0 0	18 0 0	1,507 0 0
Ditto (alternative)	1,600 0 0	79 0 0	18 0 0	1,697 0 0
Ditto (alternative)	1 950 0 0	79 0 0	18 0 0	2 047 0 0
L. G. Tate	1,410 0 0	90 0 0	35 0 0	1 535 0 0
Parr and Gillies	1,457 0 0	104 0 0	15 0 0	1,576 0 0
Lund Bros. and Co.	1,466 0 0	70 0 0	15 0 0	1,551 0 0
Brown and Co.	1,500 0 0	75 0 0	25 0 0	1 600 0 0
New and Mayne	1,500 0 0	200 0 0	25 0 0	1,725 0 0
Hill, Percival, and Co.	1,511 0 0	75 0 0	25 0 0	1,611 0 0
Hulett and Co., Limited	1,515 0 0	251 0 0	13 0 0	1,779 0 0
Marryatt and Lillywhite	1,525 0 0	140 0 0	44 0 0	1,709 0 0
Edmundsons, Limited	1,559 0 0	90 0 0	25 0 0	1,674 0 0
Rashleigh Phipps and Co.	1,585 0 0	275 0 0	28 0 0	1,888 0 0
J. C. Christie	1,668 0 0	—	—	1,668 0 0
D. C. Bate	1,688 0 0	91 0 0	45 0 0	1.824 0 0
Benham and Sons	1,753 0 0	105 0 0	18 0 0	1,876 0 0
Binks and Co.	1,877 10 0	150 0 0	45 0 0	2,072 10 0

* Approximate. † Including footlights. ‡ Gas-engine, £75.

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The tender of the Brush Electrical Engineering Company has been accepted.

Bury.—The Board of Guardians are to enter into a contract with Messrs. E. Green and Son, Limited, for the supply of a fuel economiser.

Woking.—The Local Board, as will be seen in another column, have accepted the tender of Messrs. New and Mayne for the electric lighting of Woking Station and Maybury Ward.

London.—The tender of Messrs. Graham and Biddle, of 463, Oxford-street, W., has been accepted, at £534, for the installation of the electric light for Mr. J. H. Renton, 39, Park-lane, W. Mr. W. J. Fryer, A.I.E.E., was the consulting engineer. The same firm's tender has been accepted for installing the electric light and for organ-blowing apparatus by electric motor by the wardens of the West London Synagogue, Upper Berkeley-street, W. Mr. Fryer also acted as consulting engineer in this case. The amount of the tender was £189; two other firms offered to do the work. Another contract secured by the same firm is for the electric lighting of 34, Bryanstone-square, W., for Mr. Francis Samuels, the tender reaching the sum of £445.

London (County Council).—The following tenders have been received by the London County Council in connection with the electric lighting of the Victoria-embankment:

For the supply of engines and electrical plant.

Laing, Wharton, and Down, 82A, New Bond-street	£12,100
W. Mackie, Turk's Head-yard, Turnmill-street, E.C.	8,880
T. Scott Anderson, Royal Insurance-buildings, Sheffield	5,660
Brush Electrical Engineering Company, Limited, 49, Queen Victoria-street, E.C.	5,437
C. A. Parsons and Co., Heaton Works, Newcastle	5,471
Johnson and Phillips, 14, Union-court, E.C.	5,200
Paterson and Cooper, Pownall-road, Dalston	5,000
J. G. Statter and Co., Limited, 68, Victoria-street, S.W.	4,629
Greenwood and Batley, Limited, Albion Works, Leeds	4,565
Crompton and Co., Limited, 4, Mansion House-buildings, E.C.	4,444
Electric Construction Company, Limited, Wolverhampton	4,410

For the supply of boilers, etc.

Spurr, Inman, and Co., Limited, Calder Vale Boiler Works, Wakefield	3,375
Maudslay, Sons, and Field, Limited, Westminster Bridge road	2,765
Babcock and Wilcox, Limited, 147, Queen Victoria-street, E.C.	2,554
Yates and Thom, Canal Foundry, Blackburn	2,436
J. Watt and Co., 90, Leadenhall-street	2,450
Standard Ironworks, Colchester	1,403
Davey, Paxman, and Co. (informal)	—

The Highways Committee on Tuesday recommended that the tender of Messrs. Foster and Dicksee, at £5,562, should be accepted for the erection of the generating station buildings for the electric lighting of the Victoria-embankment, but this was deferred until next spring.

BUSINESS NOTES.

Chelsea.—The Town Hall is nearly ready for the electric light.

Coupar-Angus.—The electric light is to be introduced at Jordanston House.

Carlow.—The Town Commissioners have decided to erect additional electric lamps.

Wolverhampton.—A proposal is under consideration for the electric lighting of the workhouse.

Western and Brazilian Telegraph Company.—The receipts for the week ended July 27 were £2,162.

Sunderland.—The question of wiring the Town Hall is under the consideration of the Town Hall Committee.

Bristol Tramways.—The proposed electric tramways to St. George and Kingswood are expected to be set in operation next year.

St. Helens.—The Corporation have obtained powers to supply electricity, and have appointed Mr. R. Hammond to draw a report and submit estimate of works.

Poplar, E.—The report prepared by Mr. W. H. Farnfield in regard to street lighting by electricity is to be printed for the Poplar District Board of Works.

Norwich.—Extensions are being made in the central station by Messrs. Laurence, Scott, and Co., and at present some 12,000 8-c.p. lamps are connected to the mains.

Heston and Isleworth.—The Local Board have accepted the estimate of Mr. Stewart at £22. 10s. for the alteration of the telephone system between the fire stations.

Portsmouth.—The Library and Museums Committee of the Town Council have decided to purchase an electric motor of 5 h.p. for the technical institute, at a cost of about £55.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending 29th ult. amounted to £933, as against £724 in the corresponding week of last year.

Heysham.—The Lancaster Rural Sanitary Authority have consented to the electric light company applying to the Board of Trade for a license to supply electricity to Heysham.

Hardwick's "Purine" Syndicate, Limited.—This Company has been registered, with a capital of £1,000, to carry on the business of bankers, capitalists, civil, mechanical, and electrical engineers, etc.

Cabul.—The *Dundee Advertiser* states that the Ameer has decided to introduce the electric light into his capital, and Mr. R Jamieson Browne, a Glasgow electrician, has been asked to fit up the installation.

Church-Lighting.—Owing to the delay in the supply to the Leeds House-to-House Company of a part of the plant ordered by them, the installation of electric light at the parish church will only be partially at work next Sunday.

Mansion-Lighting.—Lord Rosebery has taken Eastwell Park, the Kentish residence of Lord Gerald, for a term of three years. Extensive improvements will, it is stated, be made to the mansion, including the installation of the electric light.

Barrow.—The General Purposes Committee of the County Council have reported, in regard to the application for provisional order, that the Commons have agreed to the Lords' amendments, and that the Bill had received the Royal assent.

Tunbridge Wells.—The Local Government Board have sanctioned the borrowing by the Town Council of £13,000 for electric lighting purposes. Messrs. Longley and Co., of Crawley, are going to erect the station buildings for £2,789.

Wickham Market.—A Vestry meeting held at the White Hart Hotel, Wickham Market, appointed Messrs. R. Fulcher, E. Coleman, and H. E. Morris as lighting inspectors until the Lighting and Watching Act has been adopted by the Parish Council.

The Cardiff Exhibition.—One side of the proposed buildings round the quadrangle for the forthcoming exhibition is to be devoted to machinery and electricity. It is also suggested that there be an electric railway on the western side 2,500ft long.

Aberystwyth.—The pillars of the electric arc lamps have been erected the whole length of the Marine and Victoria terraces facing the sea, numbering 17. There are 18 more to be fixed in different conspicuous positions within the borough and on the Chain Pier.

Declaration of Dividend.—The Kensington and Knightsbridge Electric Lighting Company, Limited, have declared an interim dividend at the rate of 5 per cent. per annum on the ordinary shares for the half-year ending June 30, payable on and after August 2.

Dunstable.—The Town Council have resolved, on the recommendation of the Lighting Committee, to purchase 70 lamp-posts which have been used for electric light purposes in Barnet, and which were offered to the Council by a firm at the low figure of £1. 2s. 6d.

British and Foreign Electric and Engineering Company, Limited.—This Company has been registered with a capital of £2,000 in £1 shares, to carry on the business of electric, telegraphic, surgical and scientific instrument makers, and electrical and mechanical engineers.

Hampstead.—Mr. R. A. Chattock, who has been appointed electrical engineer to the Hampstead Vestry, was the superintending engineer of the Metropolitan Electric Supply Company's Amberley-road station. A proposal is being considered for the electric lighting of the Vestry Hall.

Glasgow.—The Glasgow and South-Western Railway Company have decided not in the meantime to appoint a mechanical and electrical engineer for St. Enoch's Station, an appointment which they announced to be open some time ago. This was a new post on the railway, and a salary of £200 was offered.

City and South London Railway.—The receipts of the Company for the week ended July 29 were £858, against £824 for the corresponding week of 1893, or an increase of £34. The total receipts for the current period of the present half-year amount to £3,458, as against £3,433 in the corresponding period of 1893.

St. Luke's.—The surveyor to St. Luke's Vestry has been directed to report to the Vestry, from time to time, as the County of London and Brush Provincial Electric Lighting Company, Limited open up the thoroughfares of the parish to lay their system of lighting, with a view to the reinstatement of the paving.

Salford.—Mr. Holland, chairman of the Gas Committee, in reply to Mr. Alderman Dickins and Mr. Alderman Mottram, stated at a meeting of the Town Council on Wednesday that he could not give the price at which the electric light would be supplied. He thought the installation would be complete in time for the winter.

United River Plate Telephone Company.—The report for the year ended March 31 shows a profit, after deduction of debenture interest, of £9,782. After various deductions, including the transfer of £3,000 to depreciation and renewal fund, there is a net balance, including £905 brought forward, of £6,417, which is carried forward.

Rollason's Wind Motor Company, Limited.—A meeting of this Company was held at Winchester House yesterday afternoon, but the proceedings were private. This Company exploits a windmill driving a dynamo for electric lighting and power purposes. An illustrated description of the wind motor was given in our issue of April 20 last.

Dover.—The surveyor has reported to the Town Council that he had written to Mr. Lawson, engineer to the Dover Electric Supply Company, asking that they should send all official notices, and he had since received the official notice of the opening up of Snargate-street. He also stated that he was going to block up Snargate-street in sections during the laying of the mains.

Recovery of Gold.—Mr. Justice Romer, in the Chancery Court on Tuesday, reserved judgment in the action brought by the Cassel Gold Extracting Company, of Glasgow, for an injunction restraining the Cyanide Recovery Syndicate from an alleged infringement

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of their patent for the extraction of gold from the ore by a solution of cyanide of potassium. The case was referred to in our last issue.

Greenock.—The Caledonian Electric Supply Company, Edinburgh, have intimated to the Greenock Police Board that the company intend to apply to the Board of Trade for a provisional order to supply electricity within the district area comprised within the municipal boundaries of Greenock. The town clerk has been instructed to notify the company that the Board of Police will oppose the application.

Driving Printing Machinery—The fast Victory web rotary machine which prints the *Oxford Times* is now driven by an electric motor of 10 h.p., erected by Mr. McLean, the engineer of the Oxford Electric Lighting Company. This is the first printing done in Oxford by electric power, and the satisfactory results lead to a belief that it is preferable to gas or steam, as being steadier, quieter, and more easily controlled.

Belfast.—At a meeting of the Electric Lighting Committee of the Corporation the electrical engineer (Mr. M'Cowen) reported the progress which had been made in the works since the last meeting, and submitted further applications for current from parties outside the proposed area of supply. He was instructed to proceed with the work in every case outside the area where the necessary guarantee form was signed.

Dock-Lighting.—The East and West India Company, London, have spent £12,000 (spread over certain years) upon a new electric light installation for the Albert Docks, and this has resulted in a saving during the six months of £1,000. The chairman of the company mentioned the other day that an increased use of electric travellers at the wood wharf had also led to economy, and that they intended to have more of these travellers.

Dunoon.—The first illumination of the Castle Gardens this season took place on Thursday night last week in the presence of over 3,000 people, when it was also made the occasion of the formal introduction of the electric light, which has been carried out by Messrs. Walter Dixon and Co., electrical engineers, St. Vincent-street, Glasgow. The opening ceremony was performed by Captain Howitt, convener of the Roads Committee.

Mill-Lighting.—Messrs. Bennett and Druce, of Preston, have secured the contract for an electric light installation throughout the Crosse Hall Mill of Mr. J. H. Gillett, of Chorley. The dynamo will be a 12-kilowatt machine, driven off the main mill engine, and about 200 incandescents, distributed over the spinning department, will be installed. We are informed that the firm is exceedingly busy with various installations in progress in the Lancashire district.

Town House Lighting.—Messrs. Rashleigh Phipps and Co. have received instructions from Mr. W. D. Mackenzie, of Fawley Court, Henley-on-Thames, for the electric lighting of his town house, 35, Park-street, which they are now engaged on. This firm have also received an order to light the house of Mr. Anderson Critchett, the celebrated oculist, in Harley-street They are also engaged upon a large number of other installations in London and country.

Halifax.—Sixty-three applications have been received for the supply of the electric light. The Masonic Hall Committee have decided to introduce this system of lighting into their premises. The work of building the station in Foundry-street is proceeding apace, part of the wall having already been erected. Three large boilers from a Blackburn firm have been placed in their foundations. Mr. Wilmhurst is the electrical engineer, and Mr. Rayner he clerk of the works.

Newcastle.—In connection with the lighting of this city, to which subject we have previously referred, a meeting of the Watch Committee was held on Monday. The directors of the gas company attended, and a conference took place respecting the lighting of lamps in the streets of the city. A local paper says that "the outcome of the discussion was a hopeful feeling that matters between the gas company and the Corporation might be amicably adjusted." The meeting was adjourned for further consideration of the subject in dispute.

Lighting in Pall-mall.—The Establishment Committee of the London County Council reported on Tuesday that they thought it desirable that the rooms taken at 17, Pall-mall East, for the housing branch of the architect's department, should be equipped with the electric light. The engineer estimates the cost of the mains, fittings, etc., at £65. The committee therefore recommended that, subject to an estimate being submitted to the Council by the Finance Committee, an expenditure of a sum not exceeding £65 be authorised for the purpose.

Dorby.—It was mentioned at a meeting of the Town Council on Wednesday that the electric light mains have been ordered to be extended in several places to meet the requirements of new customers, and that forty motors have been ordered, at a cost of about £300. The electric lighting exhibition in May was well patronised by the public. The cost of the exhibition to the Corporation was £76. 17s. 11d., which was less than the amount first contemplated. No charge was included in the above for current, which at the ordinary rate would be £45.

Wolverhampton.—Mr. F. Harman Lewis, the borough electrical engineer, has issued for the benefit of the inhabitants a circular which deals with the advantages of the electric light. It runs: "The electric light mains are now laid in your street, and as there is every probability that the electric light station will be in working order in September, the Corporation takes this opportunity of reminding you of the advantages to be derived from employing electricity as a source of artificial illumination. The charge for electric energy will be 6d. per Board of Trade unit."

A Contract Question.—The case of G. West and G. Batchelor *v.* the Chatham Electric Light Company and Jasper, was an action heard in the High Court. It was brought by Mr. G. West and Mr. G. Batchelor as assignees of a debt of the contractor for work done and materials supplied in connection with the electric light. The trial came on before the official referee, Mr. Verey, lasting two days. During the action defendants counterclaimed, but this was dismissed before trial. The referee has now given his judgment, whereby plaintiffs recover £74. 10s. 5d., and all costs. The original claim was over £80.

Bristol.—The Bristol Electric Lighting Committee of the Town Council met on Friday. The committee, having been informed of the replies to the circulars recently issued with reference to extending the mains to Clifton and Tyndall's Park, decided to extend the mains to Clifton forthwith. The work will be executed by the Corporation employés, and will be put in hand in about a month's time, so as to be completed by the end of September. It was decided to promote Mr. J. Rutherford Blaikie, third assistant engineer, to the post of chief assistant, and to appoint Mr. C. B. Jones-Mortimer third assistant engineer.

Hull.—The Electric Lighting Committee of the Hull Corporation received on Wednesday from Mr. Gibbings, the engineer, a report on additional plant required for the electric lighting station. A resolution was passed that it is desirable that the present plant should be increased by the addition of a large engine and dynamo, together with the requisite fittings, steam-piping, motor generator, etc., and that the orders for the same should be placed immediately. The committee, therefore, decided to recommend the Council that they should be empowered to purchase such engine and dynamo, fittings, steam-piping, motor generator, etc., at a cost not exceeding £2,800.

Edison-Bell Phonograph Company v. Hough.—The hearing of the motion for an interim injunction to restrain the defendant, who trades as the London Phonograph Company, from infringing certain rights which the plaintiffs claim to possess in a patent of 1886 for improvements in phonographs, was concluded on Tuesday before Mr. Justice Stirling. The defendant having offered to pay £25 into court, his lordship said that upon that sum being paid in, and on the parties undertaking to prosecute the action without delay, he thought there ought not to be an injunction, but that the defendants must keep the usual account. The injunction was accordingly refused, and liberty was given to either party to expedite the trial.

Dublin.—The sixty-second annual report of the Commissioners of Public Works in Ireland, covering the year ending March 31, 1894, has just been issued. During the 12 months under consideration the net expenditure under the control of the Board was £505,681. Amongst the items which have swelled this sum is the Amiens-street Parcel Post Depôt, which is now approaching completion. The Board have decided to employ electric lighting for this building, and have arranged for a supply from the municipal electrical system However, the Commissioners, being of opinion that the terms for this service are too high, have given notice to the Corporation that the present contract for the supply of electric light will not be resumed after three years.

Aberdeen.—On Monday a joint meeting of the Gas and Watching and Lighting Committees of the Town Council was held, when a discussion took place on the question of the electric lighting of the streets. It was stated that the cost of producing the current for street lighting purposes exceeded the sum formerly estimated. In view of this the committee decided to continue the present arrangements for another month, at the end of which the committee would have before them the first accounts Having then ascertained the actual cost of production the rate will be fixed accordingly. Mr. W. Kennaway has had his establishment in Union-street lighted by electricity, the work having been carried out by Mr. Walter Simpson, of Thistle-street, Aberdeen.

Bath.—The Bath Electric Light Company have secured the contract for the supply of current to Messrs. Cater, Stoffell, and Fortt's new premises in High-street, where over 100 incandescent lamps will be installed. Several other firms have also decided to adopt the electric light in preference to the Welsbach gas burners, and Messrs. Mactavish and Co. are now busy wiring Messrs. Coleby and Giles's premises, Stall-street, Grapes Inn, Westgate-street, and where further extensions are contemplated; and orders for wiring have been sent in by Mr. Hayward, Green-street, Mr. E. White, Kingsmead-square, and Mr. Ashcroft, York House Hotel. The Surveying Committee of the Town Council intend to recommend that the application of the Electric Lighting Company for an extension of their license to 21 years should be opposed.

Colliery-Lighting—The Alloa Coal Company have had their large Devon Colliery, at Sauchie, near Alloa, lighted by electricity. There are two dynamos driven off their large fan engine on the surface. The installation consists of four 2,000 candle arc lamps, suspended on poles 40ft. long, embracing the surroundings of the pit-head, while the different engine-rooms, screens, pit-head, workshops, and offices are lit by 16 and 50 candle lamps. Main cables are carried down the air shaft, and the whole of the pit bottom, haulage and hydraulic engine rooms, stables, and main roads are likewise fitted up with incandescent lamps, doing away with all naked oil lamps formerly in use. The company's Bannockburn Colliery is also fitted with the electric light. Both installations were carried out by Messrs. Thomas Laurie and Co., electrical engineers, of Falkirk.

Ulverston.—The Rural Sanitary Authority, as mentioned in a previous issue, have received notice of the intention of the Windermere and District Electric Light Supply Company to apply

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to the Board of Trade for a provisional order enabling the company to supply electricity within the Authority's district. At a recent meeting of the Authority, Mr. Hodgson moved that a small committee should be appointed to consider the letter and report. If the order to be asked for were granted, it would give the company a complete monopoly of electric lighting in the Authority's district. It was proposed to utilise the power of the Leven, and works were to be erected on the banks of that river for the development and distribution of electricity. This might be very beneficial in some cases, but an order to apply to the whole district would be a very sweeping matter, and would, for instance, prevent the waters of the Duddon being utilised for a similar purpose. The motion was adopted.

Edinburgh.—The estimates of the Town Council for the current year show an increase of £4,338 for electric lighting as compared with last year, but as the Council did not spend all the money last year which they estimated for the electric light, there is actually only an increase of £1,725. A meeting of a sub-committee of the Lord Provost's Committee of the Edinburgh Town Council has been held, at which a memorandum bearing on the subject of the proposed amalgamation of Edinburgh, Leith, and Portobello was submitted. It was mentioned that as the Corporation of Edinburgh are now engaged in introducing the electric light, under the amalgamation proposed, the system of electric lighting could be carried into the united burgh under the same system and from the same source as the Edinburgh light. The meeting of the Edinburgh and Leith Gas Commission was held on Monday, when the chairman, Councillor Anderson, compared the cost of gas and electric lighting. He asserted that the illuminating value to be got for 3s. 6d. would be respectively: incandescent electric light lamps, 1,540 candles; gas consumed in a 5ft. per hour jet, 5,000 candles; gas consumed in an incandescent burner, 18,440 candles. The renewals for both gas and electric incandescent lamps had to be taken into account, but for an equal amount of light the electric lighting in Edinburgh would cost more than thrice the cost of gas in ordinary burners, and 12 times as much as in incandescent burners. He thought it assured that the gas industry would not go to the wall just at once.

Liverpool.—The Warehouse Committee, at the last meeting of the Mersey Docks and Harbour Board, recommended the Board to establish a system of electric lighting at the Albert Dock warehouses at an estimated cost of £2,850. Mr. Robert Gladstone said the committee had for some time past been considering various methods whereby the warehouses at the Albert Dock might be made more efficient and more productive of revenue, and they had at last unanimously resolved that the electric light should be adopted in all the floors. They did not recommend it to be put into the cellars or vaults where gas appeared to be more suitable in many ways, but they were quite satisfied that the electric light all over the warehouses would be of very great advantage, not only in regard to any risk of fire that might be incurred at present, but also because it would enable work to be done at night and on dark days in winter much more thoroughly and satisfactorily than it was done now. They proposed also to have a number of loose cables of considerable length which could be carried into the holds of ships and illuminate them to such an extent that work could be done there at night without the smallest difficulty. The committee were hopeful that by exercising the utmost economy they would be able to do the work at a less sum than £2,850, but they asked the Board to give them power to spend that amount, because it might eventually be found necessary. The further consideration of the recommendation was, in accordance with the standing orders, postponed till next meeting.

Loan to Shoreditch Vestry.—The Finance Committee of the London County Council reported on Tuesday that they had considered an application from the Vestry of Shoreditch for sanction to the borrowing of £12,300, on the annuity system for 60 years, for the purchase of land for dust destructor and electric lighting station. The Vestry has power under the Public Health (London) Act, 1891, Amendment Act, 1893, and the Electric Lighting Orders Confirmation (No. 6) Act, 1892, to purchase land for the purposes mentioned, and to borrow the money required, and they have agreed to purchase a site in Coronet-street and Hoxton-square for the sum of £12,300. The site contains an area of about 25,266ft., the greater portion of which is freehold, a small portion being leasehold, for a term expiring at Lady Day, 1929, at a nominal rent of 1s. The price to be paid is about 11s. per foot, which the Council's valuer considers fair and reasonable As the full period could not be allowed for repayment of the loan as affecting the leasehold part of the property, the committee have thought it convenient to reduce the amount by £100, its estimated present value, and as the Vestry only asks for permission to borrow, they recommend that the seal of the Council be affixed to an order sanctioning the borrowing by the Vestry of Shoreditch of £12,200 towards defraying the cost of purchasing a site for a dust destructor and electric lighting station at a rate of interest not exceeding £3 10s. per cent. per annum, such sum being repaid by such equal half-yearly or annual payments of principal and interest combined as will repay the amount borrowed within a period of 55 years from the date of the loan. The recommendation was adopted.

The Leeds Tramways.—A motion was brought before the Leeds Town Council on Wednesday by Mr. Graham, who proposed that the Council should adopt the cable system of traction for the city tramways. The Mayor reminded Mr. Graham that the question was under the consideration of the Tramways Committee, and thought it would necessarily come before the Council on a recommendation of the committee. He did not know whether Mr. Graham might not consider it premature to bring forward the subject now. Mr. Graham said it was several months since the question was referred to the committee, and yet no recommendation had been made. Of all the methods of traction he considered the cable system the best. He certainly would not like to see the electric system now in use on the Roundhay-road section adopted all over the city. He was of opinion that it would be much better that a company, rather than the Corporation, should manage the tramways. Alderman Gaunt, in seconding the motion, said that if the committee could not make up its mind to bring some system before the Council, he would assist Mr. Graham in bringing the subject forward. Mr. Wilson thought the resolution was inopportune. Alderman Firth thought it was unfair while the committee were considering the matter to hurry the question in a way that might damage the interests of Leeds for the next 20 years. The Tramways Committee had not yet as a committee expressed any opinion as to the method they ought to recommend, and they should not be expected to bring forward a partial report. The committee would give its opinions on all the systems they had seen, and would recommend the one which they thought the best to adopt. He appealed to the Council to show its confidence in the committee until it brought forward its report. Mr. Graham was satisfied with having provoked a discussion, and with the consent of the Council withdrew his resolution.

Islington.—At a meeting of the Vestry a report was received from the Special Electric Lighting Committee stating, that with a view to preventing difficulties arising with the owners of the property in Eden-grove and Burnard-place, adjoining the site, and to remove the possibility of the Vestry being sued for infringements of the rights of such owners, and also in order to afford facilities for further extension of the works, the committee is of opinion that such property should be acquired by the Vestry, if it can be obtained at a reasonable cost, and has with this end in view directed negotiations to be opened up with various persons interested in such property; and recommending—(*a*) That, as it considers the offer of the freeholder and lessee of 3, Burnard-place (which is now let at £28 per annum, the tenant paying rates and taxes), to join and convey to the Vestry outright and to give vacant possession on completion for the sum of £450, and vendor's solicitor's costs, according to scale, a reasonable one, such offer be accepted subject to a good title being shown, and that the solicitor be instructed to complete the purchase. (*b*) That the offer of the Rev. Frederick Mann to convey to the Vestry his freehold interest in Nos. 5, 7, 9, 19, 21, and 23, Burnard-place (subject to the leases thereon), for the sum of £600 and vendor's solicitor's costs according to scale, be accepted subject to a good title being shown, and that the solicitor be instructed to complete the purchase. The report was agreed to. Mr. Lambert pointed out that on the site for the station there were two little houses, situate close to the place where the stack was to be erected. He thought it would be policy if the property were purchased. It would be useful in future years. Mr. D. W. Williams thought the committee should be given power to acquire the property. This was agreed to. The Vestry Clerk said he would ask the Vestry to pass a formal resolution asking the County Council for a loan of £51,000, the balance of £60,000, for the purpose of completing the electric lighting works. He believed the County Council would be willing to lend the money for 42 years. Mr. Lambert moved that application be made to the London County Council or some other body for a loan of £51,000 for 42 years, at a rate of interest not exceeding 3½ per cent., repayable on the annuity system. Mr. D. W. Williams seconded. Mr. Dryden thought the rate of interest was too high. He believed the County Council lent money to some authorities at 3⅛ per cent. The motion was agreed to.

Lighting of Woking.—The Local Board have opened tenders for lighting the Woking Station and Maybury Ward. They were as follows: Messrs. New and Mayne (electric light)—capital expenditure for 34 single and 13 two-light lamp columns, £400, or for 48 single and 13 double light columns, £513. 15s.; current, etc., to 60 incandescent lamps, each of 25 c.p., £252, or for 70 lamps, £310. 16s., capital to be repaid within five years, with interest at 5 per cent. per annum. The Woking District Gas Company (gas)—capital expenditure for 100 street lamps, £300; gas to same for 2,000 hours per annum, £265; agreement for three years and subject to six months' notice, interest on capital expenditure 5 per cent., 2½ per cent per annum discount to be allowed for depreciation. The clerk was instructed to write to Messrs. New and Mayne enquiring (1) whether they would be willing to make a proportional allowance if the Board did not require 2,000 hours' installation and charge a proportionate increase for any further lights that may be required; (2) whether, as they proposed to charge interest at the rate of 5 per cent. per annum for capital outlay, they would, as in the case of previous tender, be willing to make an allowance of 2½ per cent. per annum for depreciation if and when the Board take over the plant; (3) whether they would be content to extend the period of purchase from five to seven years; (4) within what period could they complete the installations? The clerk was also instructed to write to the gas company as to extending the period of purchase to seven years, and the period by which they could complete the installation. At a subsequent meeting of the Lighting Committee it was resolved that the tender of Messrs. New and Mayne be recommended to the Board for acceptance; that 48 25-c.p. lamps be provided, and 13 two 25-c.p. lamps be provided; capital cost £513. 15s., or cost price, after giving credit for all discount. Messrs. New and Mayne to be allowed 20 per cent. for establishment charges, etc. The committee recommended the latter offer for acceptance. Capital to be repaid at the end of seven years, less 2½ per cent. per annum for depreciation; interest at

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5 per cent. per annum on capital expenditure to be paid by Board; cost of current for 2,000 hours per lamp with proportionate allowance £310. 16s ; minimum of 1,000 hours per annum per lamp The committee further recommended that the Board authorise this committee to settle the actual terms of contract, and arrange for the immediate carrying out of the work, and that the clerk be authorised to instruct counsel to settle contract and advise thereon as necessary. Mr. Harris moved at the last meeting of the Local Board that the report be adopted. Mr. Storey seconded the adoption of the report, which was carried.

PROVISIONAL PATENTS, 1894.

JULY 23.

14113. **Improvements in electric energy and power recording meters.** Alfred George Cooper, 43, George-lane, Lewisham, Kent.

14123. **Improved method of fixing electric bells and telephones.** William Paul Theermann and George Christopher Elliott, 11, Great Ducie-street, Manchester.

14156. **Improvements in or connected with electrical wagons.** Oliver William Ketchum, 4, South-street, Finsbury, London.

JULY 24.

14202. **Improvements in signalling by electric lamps.** Hugh Donald Fitzpatrick, 70, Wellington-street, Glasgow. (The Boughton Telephotos Company, United States.) (Complete specification.)

14246. **An improved system of electrical distribution by alternating currents.** Charles F. Scott, 28, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, sec. 103 February 26, 1894, being date of application in United States.) (Complete specification.)

JULY 25.

14290. **Improvements in electrical lampholders and similar electrical fittings.** Gustav Binswanger, 73, St. Stephen's-road, Upton Park, London. (Complete specification.)

14303. **An improved electricity motor meter.** Carl Raab, 6, Lord-street, Liverpool.

14312. **Improvements in automatic switch devices for electric currents.** James Thornhill Ashton, 323, High Holborn, London.

14320. **Improvements in dynamo-electric machines and electromotors.** John Augustine Kingdon, 54, Beresford-road, London.

14327. **Improvements in the manufacture of aluminium and aluminium alloys, and the electro-deposition of the same.** Alfred Francis Bilderbick Gomess, 9, Warwick-court, Gray's inn, London.

JULY 26.

14371. **Improvements in fire-alarm telegraphs.** George Richard Neilson and Alfred Charles Brown, Winchester House, Old Broad-street, London.

14394. **Improvements in induction coil apparatus for electro-medical and other purposes.** Henry James Dale, 115, Cannon-street, London.

JULY 27.

14445. **Improvements in or connected with electric railways and vehicles.** James Yates Johnson, 47, Lincoln's-inn-fields, London. (Malone Wheless, United States.) (Complete specification.)

14488. **Improvements in or connected with electric arc lamps.** James Jeffryes and John Lea, 166, Fleet-street, London.

JULY 28.

14492. **An improvement in the chamber or reflector for carrying the lamps used in photographing by the electric light.** Andrew George Adamson, 154, St. Vincent street, Glasgow.

14493. **Improvements in apparatus for the use of electric light for photographic purposes.** Andrew George Adamson, 154, St. Vincent street, Glasgow.

14509. **Improvements in electric current regulators.** Herbert Vivian Keeson, 40, Loudoun-road, St. John's Wood, London.

14511. **An improvement in electric stop-motion drawing frames.** Robert Hartley and James B. Cocks, 243, Entwistle-road, Rochdale.

14518. **Improvements in telephone switchboard apparatus.** Alfred Whalley, Ashville, Helsby, near Warrington.

14533. **Improvements in apparatus for transforming electric currents.** John Ambrose Fleming, University College, Gower-street, London.

14536. **Improvements in apparatus for heating and welding by electricity.** Charles Frederick Parkinson and Walter Gatwood, 6, Bank-street, Manchester.

14545. **Improvements in the construction of dynamo-electric machines and electromotors.** Thomas Parker, Limited, and Thomas Parker, 55, Chancery-lane, London.

14546. **Electric contact by weight.** Sally David, 18, Somerfield-road, Finsbury Park, London,

14551. **Improvements relating to the transmission of signals through submarine cables and other telegraph and telephone lines, and to apparatus therefor.** David Young, 11, Southampton-buildings, Chancery-lane, London. (John Mabry McMahan, United States.)

SPECIFICATIONS PUBLISHED.

1890.

1143. **Telegraphic apparatus.** Chadburn. (Second edition.)

1891.

17965. **Transmitting and recording electrically autographic messages, signals, and markings.** Newton. (Gray.) (Second edition.)

1893.

12971. **Alternating-current motors.** Dahl.

13111. **Dynamos and electric motors.** Pease.

13133. **Electromagnetic switch.** McLean.

14664. **Electromotors.** Kingdon.

14953. **Incandescent electric lamps.** Sharp.

16017. **Electrically-actuated machine tools.** H. W. and G. J. Gibbs.

16597. **Inspissated oil for electrical insulating purposes.** Gentzsch.

16851. **Electrical insulating material.** Gentzsch.

17310. **Electric railways.** Siemens Bros. and Co., Limited. (Siemens and Halske).

24274. **Electrolytic decomposition of metallic salts.** Kellner. (Second edition.)

1894.

3674. **Galvanic batteries.** Longsdorf. (Hewett.)

8638. **Dynamo-electric machines.** Pitt. (Blondel and others.)

9215. **Circuit control for electric machines.** Davis.

10186. **Cleats for electric wires.** Nashold.

10590. **Switch and holder for electric glow lamp.** Edison and Swan United Electric Light Company, Limited, and Proctor.

10594. **Telephones.** Frank.

10660. **Incandescent electric lamps.** Goldby. (Neumann.)

10853. **Electrical accumulators.** Johnson. (Société l'Accumulateur Fulmen.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	5	5½-5¾
Bournemouth Electric Company	—	—
Brighton and Hove Company Original	100	210-215
—— "A" Ordinary	—	162-166
Brush Company, Ordinary	3	2¾-3
—— Nom. Cum., 6 per cent. Pref.	2	2¼-2½
—— 4½ Debenture Stock	100	110-113
Charing Cross and Strand	5	4½-5½
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	12½-13½
—— 6 per cent. Cumulative Pref.	10	14-14½
—— 5 per cent. Debenture Stock	115	128-130
City and South London Railway, Consolidated Ordinary	100	36-38
—— Debenture Stock	100	120-122
—— 5 per cent. Pref. Shares	10	12¾-13½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2¾-3
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	95-100
Electric Construction, Limited	2	⅛-¼
—— 6 per cent. Debentures	—	87-92
—— 7 per cent. Cumulative Pref.	2	1½-1¾
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1-1⅛
Elmore's French Company	2	⅛-¼
Elmore's Wire Company	2	¾-1
Fowler-Waring Cables	5	½-1½
W. T. Henley's Telegraph Works, Ordinary	10	7-8
House-to-House Company, Ordinary	5	1-1¼
—— 7 per cent. Preference	5	5¼-5½
India Rubber and Gutta Percha Works	10	23-24
—— 4½ per cent. Debentures	100	103-105
International Okonite, Ordinary	10	1-2
Kensington and Knightsbridge	5	4¾-5¼
—— 6 per cent. Pref.	—	6½-6¾
Liverpool Electric Supply, Ordinary	5	6½-6¾
—— —— Pref.	—	—
Liverpool Overhead Railway	10	8⅝-8¾
—— Pref.	10	13-13¼
—— 4 per cent. Mortgage Debentures of £100	100	111-113
London Electric	5	¾-1⅛
Metropolitan Electric Supply	10	8½-9
—— 5 per cent. Reg. Debentures, 1-10,000 in Bonds of £10, £20, and £40	—	—
National Telephone, Ordinary	5	4¾-5
—— 6 per cent. Cum. First Pref.	10	14-15
—— 6 per cent. Cum. Second Pref.	10	13½-14½
—— 5 per cent. Nom. Cum. Third Pref.	5	5⅜-5½
—— 4½ per cent. Deb. Stock	—	109-112
Notting Hill Company	10	4½-5½
Oriental and Electric Company, £1 shares	1	1-1½
—— £5 Shares	—	6½-6¾
—— £4½ shares	—	5-5½
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7-7½
—— 7 per cent. Pref.	5	8½-8¾
Swan United	—	—
Telegraph Construction and Maintenance	12	40-42
—— 5 per cent. Bonds	100	102-105
Westminster Electric Supply, Ordinary	5	6-6½
Yorkshire House-to-House	4½	4¼-4¾

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NOTES.

Theatre-Lighting.—The Tyne Theatre, at Newcastle, is now electrically lighted.

Electric Lighting at Prague.—The local gas company propose to establish a central electric supply station.

Electric Lighting at Andelot.—The Electric Light Committee are enquiring into the question of the adoption of the electric light.

Electricity at Trogen.—Preparations are being made for the introduction of the electric light into Trogen, Appenzell, Switzerland.

Electric Lighting at Meissen.—Messrs. Otto and Schlosser have submitted to the Municipality a scheme for the electric lighting of the town.

Electric Lighting at Bayonne.—Messrs. Brillouin and Delgay will shortly commence operations in connection with the central electric light station.

Bleaching by Electricity.—It is announced from Greiffenberg that a local firm, Messrs. Keferstein, are now using electricity in their bleaching works.

Electric Lighthouse at Stralsund.—The Arkona lighthouse is to be lighted electrically. The Crampas-Sassnitz harbour is also to be similarly lighted.

Electric Traction at Zurich.—The Municipality are considering the question of the acquisition of the tramways and the introduction of electric traction thereon.

A Pacific Cable.—As will be seen from "Contracts" column, the Canadian Government intend to lay a cable across the Pacific between Canada and Australia.

Electric Traction at Mylau (Saxony).—The local electric tramway company have now got the whole line in operation from Zwickau railway station to Schedewitz.

Electric Traction at Liege.—The Municipality have approved of the Union Elektricitäts-Gesellschaft of Berlin establishing electric traction on the local tramways.

Electric Light at Neu-Lockstedt.—The streets here are to be lighted electrically, current being obtained from Alt-Lockstedt, which has been electrically lighted for some time.

Electric Traction at Besancon.—Mr. Faye has asked for a concession for a system of electric tramway lines at Besançon. He is already interested in those of Dijon.

Electric Traction at Munich.—The local authorities have approved of electric traction being adopted on the tramway between Fürbergraben and Isarthal railway station.

Berlin Electric Traction.—The Government have approved of the scheme for an electric railway in the Berlin suburbs between Lichterfelde, Lankwitz, and Steglitz.

Telegraph and Telephone Circuits.—Mr. W. Christiani deals in the *Elektrotechnische Zeitschrift* with the employment of common circuits for Morse and telephone working.

Telephony at Brum.—A correspondence of complaints is appearing in the Birmingham papers on the subject of the unsatisfactory service of the local telephone exchange.

Fire at Chicago.—Damage by fire to the extent of £120,000 is reported to have been done last week at the Chicago works of the Siemens and Halske Electrical Company.

Electric Traction at Pankow.—Good progress is being made in connection with the electric tramway between Pankow and Gesundbrunnen. It is to be on the overhead system.

Electric Lighting at Metzingen.—An electric plant is being erected by an Esslingen firm in the Loh mill for the lighting of some local inns. The parish church is also to be lighted.

Bristol Electric Tramway.—The specifications and drawings for the new electric tramway are in a forward state, and the work of construction will be commenced without loss of time.

Electric Boats for the Police.—The Christiania authorities have decided to adopt electric propulsion for the police boats, Messrs. Lehmann and Mann, of Berlin, supplying the accumulators.

Train Indicator.—An illustrated description is given in *L'Electricien* of August 4 of the Hoffmann apparatus for indicating in railway stations the time of departure of trains and their destination.

Lighting of Auer Lamps.—A method of lighting Auer gas lamps by electricity has been devised by M. Serrin. The gas is lighted by a spark produced by a Ruhmkorff coil energised from three or four cells.

Electric Lighting at Schiltigheim.—The Elsässische Elektricitätswerke, of Strassburg, are substituting electric lighting for gas lighting in the works of the Erste Elsässische Küferei Aktiengesellschaft.

Iron and Steel Institute.—At the Brussels meeting of this institute, to which reference was made in our last issue, a paper "On Electrical Power in Belgian Ironworks," by Mr. D. Selby-Bigge, will be presented.

Personal.—Mr. J. E. Edgcombe, the electrical engineer to the Kingston Corporation, having got married, the members of the Lighting and Drainage Committees of the Town Council have presented him with a silver salver.

Electric Traction at Baden (Austria).—An electric tramway has been opened between Baden, near Vienna, and Helenenthal. By the end of the month an extension from Helenenthal to Vöslau will be completed.

India-Ceylon Telegraph Line.—When the new telegraph cable from Ceylon to India *vid* Talamannar is made in September next, Ceylon will receive the duplex system. At present Madras has the duplex and quadruplex systems.

Electric Lighting at Mylau (Saxony).—In response to circulars sent out with respect to the probable demand for current for electric lighting purposes, applications have been received for over 1,400 lamps, apart from street-lighting.

Schonlinde (Austria).—The local authorities have entrusted Messrs. Kremenezky, Mayer, and Co., of Vienna, with the contract for the erection of a central station. There will be two single-cylinder steam-engines running at 130 revolutions per minute.

Central Station at Linden.—Mr. Ernst Bremeyer, a local indiarubber manufacturer, proposes to erect a central electricity station at his works for the supply of current for lighting and power purposes. A considerable number of applications has already been received.

Electrolytic Works at Osternienburg.—The German Solvay Works, of Bernburg, have proposed to erect an electrolytic works at Osternienburg for the manufacture of chemicals, but opposition is coming from local landowners on the grounds that the gases will be injurious to their interests.

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Windmills and Electricity.—A unique plant is to be established at Bremen. The owner of the Ansgariithor windmill intends to make use of electricity, not by making his windmill drive a dynamo, but by introducing an electromotor, connected with the town electric mains, for driving his machinery when a calm prevails.

Electricity at Antwerp.—The Deutsche Elektricitäts Werke of Aix-la-Chapelle have constructed 60-h.p. turbine dynamos for the Antwerp central station. Though, as a rule, dynamos are considerably smaller than their motors, in this instance the reverse is the case, as a very high pressure is used for driving the turbines.

Electric Lighting at Augsburg.—A long time back the local gas company informed the Municipality that they were prepared to introduce the electric light, and some weeks ago prepared a plan for lighting the town electrically. This was not considered satisfactory, and a new plan has been drawn up. It is believed the work will be commenced next year.

Electric Transmission in Ain.—The water power of the River Valserine has already been utilised for driving the dynamos of the oldest electric light station in France, that of Bellegarde-sur-Valserine, Ain, but only 120 h.p. is employed there. Mr. J. Guillemet has now drawn up a project whereby about 7,500 h.p. would be made available.

Gotha is Not Up to Date.—A grant of £185 was wanted for the electric lighting of the School of Building. This cost was only one-fifth higher than for lighting by means of Auer incandescent gas lamps, but the Gotha Diet has declined to grant the money on the ground that there is so little experience available with respect to the electric light. The Duke of Edinburgh would do well to educate his new subjects.

Electric Traction at Loipzig.—The Municipality have given a concession to the Allgemeine Elektricitäts-Gesellschaft and Mr. R. Lehfeldt, of Leipzig, for the construction and working of an electric tramway. The new lines will traverse the whole of the inner part of the town, which has hitherto not been served by any tramway. The system of lines for which the concession has been granted amounts to over 21 miles.

Electric Traction at Strassburg.—Preparations are being made by the tramway company for using electric traction on the lines in the central parts of the town. Arrangements are being made with the Allgemeine Elektricitäts-Gesellschaft of Berlin for the supply of motor cars. These will be tried until it has been demonstrated that electric traction is satisfactory. When there is heavy traffic it is intended to use a trailer behind the motor car.

Central Station at Gegenbach (Baden).—The local authorities have given a 25 years' concession to the Offenburg Colliery Company for a central station for lighting the town. Messrs. O. L. Kummer and Co., of Dresden, will carry out the work. The supply station, of a capacity of 1,000 lamps, will be erected at the Berghaupten Colliery of the company, which is about 2½ miles distant from the lighting district. The transmission will take place by means of an alternating current of 3,000 volts.

Electrical Stern Attachment for Launches.—With reference to the note on this subject in our last issue, Mr. E. A. McLachlan writes as follows: "Kindly correct the following mistakes. The headnote reads in your paper 'Electrical *Steam* Attachment for Launches.' This should be 'Electrical *Stern* Attachment.' The other mistake states that the electrical equipment can be supplied to any boat at about one-half the cost of an ordinary 'electric *lamp*.' This should be 'electric *launch*.'"

Strange Story from Blackpool.—Complaint was made at the Blackpool Town Council meeting on Tuesday that serious attempts had been made to interfere with the electric light supply and the running of the electric tramway during the busy season. Scientific measures had been taken to run the tramway current to earth, and to otherwise hamper the staff, the interference being of so damaging a nature that a special watch would have to be maintained.

Strassburg.—The question of lighting the town electrically has been under consideration since 1889, and at last a decision has been come to. The Municipality have determined to allow the Allgemeine Elektricitäts-Gesellschaft of Berlin to erect and carry on a central station. It will be built on plans by Mr. Oscar von Miller, and alternating current will be employed. Steam power will be used at first, but probably when extensions are made the power of the Rhine will be utilised. The concession is for 40 years.

Ammeters and Voltmeters.—A price list of the ammeters and voltmeters constructed according to MM. Desruelles and Chauvin's patent has reached us from the Boudreaux Dynamo Brush Company, who are the English agents for these instruments, which have gained a good reputation in France for their great accuracy and high-class workmanship. In addition to these the company furnish galvanometers, resistance-boxes, portable testing sets, and Desruelles standard cells (giving one volt exact), of the same manufacturers.

Owens College, Manchester.—A special course has been arranged on the technical applications of electricity. A dynamo-house has recently been built in connection with the physical laboratory, containing a 7-h.p. Otto gas-engine, with two direct and two alternate current dynamos, specially constructed for purposes of instruction, etc. In the laboratory full instruction is given in electric and magnetic measurements, testing of dynamos, etc. The session begins on October 2. Prospectus may be obtained of Mr. H. W. Holder, M.A., registrar.

Portable Electric Pumping Plant.—The *Bulletin International de l'Electricité* refers to a portable electric pump devised by Messrs. Carl and Co., of Worms, for use in breweries and cellars. The motor and pump are arranged on a kind of trolley, the former driving the latter by means of worm gearing. The motor is put into the circuit of the existing electric light installation by means of a flexible cable, which is connected to any one of the various wall plugs in the building. The motor is made in sizes ranging from ⅓ h.p. to ¾ h.p., and the plant is said to be more economical than pumping by hand.

University College, Liverpool.—The engineering department for session 1894-95 commences on October 2. Complete courses of instruction have been arranged in civil engineering, mechanical engineering, and electrical engineering. These courses enable students to qualify for university degrees and for the college certificates in engineering. They comprise, in addition to special engineering lectures and laboratory work, instruction in mathematics, physics, electrotechnics, and chemistry. The engineering laboratories, and also the electrotechnical laboratories, are completely equipped with modern appliances. The college prospectus, and also the special engineering prospectus, can be obtained on application to the registrar.

Electric Lamps in Railway Carriages.—Mr. Boiston's electric reading lamps, according to *Indian Engineering*, will be given an extensive trial on the system of railways worked by the Bombay, Baroda, and Central India Railway Company. Some time back an experimental arrangement was made with Mr. Boiston for the

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erection of automatic machines at stations on the company's system. The company have since agreed to Mr. Boiston's proposal to introduce an electric reading lamp in carriages on passenger trains, and to this appliance being included in the concession granted to Mr. Boiston in respect of the experimental introduction of automatic machines. The fitting of the lamps will be done under the supervision of the carriage department of the railway.

Central Station at Frankfort-on-the-Maine.—This station was in the first place calculated for a capacity of 17,500 lamps simultaneously alight. For the four steam-engines projected, only three engines, with their corresponding boilers, have been authorised. The number of applications amount to 29,000 lamps, or their equivalent in motors, or equal to about 17,100 lamps simultaneously alight. In addition, there will be the lighting of the harbour, the municipal hospital, and of some public streets and offices. An agreement has been made with Messrs. Brown, Boveri, and Co. to extend the plant. This extension will include a steam dynamo and six boilers. Applications are constantly being received, some of which come from outside the district of the network of conductors at present planned.

The Snowdon Electric Railway.—The route surveyed for the electric railway from Llanberis to the summit of Snowdon covers a distance of over six miles. It starts from the Ty Clwb, near the Victoria Hotel, goes up to Ceunant Mawr, past the Llanberis waterfall, then turns on the left to the top of Derlwyn, and passes along the tops of the mountains on the west side of the Pass of Llanberis, as far as Clogwyn Coch, where the line will turn to the right and proceed as far as the Crosses; then, after running along the mountain side opposite the Snowdon Ranger Path, it will turn to the left and proceed direct to the top of Snowdon. It runs, in fact, near the Llanberis ascent. A limited company, it is reported, is about to be formed to carry out the scheme, and already half the required capital has been secured.

Notes from Italy.—The Town Council of Verona has lost the action brought against it by the local gas company for having granted a concession to an electric light company—the gas company having by its contract a lighting monopoly. A French company which had obtained powers for the electric lighting of Venice, has now declined to undertake the work. The company operating the station in Reggio Emilia has been in difficulties, but as a compromise has now been effected, the supply of light will be continued. The Edison Company of Milan has a concession for a line of electric tramway in the town, and negotiations were recently entered into with the local omnibus company, with a view to amalgamating the two undertakings. The latter has, however, declined to agree to the fusion.

Electric Lighting in Madras.—In the Madras Presidency two electric light installations have been recently carried out by Messrs. Oakes and Co., of Madras, one at the United Service Club, Bangalore, being an installation of 100 16-c.p. incandescent lamps run off a 105 volt circuit. A correspondent of the *Indian Engineer* states that the dynamo is of the Crompton type. In connection with this installation, or rather a part of it, is a set of accumulators, the battery consisting of 53 seven-plate cells of the Crompton-Howell type. The dynamo is driven by a Marshall 6-h.p. single-cylinder high-pressure stationary engine fitted with Hartnell's automatic expansion gear, the boiler being of the loco. type. The second installation put in by the company is at their own premises on the Mount-road, this being a somewhat smaller installation, comprising only 60 16-c p. incandescent lamps. The dynamo is driven by a 3-h.p. horizontal engine by Messrs. Robey and Co., supplied by steam from a 6-h.p. loco.-type boiler. Both installations were carried out by Mr. R. D. Frier, manager and engineer of the company's foundry.

Life of Incandescent Lamps.—One can hardly attach much—if, indeed, any—value to tabular statements of the life of different types of incandescent lamps, their consumption of current, and cost price per candle per hour when the lamps are designated purely by alphabetical letters, without any indication being made of the type or make of the lamps. This policy is being followed by *L'Industrie Electrique*, which some weeks ago dealt with this subject at some length; and an esteemed English contemporary, without taking into consideration the uselessness of such a compilation, subsequently reproduced the article. *L'Industrie Electrique* has now followed up its former article by a second, which is given in its issue of July 25. In this case, too, the various types of lamps are merely designated by letters, and consequently the article is of little, if any, practical value. We would suggest that in the future the names should be specifically mentioned.

Communication Between Lightships and the Shore.—In the House of Commons a few days ago, Mr. Bryce, in answer to Major Jones, stated that the committee to which the hon. member would appear to refer reported and closed its sittings in 1889. The whole subject of electrical communication between lightships and the shore was now being dealt with by the Royal Commission on Electrical Communication with Lighthouses and Light-vessels. He understood that a number of inventions, including various modes of applying swivels, for establishing electrical communication between lightships and the mainland had been considered by the Royal Commission, and he would refer the hon. member to the paragraph at the top of page 8 of their second report, dated March last, in which the Commissioners stated that, in their opinion, none of the inventions which they had considered were preferable to the system known as the "Sunk" system, which had now been applied to the Goodwin and Kentish Knock light-vessels. He had no doubt that the Royal Commission would consider, and, if necessary, test, any inventions brought before them which appeared to them to be superior to the "Sunk" system.

Train-Lighting.—An article on the electric lighting of the Danish State railway trains appears in the *Elektrotechnische Zeitschrift* of the 2nd August from the pen of Mr. J. B. Brunn, inspector of machinery at Copenhagen. Before the question of improving the illumination of the carriages was decided upon, it was resolved to make preliminary experiments in a few coaches, and for this purpose accumulators furnished by the Electrical Power Storage Company, of London, were adopted. The results were successful, and in 1892 an extension of the system was ordered to be carried out on all the express trains in Zealand. In this case the batteries used are of the Hagen type, each battery comprising 33 cells with three in reserve, and two batteries are carried on each train. The first-class compartments are lighted by two 8-c.p. lamps, whilst the second and third class coaches are equipped with lamps of 5 c.p. The batteries are charged at the railway stations in Copenhagen and Helsingor. The author concludes that although the experiments have been conducted for over two years, they have not been continued sufficiently long to allow of an impartial comparison of the cost of oil-gas illumination and of electric lighting of trains.

Electric Cranes for Bridge Building.—A large arched bridge is now being built by the Gutehoffnungshutte, of Oberhausen, over the Baltic Canal near Levensau for foot passengers and for railway traffic, and in the course of

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construction electricity is taking an important position for motive power purposes. This installation has been carried out by Mr. Gustav Conz, of Hamburg. The generating plant comprises two steam-engines coupled direct to compound dynamos, which are arranged to work in parallel, and which supply current to motors operating several electric cranes. Of course, in a case of this character the operation of cranes is very irregular. It is possible, as is pointed out by Mr. Paul Rohde in the *Elektrotechnische Zeitschrift*, that all the electric motors may at times be suddenly cut out of circuit. To meet this emergency, an automatic arrangement has been adopted at Levensau. By this means, when the outer circuit is opened, a shunt resistance is inserted, which prevents the paralleled dynamos from working against each other. This arrangement ensures the proper operation of the plant. The dynamos and motors are of the four-pole type, and the steam engines are compound, giving 25 h.p. at 400 revolutions, and provided with Tangye regulators.

Prizes Proposed to be Awarded.—The French Société d'Encouragement pour l'Industrie Nationale has issued a list of the prizes to be awarded in 1895-96. Among these may be mentioned the Henri Giffard award, to which reference was made in a previous issue, and the Melsens prize. The latter, which is offered for an application of physics or chemistry to electricity or to hygiene, is of the value of £200, and will be awarded in 1896. Awards of £80 each are to be made for a motor weighing less than 1cwt. per horse-power, and for a small motor for a domestic workshop. A similar offer is made for the commercial production of ozone and its applications. In the section "Arts Economiques," the following prizes for next year are proposed: The sum of £80 for an apparatus or industrial method for measuring or estimating the insulation of various parts of an electrical installation in operation; £120 for the presentation of a material capable of replacing indiarubber in at least one of its principal applications, or for works having contributed towards developing the production or improving the working up of this material; and £80 for an incandescent electric lamp having an intensity of a decimal candle and working with $\frac{1}{20}$ ampere at 100 volts. Models, descriptive papers or notes, and samples are to be addressed to the Secrétaire de la Société d'Encouragement pour l'Industrie Nationale, 44, Rue de Rennes, Paris, not later than December 31, 1894.

The Douglas Electric Tramway.—It will be remembered that this tramway, to which we have from time to time referred, was completed and opened as far as Groudle Glen, half the full distance, last summer. The traffic, especially since the whole of the line has been opened, is very large, as it affords a pleasant excursion for the summer visitors to the island. The line is seven miles in length, being double all the distance. It is a surface line, following for the most part the contours of the hilly country through which it passes, but at the Douglas end there is a cutting along the face of the cliff, this portion of the road being protected seaward by a massive cement concreted wall. At other portions of the line there are some long gradients, the steepest being 1 in 24. The line is made of the ordinary steel rails, laid on transverse sleepers. The speed is, by Act of Tynwald (the Manx Parliament), limited to eight miles an hour. The cost of the line, including the plant, rolling-stock, and electrical machinery, is about £9,000 a mile. Each train consists of one motor car and one trailing car, the two vehicles being together capable of seating 82 persons. The current is produced at two stations—one at Douglas and the other at the Laxey terminus. At the former end there are three steam-engines and three boilers, each engine driving a 50-kilowatt dynamo of the Manchester type. There is also a large accumulator station about halfway along the line. The current produced by the dynamos is conveyed by copper conductors supported by steel poles erected along the line. Two uprights fixed on each motor car carry a horizontal copper collecting bar, which conveys the current from the conductors to two 30-h.p. motors fixed underneath each car. These motors are geared to the axle of the driving wheels. The return is through the rails, which are connected by a copper strip at each joint. The whole of the electrical plant and machinery has been designed by Dr. E. Hopkinson, the contractors for the work being Messrs. Mather and Platt, of the Salford Iron-works, and the engineer by whom the tram line was constructed is Mr. Frederick Saunderson, of Douglas.

Lighting of Drainage Works.—Before the Manchester meeting of the Institution of Mechanical Engineers, last week, Mr. Wm. Thomas Olive gave a description of the Manchester main drainage works. The paper concluded with the following statement concerning the electrical plant at those works: The installation includes a vertical engine with 13in. cylinder and 16in. stroke to run at 130 revolutions per minute with a pressure of 80lb. per square inch, the steam being supplied from the general service boilers. Also a set of 56 storage batteries capable of running with lamps of 16 c.p. a maximum of 420 lamp hours. The dynamo is driven at a speed of 700 revolutions by a 10in. flexible centre belt direct from the engine fly-wheel, which is 5½ft. diameter and 11½in. wide on the face; it is of the inverted-magnet type, compound wound, and has a capacity for working a 220-ampere load at 100 volts when on the lamp circuits. When charging accumulators a plug switch is inserted in the series portion of the compound winding, which cuts that part out of action. For charging the accumulators in series the speed of the dynamo would require to be nearly 1,000 revolutions per minute, with a corresponding increase in speed of engine. As this, however, would materially increase the wear and tear, the batteries by means of suitable switches are arranged in two sets of 28 each when charging. By this means the speed is reduced to about 600 revolutions per minute, thereby effecting also a saving of steam. Although storage batteries usefully yield only about 70 per cent. of the energy given to them by the dynamo, they are extremely economical and handy. If a small number of lamps only are required, it would be wasteful to run the engines; besides which time would be occupied in oiling and heating up, and there would be loss by condensation. From the accumulators the lamps can be started or stopped instantly without any further attention. As the insulated cables spread for hundreds of yards in every direction about the premises, the stored energy could be applied on an emergency to portable machines for pumping, drilling, hauling, etc. The number of lamps at present in use is 134, as follows: 14 arcs of 1,200 c.p. for outside use, 12 arcs of 500 c.p. for inside use, 88 incandescent lamps of 16 c.p. for inside use, eight incandescent lamps of 50 c.p. on the approach road, and 12 incandescent lamps of 32 c.p. in the subway. These are divided on the switch-board into six main circuits, but there are also local switches for every one or two lamps, except on the approach road, where all the lamps are controlled by one switch. An illustration occurs here of the economy of electric lighting as compared with gas. To light and extinguish gas would occupy a man at least an hour every day, whilst the engine-man can turn the electric lamps on and off in an instant without leaving his post. The electric lamps also require less cleaning, as there is no smoke or soot, and the insides of lanterns are sealed from atmospheric dust.

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FACTS AND FIGURES CONCERNING SOME CONTINENTAL ELECTRIC TRAMWAYS.

The Union Internationale Permanente de Tramways is an organisation which was formed in Belgium, but has spread its influence and connection over most of the continental countries to such good purpose that its annual meetings are now attended by nearly all the leading tramway engineers and officials of Germany, Belgium, France, Austria, and Italy. In this respect it takes a much higher position than our own Tramways Institute, and the information which it compiles and circulates has a value to our readers which they will appreciate on perusal. Particulars of construction and returns as to working cost, capital outlay, etc., have been obtained from a number of tramway companies whose officials are members of the union, and whose lines are operated by electric energy, and we propose to abstract these details in such form as may prove most useful to our readers.

The first line or system of lines to notice is that of **Aix-la-Chapelle**, where overhead conductors are employed with underground feeders. The trolley wire is of silicious bronze 8mm. diameter (equal nearly to No. 0 S.W.G.), supported in the usual way from poles with horizontal arms. Each car is provided with two motors, having a total capacity of 30 h.p.; there are some considerable grades on the lines which require the operation of both motors at once, but usually one is sufficient for working the car so that the second one in such a case acts as a reserve. The necessary current is derived from the municipal electric lighting station, being generated by two special sets of engines and dynamos having an output of 200 h.p. each at a working pressure of 600 volts. Under ordinary circumstances one set is enough for the daily load, the other being then in reserve, but both are worked for heavy service on *fêtes* and holidays, and should more current still be required a continuous-current transformer is put into action, so that the electric lighting machines at the central station may be drawn upon.

The total length of line worked electrically is 22 kilometres (or, say, 13·6 miles), of which two kilometres (1¼ miles) are constructed as double track. Of the entire system—

1,300	metres, or	6 %	are on the level.
15,400	„	70 %	have grades varying up to 2·5%.
2,800	„	12·5%	„ „ from 2·5 to 3·3%
2,499	„	11 %	„ „ „ 3·3 to 5%.
100	„	·5%	„ „ up to 9%.

Thirty-four motor cars are in service; they each accommodate 14 passengers seated and 12 standing on the platforms, therein resembling the horse cars previously used, but now turned into trail cars. The tramway company considers that double-decked cars—*i.e.*, those with seats on the roof—would offer many difficulties and inconveniences, more especially in regard to the trolley pole. Its officials evidently have not been to visit the South Staffordshire tramway, or they would know that there is not the least trouble in working double-decked cars on the overhead conductor system. At Aix, however, it is considered that the ordinary type of car will serve every purpose, especially as the introduction of electric working has increased by 25 per cent. the number of journeys accomplished daily by the cars.

So far as it can be stated with a fair degree of accuracy, the capital outlay upon these lines has been as follows:

	Marks.	
Overhead conductor system	210,000	£10,500
Motor cars (34)	374,000	18,700
Depôt and workshop	26,000	1,300
Permanent way—altering and making equal to new	200,000	10,000
Miscellaneous—sidings, etc.	90,000	4,500
	900,000	45,000
Deduct proceeds of sales—horses and cars	100,000	5,000
Total	800,000	£40,000

The speed of the cars is maintained at 10 kilometres (6·2 miles) per hour within the town limits, and 15 kilometres (9·3 miles) outside in the suburbs.

The lines at **Hamburg** are also operated on the overhead conductor system; their length amounts to a total of 22·761 kilometres, or about 14 miles. The sharpest curve has a radius of 20 metres, or about 62ft., nearly equal to one chain; the steepest grade is one of 5 per cent. about 300 yards long. The track is double throughout except on two short sections, measuring in all about 600 yards. Current for working the lines is provided by the Hamburg Electricity Works, and is conveyed to different points of the system by means of underground cables. In the central station there are at present two transformers, each giving 150 amperes at 500 volts, and a dynamo having an output of 200 amperes at the same voltage. The former are fed from the lighting circuits at a pressure of 250 volts. Other transformers are in process of erection. The overhead conductor or trolley wire is maintained at a height of 17ft. to 20ft. above the street level, and runs centrally over the track. The method of suspension varies according to local conditions. In some places poles with long arms or side brackets are fixed along the roadside or edge of the footpath, whilst elsewhere the usual type of steel suspension wires are used, strung across the streets from brackets fastened to the buildings. Switches at short intervals allow the current to be cut off from any part of the line at will. The trolley wire is of hard-drawn copper, 8·25mm. in diameter (equal to No. 0 S.W.G.). The poles from which it is supported are of ornamental design, and built of steel tubes. In order to avoid contact with broken telephone wires, the ends of which might conceivably fall upon the trolley wires, thin wooden protecting laths are carried by the latter. Each motor car has one 15-h.p. motor with single-reduction gear; the motor is hung in the usual manner, so as to rest the greater portion of its weight upon the car frame by means of a spring, the remainder being carried by the axle. Resistances are used for speed regulation; the car is driven in either direction from either end, and may be pulled up suddenly when required by reversing the current. Five 16-c.p. lamps are fitted to each car—three in the body and the others in the end lights.

(To be continued.)

THE BRITISH ASSOCIATION.

The sixty-fourth session of the British Association commenced at Oxford on Wednesday last. The presidential address by the Most Hon. the Marquis of Salisbury, and the addresses to Sections A and G by Prof. A. W. Rücker and Prof. A. W. B. Kennedy, respectively presidents of the sections referred to, all deal with matters closely allied to electrical science, and we therefore reprint them as follows:

Presidential Address

BY THE MOST HON. THE MARQUIS OF SALISBURY, K.G., D.C.L., F.R.S., Chancellor of the University of Oxford.

My functions are of a more complicated character than usually is assigned to the occupants of this chair. As chancellor of the university it is my duty to tender to the British Association a hearty welcome, which it is my duty as president of the association to accept. As president of the association I convey, most unworthily, the voice of English science, as many worthy and illustrious presidents have done before me; but in representing the university I represent far more fittingly the learners who are longing to hear the lessons which the first teachers of English science have come as visitors to teach. I am bound to express on behalf of the university our sense of the good feeling towards that body which is the motive of this unusual arrangement; but, as far as I am personally concerned, it is attended with some embarrassing results. In presence of the high priests of science I am only a layman, and all the skill of all the chemists the association contains will not transmute a layman into any more precious kind of metal. Yet it is my hard destiny to have to address on scientific matters probably the most competent scientific audience in the world. If a country gentleman, who was also a colonel of volunteers, were by any mental aberration on the part of the commander-in-chief to be appointed to review an army corps at Aldershot, all military men would

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doubtless feel a deep compassion for his inevitable fate. I bespeak some spark of that divine emotion when I am attempting to discharge under similar conditions a scarceless less hopeless duty. At least, however, I have the consolation of feeling that I am free from some of the anxieties which have fallen to those who have preceded me as presidents in this city. The relations of the association and the university are those of entire sympathy and goodwill, as becomes common workers in the sacred cause of diffusing enlightenment and knowledge. But we must admit that it was not also so. A curious record of a very different state of feeling came to light last year in the interesting biography of Dr. Pusey, which is the posthumous work of Canon Liddon. In it is related the first visit of the association to Oxford in 1832. Mr. Keble, at that time a leader of university thought, writes indignantly to his friend to complain that the honorary degree of D.C.L. had been bestowed upon some of the most distinguished members of the association: "The Oxford doctors," he says, "have truckled sadly to the spirit of the times in receiving the hodge-podge of philosophers as they did." It is amusing, at this distance of time, to note the names of the hodge-podge of philosophers whose academical distinctions so sorely vexed Mr. Keble's gentle spirit. They were Brown, Brewster, Faraday, and Dalton. When we recollect the lovable and serene character of Keble's nature, and that he was at that particular date probably the man in the university who had the greatest power over other men's minds, we can measure the distance we have traversed since that time; and the rapidity with which the converging paths of these two intellectual luminaries—the university and the association—have approximated to each other. This sally of Mr. Keble's was no passing or accidental caprice. It represented a deep-seated sentiment in this place of learning which had its origin in historic causes, and which has only died out in our time. One potent cause of it was that both bodies were teachers of science, but did not then in any degree attach the same meaning to that word. Science with the university for many generations bore a signification different from that which belongs to it in this assembly. It represented the knowledge which alone in the Middle Ages was thought worthy of the name of science. It was the knowledge gained not by external observation, but by mere reflection. The student's microscope was turned inward upon the recesses of his own brain, and when the supply of facts and realities failed, as it very speedily did, the scientific imagination was not wanting to furnish to successive generations an interminable series of conflicting speculations. *That* science—science in our academical sense—had its day of rapid growth, of boundless aspiration, of enthusiastic votaries. It fascinated the rising intellect of the time, and it is said—people were not particular about figures in those days—that its attractions were at one time potent enough to gather round the university 30,000 students, who for the sake of learning its teaching were willing to endure a life of the severest hardship. Such a state of feeling is now an archæological curiosity. The revolt against Aristotle is now some three centuries old; but the mental sciences which were supposed to rest upon his writings have retained some of their ascendancy even till this day, and have only slowly and jealously admitted the rivalry of the growing sciences of observation. The subject is interesting to us, as this undecided state of feeling coloured the experiences of this association at its last Oxford visit, nearly a generation later, in 1860. The warmth of the encounters which then took place have left a vivid impression on the minds of those who are old enough to have witnessed them. That much energy was on that occasion converted into heat may, I think, be inferred from the mutual distance which the two bodies have since maintained. Whereas the visit of 1832 was succeeded by another visit in 15 years, and the visit of 1847 was succeeded by another visit in 13 years, the year 1860 was followed by a long and dreary interval of separation, which has only now, after four-and-thirty years, been terminated. It has required the lapse of a generation to draw the curtain of oblivion over those animated scenes. It was popularly supposed that deep divergences upon questions of religion were the motive force of those high controversies. To some extent that impression was correct. But men do not always discern the motives which are really urging them, and I suspect that in many cases religious apprehensions only marked the resentment of the older learning at the appearance and claims of its younger rival. In any case there is something worthy of note, and something that conveys encouragement in the difference of the feeling which prevails now and the feeling that was indicated then. Few men are now influenced by the strange idea that questions of religious belief depend on the issues of physical research. Few men, whatever their creed, would now seek their geology in the books of their religion, or, on the other hand, would fancy that the laboratory or the microscope could help them to penetrate the mysteries which hang over the nature and the destiny of the soul of man. And the old learning no longer contests the share in education which is claimed by the new, or is blind to the supreme influence which natural knowledge is exercising in moulding the human mind.

A study of the addresses of my learned predecessors in this office shows me that the main duty which it falls to a president to perform in his introductory address, is to remind you of the salient points in the annals of science since last the association visited the town in which he is speaking. Most of them have been able to lay before you in all its interesting detail the history of the particular science of which each one of them was the eminent representative. If I were to make any such attempt I should only be telling you with very inadequate knowledge a story which is from time to time told you, as well as it can be told, by men who are competent to deal with it. It will be more suitable to my capacity if I devote the few observations I have to make to a survey not of our science but of our ignorance. We live in a small bright oasis of knowledge surrounded on all sides by a vast unexplored region of impenetrable mystery. From age to age the strenuous labour of successive generations wins a small strip from the desert, and pushes forward the boundary of knowledge. Of such triumphs we are justly proud. It is a less attractive task—but yet it has its fascination as well as its uses—to turn our eyes to the undiscovered country which still remains to be won, to some of the stupendous problems of natural study which still defy our investigation. Instead, therefore, of recounting to you what has been done, or trying to forecast the discoveries of the future, I would rather draw your attention to the condition in which we stand towards three or four of the most important physical questions which it has been the effort of the last century to solve.

Of the scientific enigmas which still, at the end of the nineteenth century, defy solution, the nature and origin of what are called the elements is the most notable. It is not, perhaps, easy to give a precise logical reason for the feeling that the existence of our 65 elements is a strange anomaly and conceals some much simpler state of facts. But the conviction is irresistible. We cannot conceive, on any possible doctrine of cosmogony, how these 65 elements came into existence. A third of them form the substance of this planet. Another third are useful, but somewhat rare. The remaining third are curiosities scattered haphazard, but very scantily, over the globe, with no other apparent function but to provide occupation for the collector and the chemist. Some of them are so like each other that only a chemist can tell them apart; others differ immeasurably from each other in every conceivable particular. In cohesion, in weight, in conductivity, in melting point, in chemical proclivities they vary in every degree. They seem to have as much relation to each other as the pebbles on a sea beach, or the contents of an ancient lumber-room. Whether you believe that creation was the work of design or of inconscient law, it is equally difficult to imagine how this random collection of dissimilar materials came together. Many have been the attempts to solve this enigma; but up till now they have left it more impenetrable than before. A conviction that here was something to discover lay beneath the persistent belief in the possibility of the transmutation of other metals into gold, which brought the alchemy of the Middle Ages into being. When the immortal discovery of Dalton established that the atoms of each of these elements have a special weight of their own, and that consequently they combine in fixed ponderable proportions from which they never depart, it renewed the hope that some common origin of the elements was in sight. The theory was advanced that all these weights were multiples of the weight of hydrogen—in other words, that each elementary atom was only a greater or a smaller number of hydrogen atoms compacted by some strange machinery into one. The most elaborate analyses, conducted by chemists of the highest eminence—conspicuously by the illustrious Stas—were directed to the question whether there was any trace in fact of the theoretic idea that the atoms of each element consist of so many atoms or even of so many half atoms of hydrogen. But the reply of the laboratories has always been clear and certain—that there is not in the facts the faintest foundation for such a theory.

Then came the discovery of the spectral analysis, and men thought that with an instrument of such inconceivable delicacy we should at last find out something as to the nature of the atom. The result has been wholly disappointing. Spectral analysis in the hands of Dr. Huggins and Mr. Lockyer and others has taught us things of which the world little expected to be told. We have been enabled to measure the speed with which clouds of blazing hydrogen course across the surface of the sun: we have learnt the pace—the fabulous pace—at which the most familiar stars have been for ages approaching to or receding from our planet, without apparently affecting the proportions of the patterns which, as far as historical record goes back, they have always delineated on the evening sky. We have received some information about the elementary atoms themselves. We have learnt that each sort of atom when heated strikes upon the ether a vibration, or set of vibrations, whose rate is all its own, and that no one atom or combination of atoms in producing its own spectrum encroaches even to the extent of a single line upon the spectrum that is peculiar to its neighbour. We have learnt that the elements which exist in the stars, and specially in the sun, are mainly those with which we are familar upon earth. There are a few lines in excess to

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which we can give no terrestrial name, and there are some still more puzzling gaps in our list. It is a great aggravation of the mystery which besets the question of the elements, that among the lines which are absent from the spectrum of the sun, those of nitrogen and oxygen stand first. Oxygen constitutes the largest portion of the solid and liquid substance of our planet, so far as we know it ; and nitrogen is very far the predominant constituent of our atmosphere. If the earth is a detached bit whirled off the mass of the sun, as cosmogonists love to tell us, how comes it that in leaving the sun we cleaned him out so completely of his nitrogen and oxygen that not a trace of these gases remains behind to be discovered even by the sensitive vision of the spectroscope ?

All these things the discovery of spectrum analysis has added to our knowledge ; but it has left us as ignorant as ever as to the nature of the capricious differences which separate the atoms from each other, or the cause to which those differences are due.

In the last few years the same enigma has been approached from another point of view by Prof. Mendeléeff. The periodic law which he has discovered reflects on him all the honour that can be earned by ingenious, laborious, and successful research. He has shown that this perplexing list of elements can be divided into families of about seven, speaking very roughly : that those families all resemble each other in this, that as to weight, volume, heat, and laws of combination, the members of each family are ranked among themselves in obedience to the same rule. Each family differs from the others ; but each internally is constructed upon the same plan. It was a strange discovery—strangest of all in its manifest defects. For in the plan of his families there were blanks left ; places not filled up because the properly constituted elements required according to his theory had not been found to fill them. For the moment their absence seemed a weakness in the professor's idea, and gave an arbitrary aspect to his scheme. But the weakness was turned into strength when, to the astonishment of the scientific world, three of the elements which were missing made their appearance in answer to his call. He had described beforehand the qualities they ought to have ; and gallium, germanium, and scandium, when they were discovered shortly after the publication of his theory, were found to be duly clothed with the qualities he required in each. This remarkable confirmation has left Mendeléeff's periodic law in an unassailable position. But it has rather thickened than dissipated the mystery which hangs over the elements. The discovery of these co-ordinate families dimly points to some identical origin, without suggesting the method of their genesis or the nature of their common parentage. If they were organic beings, all our difficulties would be solved by muttering the comfortable word "evolution"—one of those indefinite words from time to time vouchsafed to humanity, which have the gift of alleviating so many perplexities and masking so many gaps in our knowledge. But the families of elementary atoms do not breed ; and we cannot, therefore, ascribe their ordered difference to accidental variations perpetuated by heredity under the influence of natural selection. The rarity of iodine, and the abundance of its sister, chlorine, cannot be attributed to the survival of the fittest in the struggle for existence. We cannot account for the minute difference which persistently distinguishes nickel from cobalt by ascribing it to the recent inheritance by one of them of an advantageous variation from the parent stock.

The upshot is that all these successive triumphs of research—Dalton's, Kirchoff's, Mendeléeff's—greatly as they have added to our store of knowledge, have gone but little way to solve the problem which the elementary atoms have for centuries presented to mankind. What the atom of each element is—whether it is a movement, or a thing, or a vortex, or a point having inertis ; whether there is any limit to its divisibility, and, if so, how that limit is imposed ; whether the long list of elements is final, or whether any of them have any common origin—all these questions remain surrounded by a darkness as profound as ever. The dreams which lured the alchemists to their tedious labours, and which may be said to have called chemistry into being, has assuredly not been realised, but it has not yet been refuted. The boundary of our knowledge in this direction remains where it was many centuries ago.

The next discussion to which I should look in order to find unsolved riddles which have hitherto defied the scrutiny of science, would be the question of what is called the ether. The ether occupies a highly anomalous position in the world of science. It may be described as a half-discovered entity. I dare not use any less pedantic word than entity to designate it, for it would be a great exaggeration of our knowledge if I were to speak of it as a body or even as a substance. When nearly a century ago Young and Fresnel discovered that the motions of an incandescent particle were conveyed to our eyes by undulation, it followed that between our eyes and the particle there must be something to undulate. In order to furnish that something, the notion of the ether was conceived, and for more than two generations the main, if not the only, function of the word ether has been to furnish a nominative case to the verb "to undulate." Lately, our conception of this entity has received a notable extension. One of the most brilliant of the services which Prof. Maxwell has rendered to science has been the discovery that the figure which expressed the velocity of light, also expressed the multiplier required to change the measure of static or passive electricity into that of dynamic or active electricity. The interpretation reasonably affixed to this discovery is that, as light and the electric impulse move approximately at the same rate through space, it is probable that the undulations which convey them are undulations of the same medium. And as induced electricity penetrates through everything, or nearly everything, it follows that the ether through which its undulations are propagated must pervade all space, whether empty or full, whether occupied by opaque matter or transparent matter, or by no matter at all. The attractive experiments by which the late Prof. Hertz illustrated the electric vibrations of the ether will only be alluded to by me, in order that I may express the regret deeply and generally felt that death should have terminated prematurely the scientific career which had begun with such brilliant promise and such fruitful achievements. But the mystery of the ether, though it has been made more fascinating by these discoveries, remains even more inscrutable than before. Of this all-pervading entity we know absolutely nothing except this one fact, that it can be made to undulate. Whether, outside the influence of matter on the motion of its waves, ether has any effect on matter or matter upon it, is absolutely unknown. And even its solitary function of undulating ether performs in an abnormal fashion which has caused infinite perplexity. All fluids that we know transmit any blow they have received by waves which undulate backwards and forwards in the path of their own advance. The ether undulates athwart the path of the wave's advance. The genius of Lord Kelvin has recently discovered what he terms a labile state of equilibrium, in which a fluid that is infinite in its extent may exist, and may undulate in this eccentric fashion without outraging the laws of mathematics. I am no mathematician, and I cannot judge whether this reconciliation of the action of the ether with mechanical law is to be looked upon as a permanent solution of the question, or is only what diplomatists call a *modus vivendi*. In any case it leaves our knowledge of the ether in a very rudimentary condition. It has no known qualities except one, and that quality is in the highest degree anomalous and inscrutable. The extended conception which enables us to recognise ethereal waves in the vibrations of electricity has added infinite attraction to the study of those waves, but it carries its own difficulties with it. It is not easy to fit in the theory of electrical ether waves with the phenomena of positive and negative electricity, and as to the true significance and cause of those counteracting and complementary forces, to which we give the provisional names of negative and positive, we know about as much now as Franklin knew a century and a half ago.

I have selected the elementary atoms and the ether as two instances of the obscurity that still hangs over problems which the highest scientific intellects have been investigating for several generations. A more striking but more obvious instance still is life—animal and vegetable life—the action of an unknown force on ordinary matter. What is the mysterious impulse which is able to strike across the ordinary laws of matter and twist them for a moment from their path ? Some people demur to the use of the term "vital force" to designate this impulse. In their view the existence of such a force is negatived by the fact that chemists have been able by cunning substitutions to produce artificially the peculiar compounds which in nature are only found in organisms that are or have been living. These compounds are produced by some living organism in the performance of the ordered series of functions proper to its brief career. To counterfeit them—as has been done in numerous cases—does not enable us to do what the vital force alone can effect—to bring the organism itself into existence, and to cause it to run its appointed course of change. This is the unknown force which continues to defy not only our imitation but our scrutiny. Biology has been exceptionally active and successful during the last half-century. Its triumphs have been brilliant, and they have been rich enough, not only in immediate result, but in the promise of future advance. Yet they give at present no hope of penetrating the great central mystery. The progress which has been made in the study of microscopic life has been very striking, whether or not the results which are at present inferred from it can be taken as conclusive. Infinitesimal bodies found upon the roots of plants have the proud office of capturing and taming for us the free nitrogen of the air, which, if we are to live at all, we must consume and assimilate, and yet which, without the help of our microscopic ally, we could not draw for any useful purpose from the ocean of nitrogen in which we live. Microscopic bodies are convicted of causing many of the worst diseases to which flesh is heir, and the guilt of many more will probably be brought home to them in due time ; and they exercise a scarcely less sinister or less potent influence on our race by the plagues with which they destroy some of the most valuable fruits of husbandry, such as the potato, the mulberry, and the vine. Almost all their power

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resides in the capacity of propagating their kind with infinite rapidity, and up to this time science has been more skilful in describing their ravages than in devising means to hinder them. It would be ungrateful not to mention two brilliant exceptions to this criticism. The antiseptic surgery which we owe chiefly to Lister, and the inoculation against anthrax, hydrophobia, and perhaps some other diseases, which we owe to Pasteur, must be recorded as splendid victories over the countless legions of our infinitesimal foes. Results like these are the great glory of the scientific workers of the past century. Men may perhaps have overrated the progress of nineteenth-century research in opening the secrets of nature, but it is difficult to overrate the brilliant service it has rendered in ministering to the comforts and diminishing the sufferings of mankind.

If we are not able to see far into the causes and origin of life in our own day, it is not probable that we shall deal more successfully with the problem as it arose many million years ago. Yet certainly the most conspicuous event in the scientific annals of the last half-century has been the publication of Mr. Darwin's work on the "Origin of Species," which appeared in 1859. In some respects, in the depth of the impression which it made on scientific thought, and even on the general opinion of the world, its momentous effect can hardly be overstated. But at this distance of time it is possible to see that some of its success has been due to adventitious circumstances. It has had the chance of enlisting among its champions some of the most powerful intellects of our time, and perhaps the still happier fortune of appearing at a moment when it furnished an armoury of weapons to men, who were not scientific, for use in the bitter but transitory polemics of the day. But far the largest part of its accidental advantages was to be found in the remarkable character and qualifications of its author. The equity of judgment, the simple-minded love of truth and the patient devotion to the pursuit of it through years of toil and of other conditions the most unpropitious—these things endeared to numbers of men everything that came from Charles Darwin apart from its scientific merit or literary charm; and whatever final value may be assigned to his doctrine, nothing can ever detract from the lustre shed upon it by the wealth of his knowledge and the infinite ingenuity of his resource. The intrinsic power of his theory is shown at least in this one respect, that in the department of knowledge with which it is concerned it has effected an entire revolution in the methods of research. Before his time the study of living nature had a tendency to be merely statistical; since his time it has become predominantly historical. The consideration how any organic body came to be what it is occupies a far larger area in any enquiry now than the mere description of its actual condition; but this question was not predominant—it may almost be said to have been ignored—in the botanical and zoological study of 60 years ago.

Another lasting and unquestioned effect has resulted from Darwin's work. He has, as a matter of fact, disposed of the doctrine of the immutability of species. It has been mainly associated in recent days with the honoured name of Agassiz, but with him has disappeared the last defender of it who could claim the attention of the world. Few now are found to doubt that animals separated by differences far exceeding those that distinguish what we know as species have yet descended from common ancestors. But there is much less agreement as to the extent to which this common descent can be assumed, or the process by which it has come about. Darwin himself believed that all animals were descended from "at most four or five progenitors," adding that "there was grandeur in the view that life had been originally breathed by the Creator into a few forms or one." Some of his more devoted followers, like Prof. Haeckel, were prepared to go a step farther and to contemplate a crystal as the probable ancestor of the whole fauna and flora of this planet.

To this extent the Darwinian theory has not affected the conquest of scientific opinion, and still less is there any unanimity in the acceptance of natural selection as the sole or even the main agent of whatever modifications may have led up to the existing forms of life. The deepest obscurity still hangs over the origin of the infinite variety of life. Two of the strongest objections to the Darwinian explanation appear still to retain all their force.

I think Lord Kelvin was the first to point out that the amount of time required by the advocates of the theory for working out the process they had imagined could not be conceded without assuming the existence of a totally different set of natural laws from those with which we are acquainted. His view was not only based on profound mechanical reasoning, but it was so plain that any layman could comprehend it. Setting aside arguments deduced from the resistance of the tides, which may be taken to transcend the lay understanding, his argument from the refrigeration of the earth requires little science to apprehend it. Everybody knows that hot things cool, and that according to their substance they take more or less time in cooling. It is evident from the increase of heat as we descend into the earth that the earth is cooling, and we know by experiment, within certain wide limits, the rate at which its substances, the matters of which it is constituted, are found to cool. It follows that we can approximately calculate how hot it was so many million years ago. But if at any time it was hotter at the surface by 50deg. F. than it is now, life would then have been impossible upon the planet, and therefore we can without much difficulty fix a date before which organic life on earth cannot have existed. Basing himself on these considerations, Lord Kelvin limited the period of organic life upon the earth to a hundred million years, and Prof. Tait in a still more penurious spirit cut that hundred down to ten. But on the other side of the account stand the claims of the geologists and biologists. They have revelled in the prodigality of the cyphers which they put at the end of the earth's hypothetical life. Long cribbed and cabined within the narrow bounds of the popular chronology, they have exulted wantonly in their new freeeom. They have lavished their millions of years with the open hand of a prodigal heir indemnifying himself by present extravagance for the enforced self-denial of his youth. But it cannot be gainsaid that their theories require at least all this elbowroom. If we think of that vast distance over which Darwin conducts us from the jelly-fish lying on the primeval beach to man as we know him now; if we reflect that the prodigious change requisite to transform one into the other is made up of a chain of generations, each advancing by a minute variation from the form of its predecessor, and if we further reflect that these successive changes are so minute that in the course of our historical period—say, 3,000 years—this progressive variation has not advanced by a single step perceptible to our eyes, in respect to man or the animals and plants with which man is familar, we shall admit that for a chain of change so vast, of which the smallest link is longer than our recorded history, the biologists are making no extravagant claim when they demand at least many hundred million years for the accomplishment of the stupendous process. Of course, if the mathematicians are right, the biologists cannot have what they demand. If, for the purposes of their theory, organic life must have existed on the globe more than a hundred million years ago, it must, under the temperature then prevailing, have existed in a state of vapour. The jelly-fish would have been dissipated in steam long before he had had a chance of displaying the advantageous variation which was to make him the ancestor of the human race. I see in the eloquent discourse of one of my most recent and most distinguished predecessors in this chair, Sir Archibald Geikie, that the controversy is still alive. The mathematicians sturdily adhere to their figures, and the biologists are quite sure the mathematicians must have made a mistake. I will not get myself into the line of fire by intervening in such a controversy. But until it is adjusted the laity may be excused for returning a verdict of "not proven" upon the wider issues the Darwinian school has raised.

The other objection is best stated in the words of an illustrious disciple of Darwin who has recently honoured this city by his presence—I refer to Prof. Weismann. But in referring to him, I cannot but give, in passing, a feeble expression to the universal sorrow with which in this place the news was received that Weismann's distinguished antagonist, Prof. Romanes, had been taken from us in the outset and full promise of a splendid scientific career.

The gravest objection to the doctrine of natural selection was expressed by Weismann in a paper published a few months ago, not as agreeing to the objection, but as resisting it; and therefore his language may be taken as an impartial statement of the difficulty. "We accept natural selection," he says, "not because we are able to demonstrate the process in detail, not even because we can with more or less ease imagine it, but simply because we must—because it is the only possible explanation that we can conceive. We must assume natural selection to be the principle of the explanation of the metamorphoses, because all other apparent principles of explanation fail us, and it is inconceivable that there could yet be another capable of explaining the adaptation of organisms without assuming the help of a principle of design."

There is the difficulty. We cannot demonstrate the process of natural selection in detail; we cannot even, with more or less ease, imagine it. It is purely hypothetical. No man, so far as we know, has ever seen it at work. An accidental variation may have been perpetuated by inheritance, and in the struggle for existence the bearer of it may have replaced, by virtue of the survival of the fittest, his less improved competitors; but as far as we know no man or succession of men have ever observed the whole process in any single case, and certainly no man has recorded the observation. Variation by artificial selection, of course, we know very well; but the intervention of the cattle breeder and the pigeon fancier is the essence of artificial selection. It is effected by their action in crossing, by their skill in bringing the right mates together to produce the progeniture they want. But in natural selection who is to supply the breeder's place? Unless the crossing is properly arranged, the new breed will never come into being. What is to secure that the two individuals of opposite sexes in the primeval forest, who have been both accidently blessed with the same advantageous variation, shall meet, and transmit by inheritance that variation to their successors? Unless this

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step is made good, the modification will never get a start, and yet there is nothing to ensure that step except pure chance. The law of chances takes the place of the cattle breeder and the pigeon fancier. The biologists do well to ask for an immeasurable expanse of time, if the occasional meetings of advantageously varied couples from age to age are to provide the pedigree of modifications which unite us to our ancestor, the jelly-fish. Of course the struggle for existence, and the survival of the fittest, would in the long run secure the predominance of the stronger breed over the weaker. But it would be of no use in setting the improved breed going. There would not be time. No possible variation which is known to our experience, in the short time that elapses in a single life between the moment of maturity and the age of reproduction, could enable the varied individual to clear the field of all competitors either by slaughtering or starving them out. But unless the struggle for existence took this summary and internicine character, there would be nothing but mere chance to secure that the advantageously varied bridegroom at one end of the wood should meet the bride, who by a happy contingency had been advantageously varied in the same direction at the same time at the other end of the wood. It would be a mere chance if they ever knew of each other's existence—a still more unlikely chance that they should resist on both sides all temptations to a less advantageous alliance. But unless they did so, the new breed would never even begin, let alone the question of its perpetuation after it had begun. I think Prof. Weismann is justified in saying that we cannot, either with more or less ease, imagine the process of natural selection.

It seems strange that a philosopher of Prof. Weismann's penetration should accept as established a hypothetical process the truth of which he admits that he cannot demonstrate in detail, and the operation of which he cannot even imagine. The reason that he gives seems to me instructive of the great danger scientific research is running at the present time—the acceptance of mere conjecture in the name and place of knowledge, in preference to making frankly the admission that no certain knowledge can be attained. "We accept natural selection," he says, "because we must—because it is the only possible explanation that we can conceive." As a politician I know that argument very well. In political controversy it is sometimes said of a disputed proposal that it "holds the field," that it must be accepted because no possible alternative has been suggested. In politics there is occasionally a certain validity in the argument, for it sometimes happens that some definite course must be taken, even though no course is free from objection. But such a line of reasoning is utterly out of place in science. We are under no obligation to find a theory, if the facts will not provide a sound one. To the riddles which nature propounds to us the profession of ignorance must constantly be our only reasonable answer. The cloud of impenetrable mystery hangs over the development and still more over the origin of life. If we strain our eyes to pierce it, with the foregone conclusion that the solution is and must be attainable, we shall only mistake for discoveries the figments of our own imagination. Prof. Weismann adds another reason for his belief in natural selection which is certainly characteristic of the time in which we live. "It is inconceivable," he says, "that there should be another principle capable of explaining the adaptation of organisms without assuming the help of a principle of design." The whirligig of time assuredly brings its revenges. Time was, not very long ago, when the belief in creative design was supreme. Even those who were sapping its authority were want to pay it a formal homage, fearing to shock the public conscience by denying it. Now the revolution is so complete that a great philosopher uses it as a *reductio ad absurdum*, and prefers to believe that which can neither be demonstrated in detail nor imagined, rather than run the slightest risk of such a heresy.

I quite accept the professor's dictum that if natural selection is rejected we have no resource but to fall back on the mediate or immediate agency of a principle of design. In Oxford, at least, he will not find that argument is conclusive, nor, I believe, among scientific men in this country generally, however imposing the names of some whom he may claim for that belief. I would rather lean to the conviction that the multiplying difficulties of the mechanical theory are weakening the influence it once had acquired. I prefer to shelter myself in this matter behind the judgment of the greatest living master of natural science among us, Lord Kelvin, and to quote as my own concluding words the striking language with which he closed his address from this chair more than 20 years ago: "I have always felt," he said, "that the hypothesis of natural selection does not contain the true theory of evolution, if evolution there has been in biology. . . . I feel profoundly convinced that the argument of design has been greatly too much lost sight of in recent zoological speculations. Overpoweringly strong proofs of intelligent and benevolent design lie around us, and if ever perplexities, whether metaphysical or scientific, turn us away from them for a time, they come back upon us with irresistible force, showing to us through nature the influence of a free will, and teaching us that all living things depend on one everlasting Creator and Ruler."

Address to the Mathematical and Physical Section.

BY PROF. A. W. RÜCKER, M.A., F.R.S, PRESIDENT OF THE SECTION.

It is impossible for a body of English scientific men to meet in one of our ancient university towns without contrasting the old ideal of the pursuit of learning for its own sake with the modern conception of the organisation of science as part of a pushing business concern. We are, as a nation, convinced that education is essential to national success. Our modern universities are within earshot of the whirr of the cotton-mill or the roar of Piccadilly. Oxford and Cambridge themselves are not content to be centres of attraction to which scholars gravitate. They have devised schemes by which their influence is directly exerted on every market town and almost on every village in the country. University extension is but a part of the extraordinary multiplication of the machinery of education which is going on all around us. The British Association, which was once regarded as bringing light into dark places, is now welcomed in every large provincial town by a group of well-known men of science; and we find ready for the meetings of our sections not only the chapels and concert-rooms which have so often and so kindly been placed at our disposal, but all the appliances of well-designed lecture-rooms and laboratories.

I do not propose, however, to detain you this morning with a discourse on the spread of scientific education, but you will forgive me if I illustrate its progress by two facts, not perhaps the most striking which could be selected, but especially appropriate to our place of meeting. It is little more than 30 years since the two branches of science with which our section deals—mathematics and physics—have been generally recognised as wide enough to require more than one teacher to cope with them in an educational institution of high pretensions and achievement. In 1860 the authorities of the Owens College, Manchester, debated whether it was desirable to create a professorship of natural philosophy in addition to, and independent of, the chair of mathematics. It was thought necessary to obtain external support for the opinions of those who advocated this step. An appeal was made to Profs. De Morgan and Stokes. The former reported that a "course of experimental physics is in itself desirable"; the latter, that "there would be work enough in a large institution for a mathematician and a physicist." In the end the chair of natural philosophy was established, and the fact that our host of to-day, Prof. Clifton, was its first occupant reminds us how little we have advanced in time and how far in educational development from the days when propositions such as those I have cited were only accepted on the authority of the names of Stokes and De Morgan. The other fact to which I would refer is that the Clarendon Laboratory, in which the meetings of Section A are to be held, though erected barely a quarter of a century ago, was the first laboratory in this country which was specially built and designed for the study of experimental physics. It has served as a type. Clerk Maxwell visited it while planning the Cavendish Laboratory, and traces of Prof. Clifton's designs can be detected in several of our university colleges.

But though our surroundings remind us of the improvement which has been effected in the equipment of our science, it would not be difficult to indicate weak points which should forthwith be strengthened. On these, in so far as they affect education, I will not dwell—and that for two reasons. In the first place, we meet not to-day as teachers, but as students; and secondly, I think that whereas as a nation we have awoke—though late in the day—to the importance of education, we are not yet fully awake to the importance of learning. Our attitude in such matters was exactly expressed by one of the most eminent of the witnesses who gave evidence before the Gresham Commission. In his opinion the advancement of knowledge must in a university in London be secondary to the higher instruction of the youth of London. If this be so—and I will not now dispute it—we shall surely all agree that somewhere or other, in London or out of it, included in our universities or separate from them, there ought to be institutions in which the advancement of knowledge is regarded as of primary and fundamental interest, and not as a mere secondary by-product thrown off in the course of more important operations.

It is not essential that in such an institution research should be the only task. Investigation may be combined with the routine work of an observatory, with teaching, with the care of standards, or with other similar duties. It is, however, essential that if the advancement of knowledge is seriously regarded as an end worth attaining, it should not be relegated to a secondary place. Time and opportunity must be found for investigation, as time and opportunity are found for other tasks. It is not enough to refer to research in a prospectus and then to leave it to be accomplished at odd times and in spare moments not claimed by more urgent demands. Those to whom the future of the higher learning in England is dear must plan and scheme

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to promote the life-long studies of men, as in the last quarter of a century they have struggled, with marked success, to promote the preparatory studies of boys and girls. That the assignment of a secondary position to research is the more popular view, and that the necessity for encouraging it has as yet hardly been grasped by many of those who control our modern educational movements is, I fear, too true. It is therefore a matter for congratulation that within the last year Oxford has established a research degree, and has thus taken an important step towards gathering within her fold workers of mature years who are able and willing not merely to gain knowledge, but to add to it. We may also note with pleasure and gratitude that the stream of private munificence has recently been in part directed to the advancement of learning. Sir Henry Thompson has generously offered a sum of £5,000 to provide a large photographic telescope for the National Observatory at Greenwich. The new instrument is to be of 26in. aperture and 22ft. 6in. focal length, or exactly double the linear dimensions of that which has been previously employed. Mr. Ludwig Mond, too, has added to his noble gifts to science by the new research laboratories which he is about to establish in connection with the Royal Institution. Albemarle-street is thronged with memories of great discoveries. The researches of Lord Rayleigh and the remarkable results of Prof. Dewar's studies of matter at low temperatures are maintaining the great reputation which the Royal Institution has gained in the past, and all English physicists will rejoice that prospects of new and extended usefulness are opening before it.

Another hopeful, though very embarrassing, fact is that the growth in the number of scientific workers makes it increasingly difficult to find the funds which are necessary for the publication of their work. Up to the present the author of a paper has had to submit it to criticism, but, when it has been approved by competent judges, it has been published without ado and without expense to himself. This is as it should be. It is right that due care should be exercised to prune away all unnecessary matter, to reduce as far as may be the necessary cost. It will, however, be a great misfortune if judgment as to what curtailment is necessary is in future passed, not with the object of removing what is really superfluous, but in obedience to the iron rule of poverty. Apart from all other disadvantages, such a course would add to the barriers which are dividing the students of different sciences. A few lines and a rough diagram may suffice to show to experts what has been attempted and what achieved, but there is no paper so difficult to master as that which assumes that the reader starts from the point of vantage which months or years of study have enabled the author to attain. Undue pruning will not make the tree of knowledge more fruitful, and will certainly make it harder to climb. Connected also with the vast increase of scientific literature is a growing necessity for the publication of volumes of abstracts, in which the main results of recent investigations are presented in a concentrated form. English chemists have long been supplied with these by the Chemical Society. The Physical Society, though far less wealthy than its elder sister, has determined to undertake a similar task. We are compelled to begin cautiously, but in January next the first number of a monthly pamphlet will be issued containing abstracts of all the papers which appear in the principal foreign journals of physics. In this venture the society will incur grave responsibilities, and I avail myself of this opportunity to appeal to all British physicists to support us in a work the scope of which will be rapidly extended if our first efforts succeed.

From this brief glance at what has been or is about to be done to promote the study of physics, I must now turn to the discussion of narrower but more definite problems, and I presume that I shall be most likely to deserve your attention if I select a subject in which I am myself especially interested. During the last 10 years my friend Dr. Thorpe and I have been engaged upon a minute magnetic survey of the United Kingdom. The main conclusions at which we have arrived are about to be published, and I do not propose to recount them now. It is, however, impossible to give so long a time to a single research without having one's attention drawn to a number of points which require further investigation, and I shall perhaps be making the best use of this opportunity if I bring to your notice some matters in the practical and theoretical study of terrestrial magnetism which deserve a fuller consideration than has yet been given to them. In the first place, then, there is little doubt that the instruments at present used for measuring declination and horizontal force are affected with errors far greater than the error of observation. We employed four magnetometers by Elliott Bros., which were frequently compared with the standard instrument at Kew. These measurements proved that the instrumental differences which affect the accuracy of the declination and horizontal force measurements are from five to ten times as great as the error of a single field observation. The dip circle which two generations ago was so untrustworthy is, in our experience, the most satisfactory of the absolute instruments. In most cases these comparisons extended over several days, but the Astronomer Royal has described in his recent report observations made at Greenwich for two years and a half with two horizontal force instruments. These differ between themselves, and the discrepancy is of the same order of magnitude as those we have detected. If such differences exist between instruments of the Kew pattern, it is probable that they will be still greater when the magnetometers under investigation are of different types. This point has been investigated by Dr. Van Rijckevorsel, who five years ago visited Kew, Parc St. Maur, Wilhelmshaven, and Utrecht, and, using his own instruments at each place, compared the values of the magnetic elements determined by himself with those deduced from the self-registering apparatus of the observatory. The discrepancies between the so-called standards which were thus brought to light were quite startling, and prove the necessity for an investigation as to their causes.

Magneticians had long been aware that the instruments used by travellers should be compared at the beginning and end of a journey with those at some fixed observatory, to make sure that the comparatively rough usage to which they are subjected has not affected their indications. But Dr. Van Rijckevorsel's expedition first drew general attention to the fact that there are serious differences between the standard observatory instruments themselves. The importance of a careful comparison between them was at once recognised. The Magnetic Sub-Committee of the International Meteorological Conference, held at Munich in the autumn of 1891, resolved that it is "necessary that the instruments employed for absolute measurements at the different observatories should be compared with each other and the results published." As far as I am aware nothing has been done to give effect to this resolution, but the necessity for such an international comparison is urgent. The last few years have been a period of unexampled activity in the conduct of local magnetic surveys. To cite instances from the north-west of Europe only, observations have recently been made on a more or less extended scale in the United Kingdom, France, Holland, North Germany, and Denmark. It will be absurd if these surveys cannot be collated and welded into a homogeneous whole, because we are in doubt whether the indications of our standard instruments for the measurement of declination and dip differ by five or six minutes of arc. If, however, an official international comparison of the magnetic standards in use in different countries is instituted, it is probable that only one observatory in each country will take part in it. It may fairly be left to each nation to determine for itself the relations between the results of measurements made in its own institutions. Apart, therefore, from all other reasons, we in England would only be able to make the best use of an international comparison if we had beforehand set our own house in order, and were able at once to extend the results of experiments made at Kew or Greenwich to Stonyhurst, Valentia, and Falmouth. This we are not at the present moment in a position to do. As far as I know, nobody has ever carried a magnetometer backwards and forwards between Kew and Greenwich to test the concordance of the published results. During the recent survey single or double sets of observations have been made at Stonyhurst, Falmouth, and Valentia with instruments which have been compared with Kew, but these measurements, though amply sufficient for the purposes of our research, were not numerous enough to serve as a firm basis for determining the discrepancies between the various standards, so that the exact relations between these important sets of apparatus are still unknown.

The first point, therefore, to which I wish to draw the attention of the section is the necessity for a full primary comparison between the standard magnetic instruments in use at our different observatories. But if this were satisfactorily accomplished, the question would arise as to whether it should be repeated at regular intervals. We have at present only a presumption in favour of the view that the standards which we know are discordant are nevertheless constant. A single instance may suffice to show how necessary it may be—at all events in the case of outlying and isolated observatories—to put this belief to the test. In the most recent account of the work of the observatory of the Bombay Government at Colába, the dips are discussed for the period of 20 years between 1872 and 1892. During this interval the adjustment of the agate plates upon which the dip needle rolls has thrice been modified. In 1877 the plates were renewed. In 1881 and 1887 the dip circle was taken to pieces and rebuilt. In the intervals the dip as determined by several needles, but always with this circle, remained approximately constant, but after each overhauling it suddenly altered, increasing by 12′ on the first occasion, by 23′ on the second, and by 20′ on the third. Mr. Chambers states that he "can give no satisfactory account of this behaviour of the instrument," but suggests that "the needle gradually hollows out a depression in the agate plates on which it rolls, and that this characteristic of the dip circle" has not before been discovered owing to the reluctance of magnetic observers to interfere with the adjustments of instruments which are apparently working well. I do not think that this explanation will suffice. Dr. Thorpe and I employed a new dip circle in the earliest part of our survey work, which has remained in accord with Kew for 10 years.

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During that time the dip has been measured some 700 times with it. This corresponds, I believe, to more than the amount of work done with the circle at Colába in six years, which in turn is longer than some of the intervals in which the Colába instruments gave results erroneous to the extent of 20′. I feel, therefore, quite sure that the difficulties which have been experienced at Bombay are not due to any "characteristic [defect] of the dip circle." But, whatever the cause may have been, surely the lesson is that, if such things can happen in so well known an institution, it is desirable that we should take the moderate pains required to assure ourselves whether smaller—but, possibly, not unimportant—errors are gradually affecting the results at any of our observatories.

This brings me to my next point—namely, that if we are to draw conclusions from the minor differences between measurements of secular or diurnal change made in the observatories, it is not only necessary that we should know whether the instruments are strictly comparable and constant, but the observations must be reduced by precisely the same methods. In 1886 the late Mr. Whipple drew the attention of the British Association to the fact that there was a systematic difference between the diurnal ranges of declination at Greenwich and Kew. His results were based on the three years 1870-72. In 1890 two of my students, Messrs. Robson and S. W. J. Smith, extended the comparison to three more recent years (1883-6-7), and obtained results in complete accord with those of Mr. Whipple. It is well known that the average daily oscillation of the magnet is affected by the magnetic weather. Sabine showed that magnetic storms do not merely buffet the needle now in this direction and now in that—they affect its average behaviour, so that the mean swing east and west is different according as we deduce it only from days of magnetic calm or include those of storm. Mr. Whipple reduced the Kew observations by two methods,* one of which depended on the calmest days only, while the other included those which were moderately disturbed. Neither agreed exactly with the method in use at Greenwich, but the difference between the results deduced from them was so small when compared with the difference between either and that obtained at Greenwich, that it seemed possible that the diurnal variations, even at these closely neighbouring places, might differ appreciably. The question whether this is so has now been answered. In 1890, at the request of the Kew Committee, the Astronomer Royal undertook to select early in each year five quiet days in each of the preceding 12 months. It was also agreed that, whether they adopted other methods or not the chief English magnetic observatories should determine the diurnal variations from these days alone. The Greenwich† and Kew observations for 1890 have therefore been worked up in exactly the same way, with the result that the discrepancy, which had persisted for 20 years, has entirely disappeared, and that the two diurnal ranges at the two observatories are in as close accord as could be expected. If, therefore, we may judge from a single year, the cause of the difference lay in the choice of days. Greenwich will in future give us two diurnal variations, one obtained from the most quiet days only, the other from all days except those of violent storm, and in these we shall have most valuable data for studying the mean effect of disturbances on the diurnal variation. To this satisfactory conclusion I have only one suggestion to add. The Astronomer Royal and M. Mascart now publish for the same stormy days the photographic traces by which the history of a magnetic storm is mapped. Is it possible for Greenwich and Paris also to agree in their choice of calm days for the calculation of the diurnal variation, so that a precise similarity of method may obtain not only between the English observatories, but between England and France?

The importance of co-operation between institutions engaged on the same tasks having been illustrated, I am glad to be able to announce that another step is about to be taken in the same direction. For some years, in spite, I believe, of great financial difficulties, the Cornwall Royal Polytechnic Society has maintained a magnetic observatory at Falmouth. The results of the observations have hitherto been printed in the *Journal* of the society only, out the Royal Society has now consented to publish them in the *Proceedings*. Before long, therefore, the Kew and Falmouth records, which are already worked up in the same way, will be given to the world side by side. Is it too much to hope that this may be the first step towards the production of a British magnetic year-book, in which observations whose chief interest lies in their comparison may be so published as to be easily compared? We owe to private enterprise another advance of the same kind. The managers of the new journal, *Science Progress*, have made arrangements with the Kew Committee for the yearly publication of a table showing the mean annual values of the magnetic elements as determined at the various magnetic observatories of the world. It will, therefore, in future be possible to get a general idea of the rate of secular change in different localities without searching through a number of reports in different languages, which can only be consulted in the rooms of the few societies or institutions to which they are annually sent. The present state of our knowledge of the secular change in the magnetic elements affords indeed very strong support to the arguments I have already adduced in favour of a comparison between the instruments of our magnetic observatories.

The whole question of the cause of this phenomenon has entered on a new stage. It has long been recognised that the earth is not a simple magnet, but that there are in each hemisphere one pole or point at which the dip needle is vertical, and two foci of maximum intensity. A comparison of earlier with later magnetic observations led to the conclusion that one or both of the foci in each hemisphere is in motion, and that to this motion—however caused—the secular change in the values of the magnetic elements is due. Thus, the late Prof. Balfour Stewart, writing in 1883, says: "While there is no well-established evidence to show that either the pole of verticity or the centre of force to the North of America has perceptibly changed its place, there is, on the other hand, very strong evidence to show that we have a change of place on the part of the Siberian focus."* The facts in favour of this conclusion are there discussed. The arguments are based, not on the results of any actual observations near to the focus in question, but on the behaviour of the magnet at points far distant from it in Europe and Asia. The westerly march of the declination needle, which lasted in England up to 1818, and the easterly movement which has since replaced it, are connected with a supposed easterly motion of the Siberian focus, which, it is added, "there is some reason to believe . . . has recently been reversed." In opposition, therefore, to the idea of the rotation of a magnetic focus round the geographical poles which the earlier magneticians adopted, Stewart seems to have regarded the motion of the Siberian focus as oscillatory. A very different aspect is put upon the matter by a comparison of the magnetic maps of the world prepared by Sabine and Creak for the epochs 1840 and 1880 respectively. Captain Creak, having undertaken to report on the magnetic observations made during the voyage of the "Challenger," supplemented them with the unrivalled wealth of recorded facts at the disposal of the Hydrographic Department of the Admiralty. He was thus able, by a comparison with Sabine's map, to trace the general course of the secular changes all over the world for 40 years. The negative results may be shortly stated. There is no evidence of any motion either of magnetic pole or focus. The positive conclusions are still more curious. There are certain lines on the surface of the earth towards which in the interval under consideration the north pole of the needle was attracted. From each side the compass veered or backed towards them. Above them the north pole of dip needle moved steadily down. There are other lines from which, as tested by compass and dip circle, a north pole was in like manner repelled. The two principal points of increasing attraction are in China and near Cape Horn; the chief points of growing repulsion are in the North of Canada and the Gulf of Guinea. I am sure that my friend Captain Creak would be the first to urge that we should not generalise too hastily from this mode of presenting the facts, but there can be no doubt that they cannot be explained by any simple theory of a rotating or oscillating pair of poles. *Primâ facie* they suggest that the secular change is due not so much to changes at the principal magnetic points, as to the waxing and waning of the forces apparently exerted by secondary lines or points of attraction or repulsion. All down the west coast of America, close, be it noted, to one of the great lines of volcanic activity, north hemisphere magnetism has since 1840 been growing in relative importance. Near Cape Horn a weak embryonic pole is developing of the same kind as the well-known pole at the other end of the continent near Hudson's Bay. Along a line which joins Newfoundland to the Cape of Good Hope, precisely the reverse effects have been experienced; while in the Gulf of Guinea a south hemisphere pole is growing within the tropics. Of course, I do not suggest that these secondary systems can ever determine the principal phenomena of terrestrial magnetism, or reverse the magnetic states of the hemispheres in which they occur. These are no doubt fixed by the rotation of the earth. I do, however, wish to emphasise the fact that they show that either secular change is due to the conjoint action of local causes, or that if some single agent such as a current system within the earth, or a change of magnetic conditions outside it, be the primary cause, the effects of this cause are modified and complicated by local peculiarities. Mr. Henry Wilde has succeeded in representing with approximate accuracy the secular change at many points on the surface of the earth by placing two systems of currents within a globe, and imparting to the axis of one of them a motion of rotation about the polar axis of the earth. But he has had to supplement this comparatively simple arrangement by local features. He has coated the seas with thin sheet iron. The ratio between the two currents which serves to depict the secular change near the meridian of Greenwich fails in the West Indies. Thus this ingenious attempt to imitate the secular change by a

* Sabine's and Wild's.

† The Greenwich observations for subsequent years have not yet been published

* *Encyclopædia Brit.*, ninth edition. Art. "Meteorology—Terrestrial Magnetism."

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simple rotation of the magnetic pole supports the view that local peculiarities play a powerful part in modifying the action of a simple first cause, if such exist. I need hardly say that I think the proper attitude of mind on this difficult subject is that of suspended judgment, but there is no doubt that recent investigation has, at all events, definitely raised the question how far secular change is either due to or modified by special magnetic features of different parts of the earth.

It is possible that light may be thrown upon this point by observations on a smaller scale. Assuming for the moment that the difference in the secular changes on opposite sides of the Atlantic is due to a difference of local causes, it is conceivable that similar causes, though less powerful and acting through smaller ranges, might produce similar though less obvious differences between places only a few miles apart. For testing this Greenwich and Kew are in many respects most favourably situated. Nowhere else are two first-class observatories so near together. Differences in the methods of publishing the results have made it somewhat difficult to compare them, but the late Mr. Whipple furnished me with figures for several years which made comparison easy. Without entering into details it may be sufficient to say that the declination needles at the two places do not from year to year run parallel courses. Between 1880-82 Kew outstripped its rival, between 1885 and 1889 it lost, so that the gain was rather more than compensated. The difference of the declination of the two places appears to increase and diminish through a range of five minutes of arc. This evidence can be supplemented by other equally significant examples. No fact connected with terrestrial magnetism is more certain than that at present the rate of secular change of declination in this part of Europe increases as we go north. This is shown by a comparison of our survey with those of our predecessors 50 and 30 years ago, by M. Moureaux's results in France, and by Captain Creak's collation of previous observations. Yet, in spite of this, Stonyhurst. which is some 200 miles north of Greenwich and Kew, and should therefore outrun them, sometimes lags behind and then makes up for lost time by prodigious bounds. Between 1882 and 1886 the total secular change of declination at Stonyhurst was about 3′·5 less than at Greenwich and Kew, whereas in the two years 1890-92 it reached at Stonyhurst the enormous amount of 28′, just doubling the corresponding alteration registered in the same time at Kew. If these fluctuations are caused by the instruments or methods of reduction my argument in favour of frequent comparisons and uniform treatment would be much strengthened, but, apart from the inherent improbability of such large differences being due to the methods of observation, the probability of their physical reality is increased by the work of the magnetic survey.

The large number of observations at our disposal has enabled us to calculate the secular change in a new way, by taking the means of observations made about five years apart at numerous though not identical stations scattered over districts about 150 miles square. The result thus obtained should be free from mere local variations, but as calculated for the south-east of England for the five years 1886-91 it differs by nearly 5′ from the change actually observed at Kew. We have also determined the secular change at 25 stations by double sets of observations made as nearly as possible on the same spot at intervals of several years. The results must be interpreted with caution. In districts such as Scotland, where strong local disturbances are frequent, a change of a few yards in the position of the observer might introduce errors far larger than the fluctuations of secular change. But when all such cares are eliminated, when all allowance is made for the possible inaccuracy of field observations, there are outstanding variations which can hardly be due to anything but a real difference in the rate of change of the magnetic elements. A single example will suffice. St. Leonards and Tunbridge Wells are about 30 miles apart. Both are situated on the Hastings sand formation, and on good non-magnetic observing ground. At them, as at the stations immediately around them—Lewes, Eastbourne, Appledore, Etchingham, Heathfield, and Maidstone—the local disturbing forces are very small. All these places lie within a district about 40 miles square, at no point of which has the magnet been found to deviate by 5′ from the true magnetic meridian. No region could be more favourably situated for the determination of the secular change, yet according to our observations the alteration in the declination at St. Leonards in six years was practically equal to that at Tunbridge Wells in five. It is difficult to assign so great a variation to an accumulation of errors, and this is only one amongst several instances of the same kind which might be quoted. We find, then, when we consider the earth as a whole, grave reason to question the old idea of a secular change caused by a magnetic pole or focus pursuing an orderly orbit around the geographical axis of the earth, or oscillating in some regular period in its neighbourhood. It would, of course, be absurd to admit the possibility of change in the tropics and to deny that possibility in the arctic circle, but the new facts lead us to look upon the earth not as magnetically inert, but as itself—at the equator as well as at the pole—producing or profoundly modifying the influences which give rise to secular change. And then, when we push our enquiry further, accumulating experience tells the same tale. The earth seems, as it were, alive with magnetic forces, be they due to electric currents or to variations in the state of magnetised matter. We need not now consider the sudden jerks which disturb the diurnal sweep of the magnet, which are simultaneous at places far apart, and probably originate in causes outside our globe. But the slower secular change, of which the small part that has been observed has taken centuries to accomplish, is apparently also interfered with by some slower agency, the action of which is confined within narrow limits of space. Between Kew, Greenwich, and Stonyhurst, between St. Leonards and Tunbridge Wells, and I may add between Mablethorpe and Lincoln, Enniskillen and Sligo, Charleville and Bantry, the measured differences of secular variation are so large as to suggest that we are dealing not with an unruffled tide of change, which, unaltered by its passage over continent or ocean, sweeps slowly round the earth, but with a current fed by local springs or impeded by local obstacles, furrowed on the surface by billows and eddies, from which the maguetician, if he will but study them, may learn much as to the position and meaning of the deeps and the shallows below. But if this is the view which the facts I have quoted suggest, much remains to be done before it can be finally accepted; and in the first place—to come back to the point from which I started—we want, for some years at all events, a systematic and repeated comparison of the standard instruments in use at the different observatories. That they are not in accord is certain; whether the relations between them are constant or variable is doubtful. If constant, the suggestions I have outlined are probably correct; if variable, then the whole or part of the apparent fluctuations of secular change may be nothing more than the irregular shiftings of inconstant standards. I cannot myself believe that this is the true explanation, but in any case it is important that the doubt should be set at rest, and that if the apparent fluctuations of secular change are not merely instrumental, the enquiry as to their cause should be undertaken in good earnest.

The question is interesting from another point of view. It is now fully established that even where the surface soil is non-magnetic, and even where geologists have every reason to believe that it lies upon non-magnetic strata of great thickness, there are clearly-defined lines and centres towards which the north-seeking pole of a magnet is attracted, or from which it is repelled. To the magnetic surveyor fluctuations in secular change would appear as variations in the positions of these lines, or as changes in the forces in play in their neighbourhood. Greenwich and Kew are both under the influence of a widespread local disturbance which culminates near Reading. At both places the needle is deviated to the west of the normal magnetic meridian, and if the westerly declination diminishes sometimes faster and sometimes more slowly at one observatory than at the other, this must be, or at all events would in the first instance appear to be due to local changes in the regional disturbing forces. The questions of the nature of the irregularities of secular change and of the causes of local disturbances are therefore intermingled, and information gained on these points may in turn be useful in solving the more difficult problem of world-wide secular variations. Two causes of regional and local disturbances have been suggested—viz., earth currents, and the presence of visible or concealed magnetic rocks. The two theories are not mutually exclusive. Both causes of the observed effects may, and probably do, coexist. I have, however, elsewhere explained my reasons for believing that the presence of magnetic matter, magnetised by induction in the earth's field, is the principal cause of the existence of the magnetic ridge lines and foci of attraction which for so many years we have been carefully tracing. I will only now mention what appears to me to be the final and conclusive argument, which, since it was first enunciated, has been strengthened by the results of our more recent work. We find that every great mass of basic rock, by which the needle is affected at considerable distances, attracts the north-seeking pole. Captain Creak some years ago showed that the same statement is true of those islands in the northern hemisphere which disturb the lines of equal declination, while islands in the southern hemisphere repel the north pole and attract the south. In other words, these disturbances are immediately explained if we suppose that they are due to magnetic matter magnetised by induction. The theory of earth currents would, on the other hand, require that round the masses of visible basalt, and round the island investigated by Captain Creak, currents, or eddies in currents, should circulate in directions which are always the same in the same hemisphere, and always opposed on opposite sides of the equator. For this supposition no satisfactory explanation is forthcoming, and therefore, with all reserves and a full consciousness that in such matters hypothesis differs but little from speculation, it appears to me that the theory that induced magnetism is the main cause of the disturbance has the greater weight of evidence in its favour. If this be granted, it is evident that the positions of the main lines and centres of attraction would be approximately constant, and, so far as it is possible to form an opinion, these conditions

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seem to be satisfied. There has certainly been no noticeable change in the chief loci of attraction in the five years which have elapsed between the epochs of our two surveys. Mr. Welsh's observations made in Scotland in 1857-8 fit in well with our own. Such evidence is not, however, inconsistent with minor changes, and it is certain that as the directions and magnitude of the inducing forces alter, the disturbing induced forces must alter also. But this change would be slow, and as the horizontal force is in these latitudes comparatively weak, the change in the disturbing forces would also be small, unless the vertical force altered greatly. It is at all events impossible to attribute to this cause oscillations which occupy at most eight or ten years. It is possible to suggest other changes in the state of the concealed magnetic matter—alterations of pressure, temperature, and the like—to which the oscillations of secular change might be due, but probably there will be a general consensus of opinion that if the slowly changing terms in the disturbance function are due to magnetic matter, the more rapid fluctuations of a few years' period are more likely to be connected with earth currents. It becomes, therefore, a matter of interest to disentangle the two constituents of local disturbances; and there is one question to which I think an answer might be obtained without a greater expenditure than the importance of the investigation warrants. Are the local variations in secular change waves which move from place to place, or are they stationary fluctuations, each of which is confined to a limited area beyond which it never travels? Thus, if the annual decrease in the declination is at one time more rapid at Greenwich than at Kew, and five years afterwards more rapid at Kew than at Greenwich, has the maximum of rapidity passed in the interval through all intervening places, or has there been a dividing line of no change which has separated two districts which have perhaps been the scenes of independent variations? The answer to this question is, I take it, outside the range of our knowledge now, but if the declination could be determined several times annually at each of a limited number of stations in the neighbourhood of London, to this enquiry, at all events, a definite answer would soon be furnished.

There are two other lines of investigation which I hope will be taken up sooner or later, for one of which it is doubtful whether the United Kingdom is the best site, while the other is of uncertain issue. If, however, it be granted that the principal cause of local and regional magnetic disturbances is the magnetisation by the earth's field of magnetic matter concealed below its surface, the question as to the nature of this material still remains to be solved. Is it virgin iron or pure magnetite, or it is merely a magnetic rock of the same nature and properties as the basalts which are found in Skye and Mull? There is, of course, no *à priori* reason why all these different materials should not be active, some in one place and some in another. As regards the United Kingdom, I have, both in a paper on the "Permeability of Magnetic Rocks," and in the description of the recent survey, made calculations which tend to prove that if we suppose that the temperature of the interior of the earth is, at a depth of 12 miles, such as to deprive matter of its magnetic properties, and if we further make the unfavourable assumption that down to that limit the susceptibility is constant, the forces which are observed on the surface are of the same order of magnitude as those which could be produced by large masses of ordinary basalt or gabbro. It would not, however, be wise to generalise this result, and to assume that in all places regional disturbances are due to basic rocks alone. We know that local effects are produced by iron ore, for the Swedish miners seek for iron with the aid of the magnet, and in some other cases magnetic disturbances of considerable range are so intense as to suggest that material of very high magnetic permeability must be present. If the concealed magnetic matter were iron, and if it were present in large quantity, it is evident that the results of experiments with the magnetometer and dip circle might be supplemented by observations made with the plumb-line or pendulum. In such a case the region of magnetic disturbance would also be a region of abnormal gravitational attraction. An account of a suggested connection between anomalies of these two kinds occurring in the same district has lately been published by Dr. Fritsche.*

Observations made about 30 years ago by a former director of the Astronomical Observatory in Moscow led to the conclusion that throughout two large districts to the north and south of that city the plumb-line is deviated in opposite directions. The deflections from the vertical are very considerable, and indicate a relative defect in the attraction exerted by the rocks in the neighbourhood of Moscow itself, and the suggestion has been made that there is either a huge cavity—a bubble in the earth-crust—under the town, or that the matter beneath it is less dense than that which underlies the surface strata on either side at a distance of 10 or 12 miles. As long ago as 1853, Captain Meyen made magnetic observations in order to determine whether the same district is also the seat of any magnetic irregularity. His stations were hardly sufficiently numerous to lead to decisive results, but the magnetic elements have recently been measured by Dr. Fritsche at 31 places within 50 miles of Moscow. The experiments were all made within 11 days, so that no correction for secular change is required. They indicate a locus of magnetic attraction running through Moscow itself. South of the town the disturbance again changes in direction so as to show either that repulsive forces are in play, or that there is another magnetic ridge line still further to the south. Dr. Fritsche thinks that these observations explain the gravitational anomalies without recourse to the somewhat forced hypothesis of a vast subterranean cave. He assumes that there is a concealed mass of iron, which approaches near to the surface at Moscow, and also along two loci to the south and north of the city. He attributes the magnetic irregularities to the attraction of the central iron hill, the deflections of the plumb-line to the flanking masses. It is perhaps not inconceivable that such results might follow in a special case, but without the support of calculation it certainly appears that the magnetic experiments point to the existence of the principal attracting mass under the town. This is, in fact, the arrangement shown in the figure with which Dr. Fritsche illustrates his hypothesis. If this is so, the theory would *primâ facie* seem to require that the bob of a plumb-line should be attracted towards, and not, as is actually the case, away from, the centre of the magnetic disturbance. On the whole, then, though the coexistence of large magnetic and gravitational disturbances in the same place is suggestive, I do not think that they have as yet been proved to be different effects of the same hidden mass of magnetic matter. In a few weeks an international geodetic conference will meet at Innsbruck, at which the Royal Society will be represented. It is, I believe, intended to extend the detailed investigation of the relations between the nature of the earth's crust and the gravitational and magnetic forces to which it gives rise. We may therefore hope that special attention will before long be given to localities where both may combine to give information as to facts outside the range of the ordinary methods of geology.

The second phenomenon on which more light is desirable is the permanent magnetisation of magnetic rocks. It is known that fragments of these are strongly but irregularly magnetised, but that the effect of very large masses at a distance appears to be due to induced rather than to permanent magnetism. There are three questions to which I should like an answer. Are underground masses of magnetite ever permanently magnetised? Are large areas of surface masses, say a few hundred square yards in extent, ever permanently and approximately uniformly magnetised in the same sense? Is there any relation between the geological age and the direction of the permanent magnetism of magnetic rocks? Enquiries such as these can only be taken up by individual workers, but I venture to think that the comparison of the observatory instruments and the fluctuations of secular change outside the observatories could best be investigated under the auspices of a great scientific society. The co-operation of the authorities of the observatories will no doubt be secured, but it is most important that the comparisons should in all cases be made with one set of instruments, and by the same methods. Whether the British Association, which for so long managed a magnetic observatory, may think that it could usefully inaugurate the work, it would be improper for me in a presidential address to forecast. Who does it is of less importance than that it should be done, and I cannot but hope that the arguments and instances which I have to-day adduced may help to bring about, not only the doing of the work, but the doing of it quickly.

[The address by Prof. A. B. W. Kennedy to Section G will be found on page 157.]

* "Die magnetischen Localabweichungen bei Moskau und ihre Beziehungen zur dortigen Local-Attraction," *Bulletin de la Société Impér. des Naturalistes de Moscou*, 1894, No. IV.

A NOVELTY IN LAMP SHADES.

Some electrical firms are introducing striking and pleasing novelties in electric lamp and candle shades, some of which are on view in the showrooms of the Edison and Swan Company, Messrs. Rashleigh Phipps and Co., Mr. Frank Suter, etc. The shades are made of a specially selected description of natural feathers, dyed in choice shades, and arranged in artistic shapes and combinations of colour. Among these may be cited some beautiful designs of shades for floor and table lamps, consisting of various kinds of flowers made separately and grouped together on skeleton frames. The effect obtained is quite different from the somewhat hackneyed style of silk and lace shades that are now much in vogue. The general construction of these shades is protected by patent, and every design is registered. They have mainly been designed by Miss Beatrice Davenport for the Plume Company, for whom Messrs. Chas. Ingle and Co., of 157, High Holborn, are the wholesale agents.

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TO CORRESPONDENTS.

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THE MARQUIS OF SALISBURY AT THE B.A.

It is well that from time to time the president of the British Association should be someone not generally understood to be steeped to the lips in scientific lore, nor a recluse whose home is in the laboratory and whose soft nothings in conversation smack only of life-long scientific studies. Quoting from recollection, was it not Burns who said:

> "O wad some power the giftie gie us
> To see oursels as ithers see us"?

And so one outside the charmed circle of intense scientific thought speaks from that outside, and tells us what he and others think of the scientific progress of the century. Practically, it comes to this, that we have accumulated facts and added largely to knowledge, but the real solution of the great always present problems seems as far off as ever. The Marquis of Salisbury, while not making little of the work done, acts on the scientific body like a good surgeon with a keen knife shredding a limb to save the patient—lays bare the depth of our ignorance, yet leaves us to continue to struggle into the unknown, promising good results, even if the solution of these problems is unattainable. The address of the president of the association does not appeal directly to electricians, except that it shortly, and perhaps incidentally, goes to the root of the structure upon which they and the devotees to optical research base the modern theories. The address is very readable, therefore it is the more unnecessary for us to epitomise it, and can devote more space to the one prominent feature in our portion of science. Light undulation can, according to our theories, only be propagated through some medium. For the want of a more tangible medium the existence of something pervading space was assumed. Its actuality has never been proved, and though this view of the case would be scouted with scorn, there is no valid reason why a second Newton, Young, or Fresnel should not to-morrow propose another theory just as good and just as vulnerable as the one which now holds. Even with the hypothetical ether, which can be and is endowed with any and all the properties required, there is a feeling sometimes finding expression that facts necessitate theories asking too much from it. Lord Salisbury points out its anomalous position, but Section A has more than once heard the despairing cry of "Don't do away with the ether if you leave us blankness." The presidential address puts the whole question into a nutshell. Modern electricians swear by the ether, not because it exists, but because they want it to exist to explain their views. Has not scientific thought always had this tendency? If the theory requires something from the unknown, assume that something, and then assert the correctness of the theory. That theory becomes more or less fashionable for many years, till, in fact, some unorthodox spirit of overwhelming power comes along and suggests a new theory, when his pupils make that theory prominent and cry anathema on all who do not accept it. Lord Salisbury has done good work if by his address he takes a little of the conceit out of the hangers-on of

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science—those who form the claque, not the real players; for the latter are real seekers after truth, while the former are followers after men. The real scientific man does not assert infallibility—it is only the hanger-on who acts as if he was infallible. The length and breadth, the height and depth of our ignorance of nature are incalculable. A few directions in which it is patent are pointed out in this address, but there are thousands of other problems almost as important and as yet quite unsolvable. Really, instead of being proud of nineteenth-century progress, we ought rather to be deeply humble at the extent of our known ignorance.

TRAIN-LIGHTING.

A note in another column to the effect that the Danish State Railways have been for two years more or less successfully experimenting with the electric lighting of trains, may cause renewed attention to this subject. There can be no two opinions as to the value of this illuminant but the practical difficulties in the way have delayed its adoption. A variety of experiments have been made over English lines, but with one exception little progress can be reported. This being so, the thoughtless man may write down electricity for lighting trains a failure. That conclusion is unsound, for most people can see why an experiment may not succeed, yet why the work on a larger scale would succeed. Few people realise the cost of fitting up for lighting the carriages on a large railway system, and to make electric lighting a success, all, or almost all, the carriages should be fitted for such lighting; otherwise the breaking up of trains mingles the variously-lighted vehicles, and here the difficulty comes in. What manager, or what line, for the matter of that, has pluck enough to sink the initial cost of conversion, say, from oil to electricity? When the train service is such that little or no breaking of trains is involved, the method of lighting is simplified. Oh, but the reader may say, the Danish experiments are with batteries, and most of the other experiments have been similarly made. Granted; and allowing the carriage to be self-contained, we find this difficulty cropping up when trains are broken up: the accumulator-lighted carriages are on different trains, therefore different distances are used through different periods of time, and so the demand upon the accumulators is very varied. This greatly affects the matter of charging; in fact, so troublesome is the matter that most of the experiments have been given up in despair. Two things are wanted to obtain electrically-lighted trains. In the first place, the public using the trains must strenuously kick at the miserable oil lamp now used. It must importune the railway authorities for a better light. Secondly, the railway authorities have still to be educated. Their education seems to go in steps. They take a leap upward and then rest, because the energy expended has exhausted them. They realise only in a fitful way that every departure in ameliorating the travelling troubles of the public has resulted in augmented revenue. The northern and eastern lines have seen this. A better service, better carriages, increased accommodation, each has led to increased revenue, and so it would be if the authorities went further. One day the plunge will be taken, and a big line will go in for electric lighting throughout; then some will agitate for a buffet in every corner and a secluded seat to every individual, but we will be satisfied for the moment with more light. Experiments, to be moderately successful, must be with trains that are not constantly broken up, and should be made with a view rather to court success than failure. Some, we fear, have been made just to see how you could get on under the worst conditions, and here any electrical engineer could easily have predicted failure.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

LOWRIE'S INTRAPOSED SYSTEM.

SIR,—Your journal of July 27 contains a description of Mr. W. Lowrie's intraposed automatic system, the main feature of which is an automatic switch. I am afraid the inventor will be disappointed when he actually tries this apparatus. As described, it is not very likely to work satisfactorily. When the switch is off and the current is switched on to the pressure coil, the series coil being short-circuited, a strong current will be induced in the series coil, but this current will not produce equal poles at the pole-pieces. The induction will be due to the combined action of primary and secondary currents, as in any other transformer, and not be in step with either of them. The two pole-pieces will continue to attract each other, and if the resistance of the coils is not high enough to keep the currents within safe limits, a burn-out in one of the coils will be the only result of switching on. If this does not take place, the maximum induction will be somewhat lower than if the series coil was on open circuit due to the drop of volts over the resistance of the pressure coil, but the pole-pieces will at any moment be of opposite polarity and attract each other.

While speaking of automatic alternating switches, I should like to mention a switch of that kind introduced by Messrs. Swinburne and Co. at my suggestion—viz., an automatic synchronising switch to be used instead of the usual synchronising transformer. The controlling electromagnet is a horseshoe magnet, with a coil on each limb and a keeper, which actuates the switch. One of the coils is connected across the omnibus bars of the station, the other across the terminals of the alternator that has to be switched on to the 'bus bars. The keeper will be held up by the electromagnet until the E.M.F. of the alternator is in step with and about equal to the difference of potential between the 'bus bars, then the induction will disappear and the keeper will fall by its own weight and switch the alternator on to the 'bus bars. At the same time it disconnects both coils on the electromagnet, so that no power is wasted except while synchronising. Besides being far more reliable than the ordinary way of synchronising by means of lamps, this switch saves valuable time, because there is no necessity for keeping the alternator at synchronising speed for some time: it is only necessary to speed up fairly slowly; at the moment the synchronism is reached the switch will act, and the alternator is then kept in step in the usual way.—Yours, etc.,

August 7, 1894. S. A. FABER.

Electric Lighting in Ceylon.—Following up the experimental installations in Colombo, an Indian contemporary learns that several hotel proprietors, mill owners, and the harbour authorities intend illuminating their premises with the electric light. Proposals are also before the Municipality for lighting the town of Colombo.

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PRACTICAL NOTES ON DYNAMO CALCULATION.* IX.

BY ALFRED E. WIENER.

(*b*) *Radiating Surface of Ring Armatures.*—In ring armatures the construction and mounting of the core may be such that either one, two, three, or all four sides of the cross-section are in contact with the air, but in modern machines, almost without exception, all four, or at least three, of the surfaces constituting the ring are radiating areas, Fig. 20.

In the first-mentioned case (four sides) we have the formula:

$$O_a = 2 \times d_a''' \times \pi \times (l_a + b_a + 4 \times h_a) \quad . \quad (45)$$

and in the latter case (three sides):

$$O_a = d_a'' \times \pi \times (l_a + 2\,h_a) + 2 \times d_a''' \times \pi \times (b_a + 2\,h_a \quad (46)$$

O_a = radiating surface of armature, in square inches;
d_a'' = external diameter of armature, in inches;
d_a''' = mean diameter of armature core, in inches;
l_a = length of armature core, in inches;
b_a = radial depth of armature core, in inches;
h_a = height of winding space, in inches.

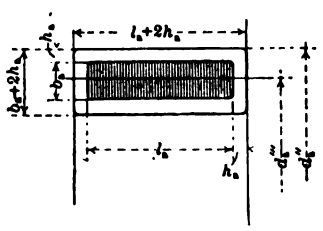

FIG. 20.

18. *Specific Energy Loss—Rise of Armature Temperature.*—While the amount of the consumed energy, W_a, formula (42), determines directly the quantity of heat generated in the armature, the amount of heat liberated from it depends upon the size of its radiating surface, upon its circumferential velocity, and upon the ratio of the pole area to the radiating surface.

The most important of these factors in the heat conduction from an armature naturally is the size of the radiating surface, while the speed and the ratio of polar embrace are of minor influence only; and it is, therefore, the ratio of the energy consumed in the armature to the size of the cooling surface—that is, the specific energy loss—which limits the proportion of heat generated to heat radiated, and which consequently affords a measure for the degree of the temperature increase of the armature.

A. H. and C. E. Timmermann,† of Cornell University, who made the armature radiation the subject of their paper read before the American Institute of Electrical Engineers, in May, 1893, from a series of elaborate experiments drew the following conclusions:

1. An increase of the temperature of the armature causes an increased radiation of heat per degree rise in temperature, but the ratio of increase diminishes as the temperature increases, and an increase of the amount of heat generated in the armature increases the temperature of the armature, but less than proportionately.

2. As the peripheral velocity is increased, the amount of heat liberated per degree rise in temperature is increased, but the rate of increase becomes less with the higher speeds.

3. The effect of the field poles is to prevent the radiation of heat; as the percentage of the polar embrace is increased, the amount of heat radiated per degree rise in temperature becomes less.

Combining these results with the data and tests of various dynamos, the author finds the following values given in Table XXX. of the temperature increase per unit of specific energy loss—that is, for every watt of energy dissipated per square inch of radiating surface—under various conditions of peripheral velocity and polar embrace:

* From the *Electrical World* (New York).

† A. H. and C. E. Timmermann, *Transactions* American Institute of Electrical Engineers, vol. x., p. 336 (1893).

TABLE XXX.—Specific Temperature Increase in Armatures.

Peripheral velocity in feet per second.	Rise of temperature per unit of specific energy loss in degrees centigrade, τ_a. Ratio of pole area to total radiating surface: ·8	·7	·6	·5	·4	·3	·2
0	110	100	95	90	86	83	80
10	80	74	70	67	64	62	60
20	64	61	58	56	54	52	50
30	55	53	51	49½	48	46½	45
40	50	48½	47	46	45	44	43
50	48	47	46	45	44	43	42
75	47	46	45	44	43	42	41
100	46	45	44	43	42	41	40
150	45	44	43	42	41	40	40

In Fig. 21 these temperatures are represented graphically; Curves I., II. . . . . VII., corresponding to columns 2, 3, . . . 8 of Table XXX. respectively.

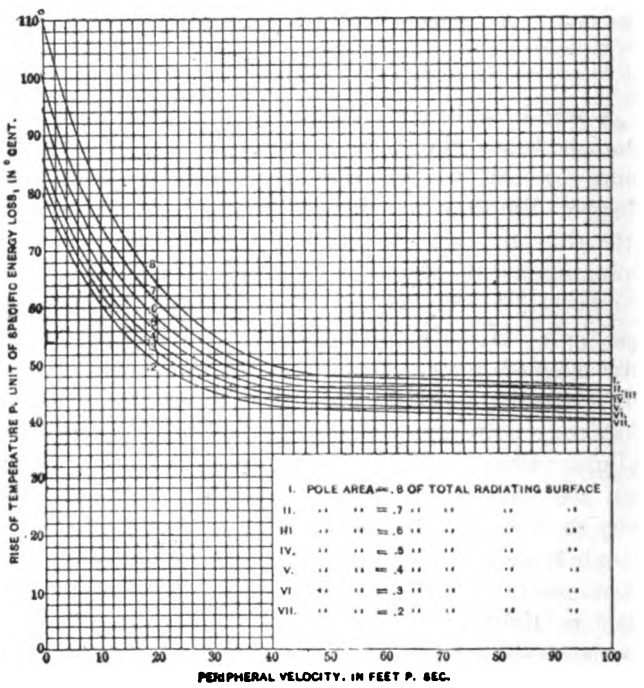
RISE OF TEMPERATURE P. UNIT OF SPECIFIC ENERGY LOSS, IN °CENT.
PERIPHERAL VELOCITY, IN FEET P. SEC.
I. POLE AREA = .8 OF TOTAL RADIATING SURFACE
II. " " = .7 " " "
III. " " = .6 " " "
IV. " " = .5 " " "
V. " " = .4 " " "
VI. " " = .3 " " "
VII. " " = .2 " " "

FIG. 21.

Multiplying this specific temperature increase by the respective specific energy loss, the rise of temperature in any armature can be found from:

$$t_a = \tau_a \times \frac{W_a}{O_a} \quad . \quad . \quad . \quad . \quad . \quad (47)$$

where t_a = rise of temperature in armature, in degrees centigrade;
τ_a = specific temperature increase, or rise of armature temperature per unit of specific energy loss, from Table XXX. or Fig. 19;
W_a = total energy consumed in armature, in watts, formula (41);
O_a = radiating surface of armature, in square inches, from formulæ (44), (45), or (46) respectively;
$\frac{W_a}{O_a}$ = specific energy loss—*i.e.*, watts energy loss per square inch of radiating surface.

Empirical Formula for Heating of Drum Armatures.—From tests made with drum armatures, Ernst Schulz* derived an empirical formula, which, when translated into our symbols and units, becomes:

$$t_a = \cdot 00045 \times \frac{\mathfrak{B}_a \times P \times N \times M}{O_a} \quad . \quad . \quad (48)$$

t_a = rise of armature temperature, in degrees centigrade;
$\mathfrak{B}_a$ = magnetic density in armature body, in lines per square inch;
P = number of pairs of magnet poles;
N = number of revolutions per minute;
M = mass of iron in armature core, in cubic feet;

* Ernst Schulz, *Elektrotechn. Zeitschr.*, vol. xiv., p. 367 (June 30, 1893), the *Electrical World*, vol. xxii, p. 118 (August 12, 1893).

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O_a = armature surface, in square inches. (In his calculations, Mr. Schulz, for convenience, takes the external surface of the cylindrical part, $d_a'' \pi \times l_a + \frac{d_a''^2 \times \pi}{2}$, instead of the radiating surface proper, formula (44), but no fault arises from this, as the constant takes care of the difference.)

The numerical factor depends upon the units chosen, upon the ventilation of the armature, upon the quality of the iron, and upon the thickness of the lamination, and consequently varies considerably in different machines. For this reason it is advisable not to use formula (48), except in case of calculating an armature of an existing type for which this constant is known by experiment. In the latter case, Schulz's formula, although not as exact, is even more convenient than the direct equation (47), which necessitates the separate calculation of the energy losses, while (48) contains the factors determining these losses, and therefore will give the result quicker, provided that the numerical factor has been previously determined from similar machines. For various drum armatures experimented upon by Mr. Schulz, the constant varied between ·0003 and ·0005, and averaged about ·00045.

19. *Circumferential Current Density of Armature.*—An excellent check on the heat calculation of the armature, and in most cases all that is really necessary for an examination of its electrical qualities, is the computation of the circumferential current density of the armature. This is the sum of the currents flowing through a number of active armature conductors corresponding to unit length of core periphery, and is found by dividing the total number of amperes all around the armature by the body circumference:

$$J = \frac{K \times \frac{C}{2P}}{d_a \times \pi} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (49)$$

J = circumferential current density in amperes per inch length of core periphery;

K = total number of armature conductors all around periphery;

C = total current generated in armature, in amperes;

2 P = number of electrically parallel armature portions (number of poles);

$\frac{C}{2P}$ = current flowing through each conductor, in amperes;

$K \times \frac{C}{2P}$ = total number of amperes all around armature; this quantity is called "volume of the armature current" by W. B. Esson, and "circumflux of the armature" by Silvanus P. Thompson.

d_a = diameter of armature body in inches; in case of a toothed armature, on account of the considerably greater winding depth, the external diameter, d_a'', is to be taken instead of d_a, in order to bring toothed and smooth armatures to about the same basis; for a similar reason, for an inner-pole dynamo, the mean diameter, d_a''', should be substituted for d_a.

(To be continued.)

BRITISH ASSOCIATION.

Address to the Mechanical Science Section.

BY PROF. A. B. W. KENNEDY, LL.D., F.R.S., M.I.C.E., PRESIDENT OF THE SECTION.

The Critical Side of Mechanical Training.

While there is no place in the kingdom more suitable for a meeting of the British Association than Oxford, and certainly no place in which it is more delightful for the members to meet, it is yet to be admitted that there are few places which have much less in common with the special work of Section G. Nominally devoted to "mechanical science," the section has for many years specially dealt with those branches of applied mechanical science which constitute the business of the engineer—to quote the well-known words of the Royal charter: "the art of directing the great sources of power in nature for the use and convenience of man." The association of this ancient and learned city with boilers and chimneys, with the noise and racket of ordinary mechanical work, seems an incongruity. Even the harmless necessary railway station is kept as far away as possible, and the very river flows with a quiet dignity which seems to shut out the thought of anything more mechanical than the most ancient and futile of water-wheels.

Naturally enough these considerations did not tend to make more easy the choice of a subject for this address, and I have come very near to agreement with a recent critic in the opinion that presidential addresses are, in fact, almost immoral in the nature of things and fit only to be abolished. Finally I decided upon taking up my present subject, as being one in which the academic rather than the technical side of our work comes to the front, while at the same time it does not lead me out of lines in which I have been able, in past years, to work myself. It is now 20 years since I first took any active part in the scientific training of engineers, and five since I ceased to do so. I have often wished that I may have been at all as successful in teaching others at University College as I was, at the same time, in teaching myself. And since I have ceased to teach I seem to have been spending my time in finding out how much better I could now do it than was possible when I was actually engaged in it. This may be pure imagination on my part; there is nothing more easy, as we all know, than to suppose that we know best how to do the things that other people do, and not the things we have to do ourselves. Indeed, I understand that this is the recognised attitude of the really superior critic. If, however, in anything which I have to say, it should seem that I am finding fault with what is now being done, I may at least point out that most of all I am finding fault with myself for not having done right when I had the opportunity—an opportunity which can now never recur. Indeed, instead of the decorous and unobtrusive heading which I have given to this address, I might have indicated its general lines almost as truly if I had entitled it "The Regrets of an Emeritus Professor"—a name which, on a suitable binding, might even have secured it a sale at the railway bookstalls.

I know well—too well—that in the present congested state of the engineering profession there are many of us who do not like to hear the word "training" mentioned at all. It seems to mean merely the preparation of more lads to struggle for a share of work that is even now insufficient to go round. There is no doubt much to be said for this point of view. But against it one must remember that all other professions are equally full, and that, after all, lads must do something. The fault is surely that there are too many lads! If our population is really to go on increasing as rapidly as at present—the benefits of which Sections D, E, and F might have a joint meeting to discuss, if not to discover—it is inevitable that demands should come for more and more complete professional preparation. The man of exceptional parts will come to the front under any conditions, training or no training, in the future as in the past. But for ordinary men—that is, for 99 per cent. of us—it is essential that no advantage should be given to a rival in the fierce competition of life, and for them, therefore, it is of an importance hardly to be exaggerated to obtain the most complete and perfect training possible. At the same time, and on purely general grounds, it can hardly be denied that to raise the standard of our profession is indirectly to confer a benefit on the whole community. I hope, therefore, that in making certain suggestions about the training of engineers, it will not be thought that I am desirous of increasing their number, which is really an end as far as possible from my own wishes. Whether the number increases or stands still or falls off, it is of importance from every point of view that those who come forward should be as well prepared as possible. And even the most conservative of us are compelled to recognise that the standard required in engineers' offices now is enormously higher than it was 30 years ago. This may truly be either the cause or the effects of improved training, but in either case it has made the training itself a necessity.

The particular aspect of mechanical training of which I wish to speak is its critical side. I do not know how a man should be trained to be an inventor. I would not tell anyone if I did! To be a creator in mechanical matters—which, however, is a quite different thing—is a faculty given only to a very few, and with them it is "born, not made." Many of us, however, without being either inventors or creators, have sufficient natural aptitude or inclination towards things mechanical to form a basis for the trainer or educator to work on, with some hope that he may be of service. About the sciences which should be taught to such men, or the methods of teaching them, about the extent and nature of their experience in shops or on works, I do not intend to speak. I shall confine myself to one aspect of the training only, an aspect which is perhaps not always sufficiently clearly kept in view—the aspect which I have just called the critical side of mechanical training. An

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engineer is a man who is continually being called upon to make up his mind. It may be only as to the size of a bolt; it may be as to the type of a Forth Bridge; it may be as to the method of lighting a city; or only as to the details of a fire-grate. But, whatever it is, once it is settled it is decided irrevocably—it is translated into steel and iron and copper, and cannot be revoked by an Act passed in another session. The time given him in which to decide may be a day, or a month, or a year, but in any and every case (so far as my own experience goes) it is about one-tenth part of the time which he would like to have. It is only in rare cases that the decision is obvious—most often there are more courses open than even the most facile politician ever dreamt of. The matters are too complex to be dealt with mathematically or even physically; even if they were not, there are few engineers who would have the special capacity to handle them. Moreover, their solutions are seldom "unique." From this point of view, the whole use of college training, of workshop practice, of practical experience, is to provide the engineer later on with the means of critically examining each question as it comes up, of reviewing systematically the *pros* and *cons.* of each method of dealing with it, of coming finally, rapidly, and positively to some defensible decision, which may then be irrevocably carried out.

In the case of a problem in pure mathematics or physics, where only one right solution can exist, that solution is arrived at by the help of a thorough knowledge of the science in question; there is little room for the critical faculty except as to method; the result is either right or wrong. With our work, on the other hand, solutions of all problems except the very simplest—in other words, decisions on all points which present themselves—can be arrived at only by a process of criticism applied to the problems, to their statement, to their condition, to all their many possible solutions. The development of the necessary critical faculty should be one of the chief aims of every teacher and every student. A scientific training cannot make a man an engineer. Perhaps it is impossible for anything to make a man an engineer unless he has grown that way from the beginning. But a scientific training may make him, or at least give him the possibility of making himself, a critic.

In the vigorous attempts which have been made to specialise the education of engineers very early, I am afraid that the idea of teaching subjects is sometimes too prominent, to the neglect of matters less obviously useful. It is, of course, one thing to know a subject from the examination point of view, and quite another to be able to think about it, and still another to be able to write about it. In particular, I have often regretted to find how little attention has been given to a matter which perhaps may be called literary rather than scientific, but which is all-important in criticism—I mean to the power of expression. It is not easy to overrate the importance to the engineer, as to other folk, of the power of saying clearly what he means, and of saying just what he means. I do not mean only of doing this for its own sake, but because if a man cannot say or write clearly what he means, it is improbable that he can think clearly. By the power of expression I do not mean, of course, the mere power of speaking fluently in public, a thing which appears physically impossible to some people. I mean rather the power of expression in writing, which carries with it clearness and consecutiveness of thought. It is difficult to know how this matter can be taught, but at least it can be insisted upon probably to a much greater extent than is commonly the case. A man requires to see clearly not only the exact thing which he wants to say, but the whole environment of that thing as it appears to him. Not only this, but he must see the whole environment of the same thing as it appears to the persons for whom he is writing, or to whom he is speaking. He has to see what they know about the matter, what they think, and what they think they know, and if he wishes to be really understood has got to do much more than merely write the thing he means. He has carefully to unwrite, if I may use the expression, the various things that other people will be certain to think that he means. For, after all, the great majority of people are very careless listeners and readers, and it is not for the small minority who are really exact in these matters that one has to write. Moreover, it is a great help to clearness of thought and expression to keep before one always an ideal audience of people who will certainly misunderstand every single sentence about which any misunderstanding is in any way possible, and some others as well.

In attempting to think out or to discuss any question, whether it be technical or non-technical, in fact, as long only as it is non-political, the first necessity is probably a knowledge of the question itself, and not only this, but also a proper understanding of its whole environment. This knowledge must be of such a kind as to distinguish what parts of it are important, what parts of it are unimportant, what parts can be described in two sentences, and what others may require as many paragraphs; what parts affect the result but little, however large they seem; and which ones must be considered vital, although their very existence is difficult to discover. The faculty which enables a man to handle his knowledge in this fashion may be summed up in the single expression "sense of proportion." Moreover, the knowledge, to be of real value, must be as totally free from prejudices and prepossessions as in the most rigorous branch of pure science, and as thoroughly imbued with a healthy spirit of scepticism. One is accustomed to think of engineering work as mainly constructive; but, after all, it is quite as much critical. In almost every department of mechanical work there are half-a-dozen ways of solving any particular problem. In some fashion or other the engineer must be able to judge between these various methods—methods which are often very much alike, but each of which may possess certain particular advantages and certain particular drawbacks. The arithmetical criticism which merely counts the advantages and the drawbacks, and puts an equal number of the one against an equal number of the other, is common enough, but obviously useless. The very first necessity to the critic is that he should have what I have just called the sense of proportion—a sense which will enable him to distinguish mere academical objections from serious practical difficulties—which shall enable him to balance twenty advantages which can be enumerated on paper by one serious drawback which will exist in fact—which will enable him, in fact, to place molehills of experience against mountains of talk. It is perhaps a doubtful point how far this sense of proportion can be taught at all. No doubt it can only be built up upon some natural basis. I am sure that in engineering we all know men whose judgment as to whether it was advisable to take a particular course we would accept implicitly, because we know that it is based on large general criticism, in spite of the most elaborate and specious arguments against it set down on paper. Any third-year student—not to go still further back—can criticise perfectly along certain very narrow lines, just as anyone can learn the rules of harmony, and can write something in accordance with them which purports to be music. But, after all, the music may be music only in name, and the criticism may not be worth the paper it is written upon, however formal it may appear to be, unless the writer is thoroughly imbued with a sense of the proportionate value of the different points which he makes. To take the commonest possible case, I dare say we have all of us heard certain methods, mechanical, chemical, or other, stigmatised as totally wrong and absolutely useless because they contain certain easily provable errors. I am sure, too, that most of us could give illustrations of cases in which this has been said with the very greatest dogmatism when the errors of the impugned method are not one-tenth part as great as the equally unavoidable errors of observation in the most perfect method.

Probably the best special education in proportion which a man can have is a course of quantitative experimental work. I say quantitative with emphasis, as meaning something much more than mere qualitative work. Here, I think, comes in the usefulness of the engineering laboratory. We require that the training should be not only in absolute measurement, but in relative measurement, the latter being quite as important as the former. Many kinds of measurements stand more or less upon a level as a training of the faculties of observation in themselves, but no single kind of measurement is sufficient as a training in proportion. A year spent in calibrating thermometers or galvanometers might make an exceedingly accurate observer in a particular line, but it would not give the observer a knowledge of what even constituted accuracy in other directions; for accuracy is a relative and not an absolute term. In most engineering matters the conditions are, unfortunately, of a most complex kind—so complex that our problems are incapable of any solution sufficiently exact to satisfy the mathematician or physicist. The temptation to treat these problems as the mathematician treats those with which he deals—namely, to alter the assumed conditions in order to get an exact solution—is a very strong one. I am afraid it is most strong often in those engineers who are the best mathematicians. It is a temptation, however, steadily to be resisted. We must assume our conditions to be what they actually are, and not what we should like them to be; and if we cannot obtain an exact solution of our problem with its actual conditions, so much the worse for us, not so much the worse for the conditions. Our first duty is generally to find out the conditions; if they are disadvantageous (in fact I mean, and not merely in the problem) to alter them if they can be altered, but not to ignore them because they are inconvenient. We have then to find out the extent to which the known conditions permit any exactness of solution at all, and, finally, we have to keep this in view as a measurement of the highest accuracy which is attainable. To work out certain branches of the problem with such minuteness as to give us apparently very much greater accuracy than this is not only useless, but is apt to be positively misleading, as giving an impression of an accuracy which has no real existence. The relative value of accuracy in different sets of observations is in itself a matter in which a sense of proportion is wanted, and often very badly wanted. Where one has to measure half-a-dozen things, of which two are very easily measured, and the remaining four are only measurable with great difficulty, it is only human nature that we should spend our energies on getting extremely accurate results with the first two and roughly do our best with the others. It is very difficult

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under such circumstances to remember that the accuracy of the whole is not the accuracy of the best part of our work, but of the worst.

The extraordinary effect of a want of sense of proportion is nowhere better shown than in the absurd statements which are constantly made as to technical matters in public prospectuses, and the still more absurd statements made in those very numerous documents of a similar kind, of which some of us see a great many, but which do not finally emerge into public view. Fortunes are apparently to be made by inventions which, although doubtless ingenious, yet only concern one way of doing a thing which could be done equally well in half-a-dozen other ways. Everyone is expected to run after a piece of apparatus which is to save 50 per cent. of something, the total cost of that something, however, being so very small that nobody cares to save in it at all. I need hardly mention the all too-common case where a contemplated saving of 10 per cent. in the cost of a material works out yearly to an amount much more than equal to the whole cost of the original article. I believe that experimental work in an engineering laboratory can educate this critical sense of proportion very admirably in a number of ways. In the first place, it directs quantitative work into very varied channels, and not along one particular line. Secondly, it compels the observer to combine a number of measurements in such a way that the relative importance of accuracy in each can be seen. In the case of an engine trial, for instance, the combined results are affected by the accuracy of measurements of the dimensions of the machine, by the apparatus and methods used for measuring the water, by the indicator and by its springs, by the speed counter, by the thermometers, and so on. An error of 1 per cent. in counting the revolutions is just as important as an error of 1 per cent. in measuring the water, or in measuring the mean pressure. I am afraid that one could point to a good many cases in which this has been more or less forgotten. Then, by making a series of measurements all in absolute quantities, the relative importance of each quantity to the desired total result can be seen. Thus it will be found that changes in certain quantities affect the total result to a very small extent, while changes in others affect it very largely, so that not only is the accuracy with which different quantities can be determined very different, but also the same degree of accuracy is of very different importance according to the particular quantity to which it refers. Once it is found that a final result is exceedingly little affected by a particular set of changes, it ceases to be of importance to measure or observe those changes in any extremely minute way, and of course the reverse holds equally good. Finally, and this, perhaps, is the most important matter of all, measurements in such a laboratory are made to a great extent under the complicated conditions under which the actual final result has to be obtained in practical work. They are not made under the conditions which insure the greatest individual accuracy of each result.

It will be seen that throughout, but particularly in the two last points which I have mentioned, the work of an engineering laboratory is in intention and in essence different from that of a physical laboratory. The aim of the latter is to make its problems as simple as possible, to eliminate all disturbing elements or influences, and to obtain finally a result which possesses the highest degree of absolute accuracy. In most physical investigations the result aimed at is one in which practically absolute accuracy is attainable, although attainable only if infinite pains be taken to get it. It is the business of the physicist to control and modify his conditions, and to use only those which permit of the desired degree of accuracy being reached. In such investigations it sometimes becomes almost immoral to think of one condition as less important than another. Every disturbing condition must be either eliminated or completely allowed for. That method of making the experiment is the best which ensures the greatest possible accuracy in every part of the result. The business of the engineer, on the other hand, is to deal with physical problems under conditions which he can only very partially control, and the conditions are a part of his problem. He does not, for instance, experiment with a steam-engine so made that it can work with a Carnot cycle. It is in the nature of the case that he must experiment with a much less perfect machine. In burning fuel he does not use apparatus specially made to absorb the whole heat of combustion, but in the nature of the case has to investigate the behaviour of apparatus in which a very large part of that heat is unavoidably wasted. So one might go on through an immense number of instances. Perhaps the whole matter may best be summed up by saying that in a physical laboratory the conditions of each experiment are under the control of the experimenter, and are subservient to the experiment itself. In an engineering laboratory the conditions form part of the experiment. However much more difficult or complicated they render it, they still unavoidably form part of it—an experiment under any other conditions, or with those conditions removed, would *ipso facto* be irrelevant.

A critical training in matters mechanical is, however, only too similar to the celebrated training of the Mississippi pilot which so nearly broke the heart of Mr. Mark Twain. Whenever the whole matter seems to be completely mastered from one point of view, it is only to find, with a little more experience, that from another point of view everything looks different, and the whole critique has to be started afresh. Machines cannot be finally criticised—that is to say, they cannot be pronounced good or bad—simply from results measurable in a laboratory. One wishes to use steam plant, for instance, by which as little coal shall be burnt as possible. But clearly it would be worth while to waste a certain amount of coal if a less economical machine would allow a larger saving in the cost of repairs. Or it might be worth while to use a machine in which a certain amount of extra power was obviously employed, if only by means of such a machine the cost of attendance could be measurably reduced. In fact, what may be summed up in the phrase the "worth-whileness" of economies, is in itself a matter on which a whole paper might be written. Unfortunately, the latter points which I have mentioned are just such as cannot easily be measured in laboratory work, or, indeed, in any other way whatever, except by actually using the apparatus in question. All that can be said is that a careful training in the critical measurement of comparatively simple points fits a man more than anything else to gauge accurately the importance of such other matters as I have mentioned. No doubt there are many men in whom the critical faculty is insufficiently developed to allow them ever to be of use in these matters, but to those who are intellectually capable of the "higher criticism" it must be, I think, of inestimable benefit to have had a systematic training in the lower.

Is there, then, any general standpoint from which mechanical criticism can be directed? Certain points are obvious, but probably the whole matter cannot easily be generalised. A city has to be supplied with water; there are three requisites: that the water should be of proper quality, of sufficient quantity, and that it should be brought in at a reasonable cost. But in such a case the first two are so enormously more important than the third, that the ideal is comparatively simple (of course, this is quite a different thing from being simply reached). A city has to be supplied with electric light: the essential conditions are similar. But in this case there are so many qualities which are equally proper, and there are so many different ways of bringing it in in sufficient quantity, that the third point—namely, the cost—becomes especially important. A factory has to be driven by steam power: the amount of power that is wanted can be produced by so many different types of engine and boiler—all capable of approximately equal economy, and all claiming equal freedom from breakdowns—that the choice is a peculiarly difficult one from the critical point of view. It seems almost impossible that a criticism on any one basis could meet all the three cases which I have supposed, unless that basis were that the thing supplied should be the absolutely fittest, having regard to all the conditions of each case and the relative importance of each condition. Possibly in all cases we could get at some generalisation which would show us which was the absolutely fittest, if only the necessary data were in any way complete, which they very seldom are. Perhaps in one sentence we may say that that scheme, or system, or machine, will be the absolutely best in any particular case which will the longest survive and maintain its place in its particular environment. I cannot doubt that this development of Darwinian ideas in the world of the inorganic is a legitimate one. Of course the problem would be comparatively easy in each particular case if only the environment would stand still. It would even be comparatively easy if we knew how the environment was going to alter, but this we are unable to do. We only know that it certainly will change and will go on changing, and that therefore the things which we make now have not got to survive in the conditions in which we make them, but have got to survive through some new sets of conditions of which we know nothing. I do not think the difficulty is in any way met by the popular method of guessing at what will be wanted 50 years hence, which generally means simply guessing at something very big. It is of no use making our ships or our engines of a type which we choose to imagine will be that of 50 years hence. If we do they will be of no use to-day, and for that very reason they will not even be in existence, useful or other, at the end of the 50 years. Sufficiently sad illustrations of this will occur to everyone in very different directions. I hope I shall not be considered churlish in saying that I do not think that the men who have worked on this principle have really been farseeing, or have really brought us much forward. They have been men often of genius, often of great personal fascination, always of immense imagination. But they have proceeded by methods essentially opposed to anything like the gradual evolution which must occur in technical as it does in natural matters, and in too many cases the results of their labours have not even been giants, but only monsters.

As to what causes one thing to survive rather than another we can only speak very generally. Mere survival may come about by the accident of a peculiarly tough constitution. A few engines built in the times of James Watt are still to be found at work in our own day, but can no more be taken as the fittest type than some solitary megatherium would be who,

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having outlived all his contemporaries, was able in after ages to look down upon his pigmy and short-lived successors. Mere length of life in such a case may be a mere accident, and is not itself a proof of fitness. We have it thrown at us every now and then that our engines nowadays do not last like the old ones, as if the mere existence of a very old machine were a proof of its virtues. It is certainly a proof of the excellence of its construction—or, as one may say, of its constitution—and perhaps also of the very small amount of work it has done in proportion to its life and its dimensions. It is sometimes, I am afraid, rather humiliating to have to remember that, to a very great extent, the question of the fittest, so far as it affects us, is a financial one. In manufacturing processes efficiency and economy tend to survival because they lead to decreased cost of production. In structures or other large permanent works those types tend to perpetuate themselves which require the least material—that is, in which the material used is disposed to the best advantage—and in which the outlay on labour is also smallest, assuming, of course, equal fitness in other respects. There is, no doubt, at present a tendency to dispute this altogether, and to treat all reductions in cost of labour as disadvantageous, unless, indeed, the labour be very highly skilled, in which case its remuneration must necessarily be brought down for the sake of equality! I imagine this tendency will last exactly as long as the faithful can get some other people to pay the increased cost, and will thereafter determine itself somewhat suddenly. It can no more stand in the way of natural progress in engineering matters than could the somewhat similar outcry against the introduction of machinery into manufactures two generations ago. It would be as wise to paint a generation of cats green in the hope of compelling natural selection to work along new lines.

I think we may fairly assume, therefore, that efficiency and economy are both legitimate criteria as to ultimate fitness, and will remain so. Moreover, they are both matters in which measurements can be made, and as to which judgment can be guided by such measurements. But there are other characteristics, not directly measurable, by which we can in some degree form an opinion as to the ultimate fitness of things or processes.

One set of considerations which has great critical importance is summed up in the word simplicity. This does not mean fewness of parts. Reuleaux showed long ago that with machines there was in every case a practical minimum number of parts, any reduction below which was accompanied by serious practical drawbacks. Nor is real simplicity incompatible with considerable apparent complexity. The purpose of machines is becoming continually more complex, and simplicity must not be looked at as absolute, but only in its relation to a particular purpose. There are many very complex-looking pieces of apparatus in existence which work actually so directly along each of their many branch lines as to be in reality simple. I believe it almost always happens that the first attempt to carry out by a machine a new purpose is a very complicated one. It is only by the closest possible examination of the problem, the getting at its very essence, that the machine can be simplified, and this is a late and not an early stage of design. If a mechanical problem is really only soluble by exceedingly complicated apparatus, it generally becomes a question whether the solution is worth having. There is no impossibility in making a machine that will do anything. But the very simplest possible form of apparatus which would wash our hands for us in a suitable manner is probably so very complicated that for many years to come at least that operation will be performed by manual labour. Very closely allied to simplicity is what I may call directness. In nearly all mechanical processes certain transformations are unavoidable. In many mechanical processes, as I have recently had occasion to mention, a very large number of transformations is at present practically unavoidable. I myself cannot help thinking that probably one of the most distinct signs of fitness is a reduced number of transformations, the bringing of the final and the initial stages as close together as possible, and cutting out altogether the apparently worthless middle processes. But any generalisation of this kind must be very cautiously handled; these apparently useless processes are no doubt in certain cases as indispensable as is the much abused middleman in matters economic. In a critical view of any case where similar results are aimed at by hand-work and by mechanical means, it is important to recognise that the similarity of result should very seldom become identity. In the first machine to do anything mechanically which has before been done by hand, the error is often made of trying to imitate the hand-work rigorously. The first sewing machines were, I believe, made to stitch in the same way as a seamstress. It was not until a form of stitch suitable for a machine, although unsuitable for hand, was devised that the sewing machine proved successful as a practical matter. In another but analogous line, too, you may remember that the first railway carriages were practically stage coaches put upon trucks, from which the present carriages have only very slowly been evolved. The critic has also to remember that very often the attainment of some very unimportant point, or point of which the importance has been greatly exaggerated, is made the reason mechanically for very great complication. The question of proportion comes in here again, and it has to be considered in any particular case whether the academically perfect machine, which is also extremely complicated, is not inferior to the almost equally good machine which has been constructed in a practicable shape—it almost always is so.

I have endeavoured in my remarks to indicate what appears to me to be the attitude of the engineer towards a very large portion of the work which comes into his hands. In order to deal with the work it is necessary for him first of all to have a certain definite knowledge of "things"—that is to say, both of the various subjects which form part of the curricula of all technical schools, and of the further matters which form as it were his professional alphabet. These last he learns not from books or lectures as a student, but by example and attempt, as does an artist. Of this part of his training I have said nothing; it has been perhaps sufficiently talked about of late years, and there is little to say which I could have made interesting to a general gathering like this. I cannot leave it altogether, however, without dealing with one matter. Exceptional men are all-round mathematicians or physicists, still more exceptional men are both; but for ordinary folk the study of one side of mathematics, or of a single branch of physics, is the work of a lifetime. The engineer is bound to know his own profession, by hypothesis, and it is in itself no small matter. Yet in addition he must know some mathematics, some physics, some chemistry, even also some geology, if he is to take any high rank in it. It is, therefore, surely in the very nature of things impossible that he should be a great mathematician or a great physicist, or should devote as much study to those most fascinating sciences as if they themselves were the work of his life. Therefore I beseech my friends of Section A to do what they can to modify their natural attitude of superiority—even of contempt—towards us, especially when we are students. The young engineer—I speak as a member of the great majority of the ordinary kind—would probably never have chosen his profession if he had had special aptitude for mathematical work. Having chosen it, he has to look at mathematics simply as a tool, a means to an end, not an end in itself. I cannot myself see that this point of view is one disrespectful to the parent of all the sciences, and I am confirmed by the knowledge that one or two of the greatest mathematicians in the country are of the same opinion and have the courage to act on it—with infinitely beneficial results to the young men they have to deal with. But I know that to mathematicians in general—the physicists are not so bad—the very name of engineering student is odious, indicating only a man who wilfully refuses to make mathematics his "first subject," and who therefore deserves neither consideration nor quarter, to whom it is privilege sufficient that he should be allowed to pick up such crumbs as he can digest from a table prepared for his betters. I humbly protest that we deserve better treatment. It is no doubt a great misfortune to us that we cannot afford to spend our training time preparing for examinations, and that we have been compelled to choose for our future a career in which mathematics plays only a secondary part. It is our further misfortune that we have to solve 20 real live problems, each demanding a real live answer, for every single one which otherwise we would have worked out on paper. Perhaps it is also our misfortune—or it may be only our thickheadedness—to believe that in consequence of this we are quite able to judge for ourselves what units it is most convenient for us to work in, what nomenclature satisfies our requirements, and that we are as capable of getting our "g's" in their right places as even some of our distinguished critics. But this is the end of the nineteenth century: philanthropy fills our breasts. May not our misfortunes call out some pity, and not alone contempt? In spite of solemn warnings which I have lately received in the Press against the monstrous idea that a presidential address should contain any individual opinions, I venture to repeat here what I had lately an opportunity of saying before a Royal Commission—that in cases where a university or university college takes in hand the preparation of engineers—and I hope that such cases will grow in number—they should provide for them special training in mathematics, and probably also in physics, distinct from the general training in these subjects most suitable for degrees. I say this with the full knowledge that I may be accused of wishing to degrade the purity of scientific work, and at the same time with the full knowledge that I have no such wish. On the contrary, this special training is the only means by which the rank and file of us will ever know any mathematics at all. And I can say from my own knowledge that if only we can be made what I may call mathematically articulate beings, we shall be able to repay the kindness by placing before the man of pure science problem after problem of transcendent difficulty, of immense interest, and having no single drawback whatever except that its solution may really be "useful"; and, after all, this need not be brought too prominently under his notice.

This digression has turned out a long one. I have only further to say that my main object in this address has been to indicate,

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as well as I could, the general attitude which the engineer must of necessity take up towards much of his work—the point of view from which he must look at it. I shall be extremely glad if anything which I have said should cause this attitude—this point of view—to be more clearly kept in mind in the period of training than probably has been hitherto the case.

SOME REMINISCENCES OF STEAM LOCOMOTION ON COMMON ROADS.*

BY SIR FREDERICK BRAMWELL.

It has occurred to me that this paper may have some interest for Section G on two grounds: (1) that it deals with a branch of mechanical engineering of which the present generation knows practically but little; and (2) that it involves very largely the subject of water-tube boilers or their equivalents. I intend to confine myself to some reminiscences on this subject, embraced, so far as my own knowledge goes, between, say, six or seven years in the thirties or forties of this century. I think I am right in saying that by about 1825 our turnpike roads, and the stage coaches which ran upon them, had attained to the highest degree of excellence. At this time passenger railways were practically "in the air," omnibuses were running in London, and cabs were superseding the old hackney coaches; and there was a general feeling that on our magnificent turnpike roads increase of speed and economy could be attained by the employment of the steam-engine, and it was also felt that such a mode of propulsion would compete successfully with the omnibuses. The natural result was that very many men, more or less ingenious, and more or less practical, devoted their attention to the subject of steam locomotion on common roads.

I propose to describe briefly some few among the whole number of those inventions which really resulted in carriages that did practical running on common roads Certainly the most enduring and successful of these men was Walter Hancock. He took great notice of me, then an apprentice, and, after his day's run in London, frequently took me down on the coach to his factory at Stratford. I became very much interested in this subject and took occasion to see all that was to be seen, and to hear all that there was to be heard. Another coach that did good service was that of Summers and Ogle. Summers was son-in-law to the engineer, Hague, to whom I was apprenticed. I was thus, as it were, in a steam-locomotion-on-common-roads atmosphere. In 1830, as you all know, the Manchester and Liverpool Railway, which I think I may fairly call the first real passenger railway, was put to work. Nevertheless, in 1831, a Parliamentary Committee of the House of Commons was constituted, which committee reported in 1832, and I think it only fair to the enterprise of steam carriages on common roads to give the summary of their report. You will see that they refer to the excessive tolls that have been imposed, and state that such tolls would be prohibitory, if they were to remain unaltered. But not only did the opponents of steam carriages on common roads oppose them by obtaining heavy tolls to be laid on, but they used actual physical obstruction. But I do not think that either excessive tolls or road obstructions were the real cause of the cessation of the steam carriage enterprise upon common roads Year by year railways were increasing, and the public lost interest in the common road steam carriage, which was merely to develop a speed of some 15 miles an hour, which required a large expenditure of power for the weight moved; and they turned, and wisely turned, towards the iron way.

Among the six or seven names with which I am most familiar it is difficult to assign any definite order of sequence of invention, inasmuch as in some cases the same inventor took out patents at varying dates. Hancock had a patent in 1827; so had Gurney; Summers and Ogle, in 1830; Church, in 1832; Macerone, 1833; Dance, 1833; and Hancock another patent as late as 1839. Hancock, and most of those who worked on the subject, dealt very wisely in one most important respect with their carriages to be used on common roads—that is to say, the vehicles themselves were very commonly like a large stage coach, or (as I shall have to say with respect to Hancock) were of the omnibus form, or deviated from this by the adoption of the *char-a-banc* construction. With the exception of the driving wheels there was no moving part of the machinery visible. There was no noise from the exhaust (in the best of them) nor any visible indication of fire or steam—that is to say, neither smoke nor a white cloud. Their appearance, therefore, was not such as to be of necessity alarming to horses. But for years after Hancock steam locomotion on common roads remained in abeyance, and when it was taken up again it was with the totally different object of traction engines, travelling ploughing-engines, and road-rollers. These were carried out by some of the best of our mechanical engineers, and as machines were excellent; but with respect to the horse difficulty were about as bad as they well could be. All the moving machinery was visible; there was the "barking" noise due to the steam blast, they occasionally emitted fire, and their general forms must have been an abhorrence to any horse possessed of the slightest particle of good taste. The result, as we know, has been legislation confining the use of these vehicles to night, or, if worked in the day, to be preceded by a man with a red flag and various paraphernalia.

I will now give a few particulars of the steam carriages to which I have already alluded, and I will commence with that of Hancock. In all cases the passengers and the engine and boiler were carried on one and the same structure, except when, to show the power of the engine, an ordinary omnibus body was towed behind the steam carriage. Whatever may have been the nature of Hancock's earlier experiments, he settled down into a construction of boiler consisting of a number of flat chambers placed side by side, with spaces for the ascent of the products of combustion in between the chambers containing the water. The boiler was an equivalent for a water-tube boiler, in that (as in water-tube boilers) the fire was outside the water, and not inside. This boiler combined lightness, strength, and large heating surface. By a simple arrangement there was formed a complete connection for the water at the lower part of all the chambers, and another similar connection for the steam at the upper part of the chambers. Into one of the lower sockets was pumped the feed water, and on the upper sockets were placed the safety-valves. The steam to the engine was taken off by a pipe from a central intermediate ring. The upper and lower sockets were also connected by a vertical pipe, external to the fire casing, in which were placed at frequent intervals a series of—not gauge cocks, but—gauge valves to serve the purpose of a glass water gauge. It should have been stated that the joints between the various chambers were made by a simple copper-wire ring, somewhat flattened out by the pressure produced by the nuts of the tie-bolts. For years past such or similar modes of making joints tight have been well known, but Hancock was the first, or certainly among the first, to dispense with red lead and other abominations, and to make metal to-metal tight joints. I do not remember how he made his steam and water connections. I am not sure, but I believe, that this boiler was put into a steam carriage, which however, was a failure Hancock's collection of chambers was placed a short distance above the fire, or in the last patent was placed not directly over the fire, but at the side. There was an external casing which contained the boiler, the fire-chamber, and the ashpan. This pan was closed and the draught was excited by a fan driven off the main engine The waste steam was blown into the ashpit and passed up through the fire, with the result that, except upon a very damp morning, at first starting there was not, as I have already said, any visibility of the waste steam, neither was there any sound. The safety-valve also, when it blew off, delivered the escaping steam into a silencing box. The engines were of the inverted vertical type, working on to a crankshaft, carrying a pitched pulley for a chain. This pulley could be uncoupled from the shaft by a clutch, and then the engines could be worked to drive the fan to get up steam or to feed the boiler. I need hardly say this was long before the days of injectors, and was also long before any common use of donkey engines. On the axle of the hind wheels was a corresponding pitched pulley, either of equal diameter with that on the crank-shaft, or, I am inclined to think, of somewhat greater diameter. The wheels were of wood, having very strong spokes, enclosed in a cast-iron nave, with covering plate. They were loose upon the ends of their shaft, and had, on the outsides of the nave, two driving projections. On the ends of the shaft were two drivers, which could be drawn out of gear with the wheels by screws. In ordinary running, both drivers were in gear, but there was left a very large amount—probably 100deg. or more—of that which may be called "back-lash." Supposing that in steering through the streets it became necessary to make a slight curve. The result was that the wheel on the inner side of the curve did the driving, while the wheel on the outer side overran the driver. It thus became possible to follow a sinuous track with great ease so long as the curves were inconsiderable in length. This preparation to accommodate the driving wheels to the conditions needed when making a curved track would, in these days, be, of course, wholly unnecessary, on account of the employment of the "jack-in-the-box" arrangement, to attain the desired end, and to do so in a much better way. In the latest of Hancock's coaches, the "Automaton," provision was made for partially condensing the exhaust steam by passing it through condensers of somewhat the same construction as that of the boilers, and placed in the water-tanks which were under the floor of the *char-a-banc*. I am under the impression, however, that these were never a success.

In these days injectors were not, and considerable difficulty had from time to time been experienced by the sticking up of the valves of the feed pumps. To guard against this, Hancock used two suction valves in succession and two delivery valves in succession The steering was done by means of an ordinary fore-carriage fixed upon a central vertical pin, carrying a pitched chain-wheel geared up to a wheel of the same kind keyed on to a vertical steering spindle, on which was a hand-wheel It was found in the outset, especially when going over pavement, that the blows inflicted by the pavement on the forewheels were communicated to the arms of the steersman with a very distressing effect. This was entirely got over by the simple expedient of a foot-brake These coaches worked for a period extending over 12 years. They, or some of them, made long journeys with great success; but their most interesting use, as showing the ability of steam-driven coaches to cope with the needs of the traffic of a great city, of many road materials, and of gradients exceeding that of any hill on the road from London to Holyhead, was their lengthened employment for ordinary omnibus traffic between the Bank and Paddington, and, morning and evening, between the Bank and Stratford.

The next carriage with which I will deal is that of Goldsworthy Gurney. The boiler was essentially a water-tube boiler, and consisted of two main tubes (cast iron I believe they were) placed horizontally parallel the one above the other; from the lower of these main tubes there issued a series of wrought-iron tubes slanting upwards for some distance, and then bending, continuing on,

* Abstract of a paper read before Section G of the British Association.

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over, and to the top main tube. This carriage (or rather these carriages) made various experimental runs with more or less success—notably one from London to Bath, and worked for a considerable time between Cheltenham and Gloucester—but was eventually abandoned. I never saw it running, nor did I ever see it together as a whole; my personal knowledge was confined to the boiler, and was of the character of that of the converted cannibal, who, being asked what he thought of the late bishop said he knew he was a very nice man for he had eaten a bit of him. The very first day of my apprenticeship was occupied in holding the chisel rod for a labourer who was cutting up the boiler into scrap.

The next carriage I will mention was that of Sir Charles Dance. This was a steam traction engine, and had no seats for passengers, but towed an omnibus behind it. The engine was built by Messrs. Maudsley and Field. The boiler is a strictly water-tube boiler, and in cross-section somewhat like a capital letter X. Smaller tubes started from horizontal tubes at an angle of 45deg. or thereabouts, interspaced so as to pass each other at the centre of the X, and going upwards until they reached the special arrangements by which the steam was separated from the water. The pipes continued upwards, and were united by cross tubes from which the steam was taken. This carriage worked extremely well, and went at a very considerable pace. For instance, I remember travelling by it from London to Reading—a distance of about 45 miles—which, on the down journey, was performed from Hyde Park Corner in 3¼ hours, towing a full omnibus behind it. I remember we put up in the inn yard of a coaching house—the name of which I have forgotten—but we had to select this yard because it had gates at each end, and therefore we could get out without having to turn round in the yard. I presume Messrs. Maudsley simply followed directions, but however this may be, the driving wheels of the traction engine were both of them keyed on the shaft hard and fast as though they had been the paddle wheels of a steamer, with the result that it was impossible to make a curve of a small radius. I doubt whether this traction engine (for such it was) worked more than experimentally for one or two seasons.

The boiler of Summers and Ogle is strictly a water-tube boiler. The tubes are vertical, and have each an internal tube, giving therefore an annular water space. The external vertical tubes are connected at their top and bottom in transverse tubes which, I believe, were of a ▭ section—the lower ones to make the water connection, the upper ones to make the steam connection, while the internal tubes served as stays to join the vertical and horizontal tubes together. This boiler was made of charcoal iron, was proved to 364lb. on the square inch, and ran at 240. The boiler weighed 8½cwt., and had 245ft. of heating surface, including the portion which was occupied by the steam. The iron was $\frac{1}{16}$in. thick. This coach worked very successfully in a variety of long and short journeys, but, like all the rest, was eventually abandoned.

Macerone and Squire's boiler is practically Summers and Ogle's boiler—that is to say, vertical water-tubes—but with the internal tubes omitted, and with the side tubes longer than the tubes in the middle, so as to form a partial external wall to the fireplace. Colonel Macerone was a powerful man with his pen, and those who are interested in the subject of steam locomotion, and are willing to take it from Colonel Macerone's point of view, are referred to a pamphlet published by Effingham Wilson, Royal Exchange, and George Herbert, Cheapside, in 1835. There is another pamphlet by Macerone, I believe, in the following year, called "Macerone *v.* The Mechanics' Magazine," which may interest students of the subject The carriage ran very successfully, but it was eventually abandoned.

The boiler of the Church coach was first made in a water-jacketed horizonal portion of the boiler, which at its higher end carried a vertical cylinder having a bottom tube plate, through which rose a number of vertical tubes, which at their top ends, as I remember was said at the time, turned over and outwards like the supports of the ribs of an umbrella, and thus were enabled to pierce the sides of the vertical boiler, and to obtain access for the products of combustion which had passed through them to a circular flue space surrounding the vertical part of the boiler. In an alternative plan the vertical part of the boiler had an internal cylinder, leaving only a thin annular water space. Near the bottom of this inner cylinder small tubes issued, and were bent upwards so as to rise vertically through the top plate of the cylinder. These were true water-tubes. The products of combustion arose between these tubes, and escaped by outlets made through the annular water space into the circular flue, which, as in the previous instance, surrounded the boiler. My recollection is that these boilers, or one of them, was put into a coach, or coaches, which actually ran, but I cannot find any particulars of the journey.

The Griffith was constructed by Messrs. Bramah for Mr. Griffith. The carriage is stated to weigh 3½ tons, and was destined to carry three tons of merchandise, but I have no account of its running. The boiler consisted of two flat vertical water-chambers, placed one on each side of the fire, and connected together by horizontal water-tubes—2ft. long and 1¼in. in diameter—of which there were 114. The boiler never could be kept tight, and the whole thing was a failure.

The Scott Russell is the last steam coach of which I intend to give any description. As many as seven or eight were built to run between Glasgow and Paisley. These coaches had been running some time when, on July 29th, 1834, one of them exploded as it was starting from the Halfway House. Three persons were killed, practically on the spot, and I believe two or three of the wounded died afterwards. Mr. Scott Russell did not take out any patent for his boiler except in this sense, that he patented a cubical vessel made of extremely thin flat sides, but strengthened by innumerable tie-rods going from side to side. I believe he suggested one for each square inch. He shows no other drawing than this typical vessel, but says, in effect, it would be easy to apply his principle when flues, etc., are introduced for the purpose of employing the vessel as a boiler. I believe this construction was adopted in the coaches before mentioned.

My last reminiscence of a passenger steam carriage on common roads is a comparatively recent one. I refer to the carriage constructed by the late Mr. Loftus Perkins. This was purely experimental; it carried only two or three persons. The boiler was the well-known "Perkins" water-tube boiler; the engines were compound, and with the boiler were carried on the framing of the single steering wheel (it was a three-wheeled vehicle), which was also the driving wheel, so that the crankshaft was always normal to the direction in which the carriage was going.

When speaking of Hancock, I gave him the credit for being the introducer of diminishing "priming," by the use of very small steam-pipes. Perkins, with this high-pressure steam of some 600lb., carried this principle to a still greater extent, and he was in the habit of wearing on his watch-chain a piece of pipe having a bore of only $\frac{1}{8}$in, through which he had taken the steam for 40 h.p. I am informed by a letter from Mr. Perkins's son that this engine is still in use at the Gypsum Works, near Battle.

I do not make any reference to Nairn's carriage, which ran for a long while between Edinburgh and Leith. I do not refer to this because, although, no doubt, it is one of my reminiscences, it is one of so recent a date that it must be included among your reminiscences Neither do I propose to enter into the description of the competition among the self-moving road vehicles in France, but I am glad to see, from the illustrations in the technical papers that the French have appreciated the desirability, indeed the need, of constructing the vehicles in a manner that should not shock the susceptibility of horses; and as one who is, and always has been, much interested in this subject of steam locomotion on common roads, I am very glad to find that it has been taken up by our neighbours, who, having regard to their great engineering ability and their consummate taste, should of all people be likely to obtain a successful result.

THE HISTORY OF WOODHOUSE AND RAWSON UNITED, LIMITED,

As Detailed in the Bankruptcy Court.

MONDAY.

The public examination of the directors and officers was resumed on Monday, before Mr. Registrar Hood, at Bankruptcy-buildings, Carey-street. Lincoln's-inn.

Mr. F. L. Rawson the managing director, was further examined by the Official Receiver. He said that in February, 1891. a prospectus was issued inviting applications for debentures. One of the statements in the prospectus was that "the debenture stock will, upon the existing debentures being paid off, which will be done by the directors as soon as possible, become a first charge on the entire undertaking." A circular was also issued with reference to the same debentures, which stated that the debentures would be secured as a first charge on the whole of the Company's undertaking, there being no qualification. The circular and the prospectus were sent out together, and, although witness could not say that every applicant had received both, he was certain that all those who did apply (being for the most part original debenture-holders) were fully alive to the actual position of matters.

The **Witness**, examined by Mr. Pilling, said that he had never been repaid the loan of £5,000 made by him to the Phœnix Trust. He had a running account with the trust, but they were nearly always in his debt. The United Company took no risk, in his opinion, in regard to the promotion of the American Elmore Company. An agreement was entered into whereby the United Company undertook to form the company, but witness said the legal construction of the document was open to argument. The Phœnix Trust underwrote a great number of shares in the Elmore Company, and received £34,000 as their commission in the matter. When the affairs of the Phœnix Trust were wound up. the shares held by the trust were distributed amongst the shareholders. The United Company and witness received a portion of deferred shares in the American Elmore Company, but he did not think it was the fact that no other persons interested received deferred shares. Questioned with reference to the prospectus of the Company, witness said that the Board of the old company were responsible for the estimate of the profits (£75,000) for the year 1889, and, as a member of that Board, he was willing to accept any responsibility which might be attached thereto. The estimate was prepared at the instance of the new directors, and the accountant reported that it was a fair one. As a matter of fact the profit proved to be £78,000, and he therefore considered that the estimate was carefully and correctly made. He denied that the sum to be divided amongst the shareholders of the old company was £348,000. His personal account with the United Company showed transactions amounting to £83,000. An advance of £28,000 was made to him for the purpose of paying for shares which he had acquired in the Company at a premium of 5s. per share, the shares being deposited as security, and an assignment of his interest in founders' shares of the old company being also made to the United Company. He had throughout steadily increased his shareholding in the concern.

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He had never received any remuneration in respect of the formation of the new company.

Mr. Registrar Hood invited witness to make a statement as to the representations made in the prospectus as to the financial portion of the Company's business, and pointed out that although the powers conferred by the memorandum of association were very wide, there was very little said in the body of the prospectus as to the extent the financial busines would be conducted.

Witness then entered upon a lengthy statement as to the past history of the Company. He said that testimonials had been given by Government officials and others of the high class of work turned out by the Company. In some departments of the business they were without rivals.

Mr. Registrar Hood said that, notwithstanding the great skill which the Official Receiver had exercised in presenting the complicated story of the Company, there might be certain facts of importance which had not been brought out. If any of the persons who had been examined thought it desirable to place further facts before the Court, he would grant them a supplementary sitting.

Mr. F. L. Rawson next gave an explanation by way of re-examination as to his connection and transactions with the Company. He denied that the Company had ever acted as promoters of other companies, although they had assisted in the formation of companies for the working of electrical patents only. Great care had been exercised in the formation of the United Company, the new directors being most particular with regard to the information supplied to them. He had given to the Company the option of a call on certain shares in the Elmore Company, which ultimately proved to be worth £35,000. A suggestion had been made that the business of Woodhouse and Rawson was insolvent in 1885, but there was not the slightest ground for it. At the time the Company was formed it was not contemplated that the financial business would grow to such an extent as it had done. Witness had hoped that within three years the industrial portion would have so developed as to enable the directors to pay a dividend of 5 per cent. on that branch alone. Witness said that he had endeavoured not to further his own interests in any way except by the successful working of the Company.

WEDNESDAY.

The case stood over on the last occasion to enable Mr. F. L. Rawson to make a complete statement as to the part he had taken in the Company's transactions and affairs, but he now said that his notes on the case were very voluminous, and it would take him some time to read the statement. He suggested that he should be permitted to put in the draft materials for his statement, and to address the Court on certain points which he desired to amplify.

The **Official Receiver** said this course would be most inconvenient, because the statement could not be used as evidence against other persons.

Mr. Jenkins suggested that the course to be adopted would be to allow Mr. Rawson an opportunity of putting in his statement in full, and if any questions arose upon it, an application might be made for a further public examination.

Mr. Registrar Hood adopted the view suggested by the learned counsel, and said the case would be mentioned formally in Chambers on the 15th inst., when Mr. F. L. Rawson could put in his statement.

Mr. Jenkins then examined the **Witness** with reference to the balance-sheet issued by the Company in 1891. He said that 25 founders' shares in the Phœnix Trust were included in the accounts at £15 000. He satisfied himself that if the trust had gone into liquidation then the shares would have produced that amount. As a matter of fact, the United Company were in a position to put the trust into liquidation, but refrained from doing so because it was about to bring out the American Elmore Company, from which it was anticipated that a considerable profit would accrue to the United Company. The American Elmore Company being successfully floated, the United Company realised the profit. The subject of the Epstein shares taken in the balance-sheet as of the value of £35,000 was considered by the Board very carefully, and they asked witness whether he could refer them to any expert who could give an opinion as to their value. Witness could not do so, but assured the directors that they were worth the sum mentioned. He offered to buy £3,000 worth of the same shares at par. Shares in a Spanish company were taken at the quotation upon the Barcelona Bourse. The amount of £5,000 paid to the United Company by the Phœnix Trust as their share of the profit made on the formation of the Austro-Hungarian Elmore Company was received in shares, which were quoted in the financial papers at that value. Witness devoted his time and attention almost entirely to the financial side of the business, and laid the various patents and negotiations before the Board, and, if they were approved, the details of working them out devolved upon him. Sir Rawson W. Rawson and Sir John Stokes interested themselves in the industrial portion of the business more than in the financial part, and endeavoured to get the affairs of the old company wound up.

Questioned by **Mr. Pilling** with reference to the option to call for Elmore shares which he stated on the last occasion he had given up to the Company, **Witness** said that he originally gave it to the old company, and when the new company was formed the directors claimed it. Their claim was disputed, and the matter was ultimately settled in favour of the new company.

The **Official Receiver** asked that in the event of further questions arising he should have leave to apply for a further sitting for public examination.

His **Honour** granted the application, and the enquiry was then adjourned generally.

COMPANIES' MEETINGS.

UNITED RIVER PLATE TELEPHONE COMPANY, LIMITED.

The ordinary general meeting was held last week at Winchester House.

Mr. J. Irving Courtenay (the chairman), in moving the adoption of the report, said the business of the Company during the past year showed a decided improvement. They had gone through another very trying period of disturbance political and monetary, and it might reasonably have been expected that the number of subscribers would have fallen off but, on the contrary, there had been an increase of 606. They had to make some addition to the salaries of their employés, the full effect of which had yet to be felt. The loss on exchange was enormous, and for the year under review it amounted to £54,124, the highest figure yet reached. So far as the past year was concerned, it swallowed up the larger part of the profit that otherwise would have been available for distribution among the shareholders. The net profit, after paying the debenture interest and all other charges, was £9,782. The Board had allocated to certain accounts the sum of £4,270, of which the principal item was £3 000 transferred to depreciation and renewal fund. The net balance to be carried forward to next year was £6 417.

Mr. Frank W. Jones seconded the motion for the adoption of the report, which was carried.

COMPANIES' REPORTS.

CROMPTON AND CO., LIMITED.

Directors: Viscount Emlyn (chairman), Rookes Evelyn Bell Crompton, Esq., and John Francis Albright, Esq. (managing directors), H. H. J. W. Drummond, Esq., Bernard Gibson, Esq., Carleton F. Tufnell, Esq.

Sixth report of the directors to be presented at the annual general meeting of the shareholders at the City Terminus Hotel, Cannon-street, E.C., on Monday, August 13, 1894, at 3 p.m.

The directors beg to submit the sixth annual statement of accounts made up to March 31 last. The amount of the Company's business has satisfactorily increased, but the net profits, in consequence of close competition, show a reduction as compared with last year, and this notwithstanding the fact that the directors by careful management have reduced the expenses in many departments. The net profits for the year amount to £11,741. 2s. 7d., and after providing for debenture interest, and the payments set out in the revenue accounts, there remains a balance of £6,116. 3s. 5d., out of which the directors propose to set aside £1,000 for contingencies and doubtful debts, to pay a dividend of 3s. per share on the preference shares, and to carry forward the balance. The directors regret that the net profits are insufficient to allow for the full dividend on the preference shares; at the same time they do not think there is anything discouraging as to the future of the Company. The works are in first-rate order and condition, and under the new management the cost price of manufacture has been considerably reduced, while the various departments outside the works are at the same time being carefully reorganised with the view of reducing expenditure to the utmost without affecting their efficiency. Since April, 1891, the directors have entered into no contracts whatever under which the payments for work done were to be partly made in shares or securities, but they feel that the value of some of the securities previously taken as part payment may be considered doubtful. Recognising the necessity of reducing such doubtful assets or securities to their proper value in the Company's books, they propose that an amount of £20,000 shall be written off, and to enable this to be done they have obtained the assent of the two managing directors, Messrs. Crompton and Albright, to relinquish an equal amount of ordinary shares. The effect of this transaction will not be to deprive the Company of any value which the securities in question may hereafter attain, and the reduction of the amount of ordinary shares must be for the benefit of the members generally. The directors are glad to be able to report that the cooking and heating department of the Company, which has been practically established during the past year, is likely, in their opinion, to prove a very valuable addition to the Company's business. The directors, in response to their circulars in January last with regard to the proposed issue of £100,000 of 4½ per cent. debentures, have received promises from the debenture and share holders of the Company to subscribe for the new issue to the amount of nearly £32,000, but as this support was insufficient to enable the issue to be made with any certainty, the Board considered it better to wait for the statement of accounts now presented. It is intended to take further steps to place the debentures during the ensuing autumn, but they wish to urge upon the shareholders that it is in their own interests to assist in this issue, which is of such great importance to the Company. At the same time, they would remind the shareholders that the security for these debentures is undoubted. The property of the Company, even after the reductions before referred to, amounts to £236,618, including uncalled capital, but without reckoning the value of patents and goodwill, and the income of the Company for the last six years has averaged £11,839 per annum, while the interest required for the total proposed issue of debentures would only amount to £4,500 per annum. In accordance with the articles of association, the chairman, Viscount Emlyn, retires from the board of directors by

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rotation, but offers himself for re-election. The auditors, Messrs. J. H. Duncan and Co., also offer themselves for re-election.

STATEMENT OF LIABILITIES AND ASSETS AT MARCH 31, 1894.

Capital and Liabilities.	£	s.	d.
Authorised issue, 60 000 shares at £5	300,000	0	0
Ordinary shares, 8 000 issued as fully paid	£40,000 0 0		
Ditto, 1,928 shares £1 called, £1,928; payments in full, £24, £1,952	1,952 0 0		
	41,952	0	0
Preference shares, 28,180 at £5, £140,900; less arrears, £33	140,867	0	0
	182,819	0	0
Debentures issued	48 810	0	0
Loans from bankers and overdraft	27,439	7	3
Sundry creditors	33,326	5	4
Half year's debenture interest, paid April 1, 1894	1,185	3	3
Doubtful debts and contingencies account	280	2	9
Reserve fund	2,135	4	6
Unclaimed dividends	16	13	5
Revenue account balance	6,116	3	5
	£302,127	19	11

Property and Assets.	£	s.	d.
Freehold property	21,358	12	2
Stock in-trade	58,210	8	7
Work in progress on contracts	11,048	8	2
Plant, tools, furniture, fixtures, etc.	48,241	0	0
Trade debtors	57,041	10	6
Investments in shares of other companies	13,658	18	9
Chelmsford electric lighting and other subsidiary companies	39,381	3	10
Cash at bankers and in office	6,060	17	11
Preliminary expenses—suspense account	750	0	0
Patents account	13,787	0	0
Electric cooking and heating department, cost of establishing	2,590	0	0
Goodwill	30,000	0	0
	£302,127	19	11

PROFIT AND LOSS ACCOUNT FOR YEAR ENDING MARCH 31, 1894.

Dr.	£	s.	d.
Trading and office expenses, salaries, agencies, etc.	19,742	19	7
Repairs to buildings and plant	1,102	18	7
Depreciation of plant and machinery, patents and fixtures	4,497	4	3
Balance carried to revenue account	11,471	2	11
	£37,084	5	4

Cr.	£	s.	d.
Gross profit from trading account, pupils' premiums, profits and dividends on investments	37,084	5	4
	£37,084	5	4

Dr. REVENUE ACCOUNT.	£	s.	d.
Interest on debentures	2,365	18	5
Interest on bankers' advances	1,227	7	1
Preliminary expenses (written off)	277	2	0
Directors', trustees', and auditors' fees	1,443	17	10
Income tax £310 14 2			
Balance available for distribution 6,116 3 5			
	6,426	17	7
	£11,741	2	11

Cr.	£	s.	d.
Net profit from profit and loss account	11,741	2	11
	£11,741	2	11

BIRMINGHAM CENTRAL TRAMWAYS COMPANY, LIMITED.

Directors: Joseph Ebbsmith, Esq. (chairman); William Neale, Esq.; B. J. Round, Esq.; John Booth, Esq.

Report of the directors to be submitted to the shareholders at the thirteenth ordinary general meeting, to be held at the Queen's Hotel, Stephenson-place, Birmingham, on Wednesday, August 15, 1894, at 12.30 p.m.

Working Accounts.—The working profit for the past year, omitting the Corporation charges for maintenance, amounts to £52,804. 8s. 11d., as compared with £50,424 1s. 10d. for the year ended June 30, 1893, showing an improvement of £2,380. 7s. 1d. The Corporation charges for maintenance, however, have again advanced by the sum of £1,729. 14s. 11d., which reduces the net comparative increase of working profit to £650. 12s. 2d. For the information of the shareholders, the total amount of the Corporation charges for maintenance for the past year (£8,699. 15s. 11d.) has been debited as a distinct item to revenue account, instead of being apportioned between the various departments as heretofore. This transfer gives an apparent proportionate increase of the profits upon the working accounts, which might be misleading without this explanation.

Revenue Account.—The revenue account shows a balance of £24,978. 3s. 5d., to which has to be added the sum of £3,438. 6s. 9d. brought forward from last year's account, making together £28,416. 10s. 2d.

Application of Profits.—Your directors recommend (1) that the sum of £10,000 be placed to reserve account against depreciation; (2) that the payment of the dividend upon the 5 per cent. guaranteed shares, amounting to £5,000, be confirmed; (3) that a dividend of 2½ per cent. upon the ordinary shares of the Company, amounting to £9,700, for the year ending June 30 last, be declared and paid on September 1 next; (4) that the balance of revenue account, amounting to £3,716. 10s. 2d., be carried foward.

Balance sheet.—The balance-sheet shows the position of the Company to be one of assured and increasing strength and security, but the directors impress upon the shareholders the wisdom of dealing boldly and speedily with those items of capital expenditure which are not now fairly represented by assets of the Company, and to which reference is made year by year in the auditors' report.

Directors.—Mr. Martyn J. Smith, much to the regret of his colleagues, owing to pressure of other engagements, retired from the Board in February last. Mr. John Booth and Mr. Ebbsmith are the members of the Board now retiring by rotation, and being eligible offer themselves for re-election.

Auditors.—Messrs. Howard Smith, Slocombe, and Co. retire, and are eligible for re-election as auditors of the Company.

ABSTRACT OF ACCOUNTS.

Electric Department.

Average per mile run. d.	Dr.	£	s.	d.	£	s.	d.
	Electric haulage:						
3·34	Wages	1,936	2	2			
1·90	Fuel	1,109	2	7			
·53	Stores	306	3	10			
·13	Water and lighting	73	7	6			
·10	Sundries	57	11	9			
6·00					3,482	7	10
	Machinery:						
·73	Wages	423	17	8			
2·98	Materials	1,727	18	3			
3 71					2,151	15	11
	Car repairs:						
·32	Wages	184	13	2			
·35	Materials	199	15	1			
·67					384	8	3
	Traffic expenses:						
1·47	Wages	851	16	11			
·13	Water and lighting	72	12	11			
·03	Stores	19	6	5			
·09	Stationery, tickets, and punch royalty	55	5	0			
·02	Sundries	11	14	3			
1·74					1,010	15	6
	Permanent way and buildings (exclusive of Corporation charges):						
·02	Wages	11	12	7			
·03	Materials	16	13	5			
·05					28	6	0
	General charges—						
·09	Stationery and incidentals	50	5	7			
·81	Salaries	467	6	3			
·03	Compensation	15	5	4			
·82	Rates, taxes, and insurances	476	19	6			
·72	Professional charges	418	13	8			
·06	Sundries	33	14	2			
2·53					1,462	4	6
14·70					8,519	18	0
2·09	Balance to revenue account				1,214	8	1
16·79					£9,734	6	1

Average per mile run. d.	Cr.	£	s.	d.
16·57	Traffic receipts	9,604	3	7
·22	Advertisements	130	2	6
16·79		£9,744	6	1

Note.—Miles run, 139,123; passengers carried, 1,303,833.

The auditors, Messrs. Howard Smith, Slocombe, and Co., chartered accountants, report: "We have examined the books of account, vouchers, and other documents relating to the accounts of the Company, and find the foregoing statements to agree therewith. We are informed that it is the intention of the directors to add, out of the profits, a sum of £10,000 to the reserve against depreciation of assets, and we are of opinion that such addition is sufficient for the depreciation of the year, as regards all assets other than leasehold lines and parliamentary concessions, which apparently represent over £300,000 of the capital expenditure, and the present value of which we cannot estimate. With the foregoing explanation we believe the balance-sheet to be a complete and fair statement of the assets and liabilities of the Company, and the revenue and working accounts to truly set forth the transactions of the past year. (*See also special report.*)"

AUDITORS' SPECIAL REPORT.

Our attention has been called to the paragraph headed "Balance-sheet" in the report of the directors, and we are informed that it is their intention to recommend a reduction of the ordinary share capital of the Company for the purpose of reducing by a corresponding amount that portion of the capital expenditure which is

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not represented by any tangible assets or by goodwill. We fully concur in the wisdom of this course, and are strengthened in our opinion by the revaluations of the property and rolling-stock which the directors have laid before us. These show that the sums set aside as reserve against depreciation must be wholly applied for the tangible assets, and would not, in fact, be sufficient in the event of their immediate realisation. However substantial and regular the future profits may be, it cannot be expected that they will yield a margin sufficient to provide for the whole of that portion of the capital expenditure (over £300,000) to which special reference has been made in our reports on the accounts of this and previous years.

CONTRACTS FOR ELECTRICAL PLANT.

CONTRACTS OPEN.

Lancaster.—The surveyor to the Town Council has been instructed to obtain tenders for arc lamps for street-lighting.

Ottawa.—The Canadian Government, under the authority given it by the recent Inter-Colonial Conference, is inviting tenders from cable-manufacturing contractors for the laying and maintenance in an efficient condition of a cable across the Pacific from Canada to the Australasian colonies. Offers will be received to 1st November next.

Newcastle-on-Tyne.—Tenders are invited by the 15th inst. for the best scheme, with cost, for the lighting and heating of New Trinity Presbyterian Church, to be built in Northumberland-road. Plan may be seen and other particulars obtained from the architects, Messrs. Marshall and Dick, 4, Northumberland-street. Tenders are to be sent to Mr. J. Fulton, secretary, Building Committee, 20, Jesmond-road

London, N.W.—The St. Pancras Vestry require by the 16th inst. tenders for the supply and laying of armoured cables. Specifications, schedules of quantities, general conditions, and plan of streets can be obtained at the offices of Prof. H. Robinson, 13, Victoria-street, Westminster, on payment of 5s. Tenders must be sent to Mr. Alfred E. Pycraft, chief clerk, Electricity and Public Lighting Department, Vestry Hall, Pancras road, N.W.

Sunderland.—The Corporation of Sunderland require by the 16th inst. tenders for the supply of grip-boxes and connectors. Those desirous of tendering should send in their names and addresses to the Electrical Engineer, Electric Light Station, Dunning-street, Sunderland, and copies of drawings, specification, and form of tender will be forwarded to them on receipt of 10s 6d. Tenders, addressed to the Chairman of the Highways Committee, and endorsed "Electric Lighting Grip-boxes and Connectors," are to be delivered at the office of Mr. Fras. M. Bowey, town clerk, Town Hall, Sunderland.

RESULTS OF TENDERS.

Yarmouth.—The following tenders were received for the electric lighting of the School of Art, South Quay: Messrs. Crampton, of Cambridge, £57. 18s. 6d.; Messrs. Laurence, Scott and Co., £81. 16s. 4d.; Messrs. Crompton and Co., £86. 5s.; and Mr. Durrant, of Yarmouth, £96. 17s. 11d. The tender of the first mentioned was accepted.

BUSINESS NOTES.

Tynemouth.—The aquarium is to be lighted by electricity.

Alderley Edge.—The Local Board intend to apply for a provisional order.

Great Northern Telegraph Company.—For the month of July the receipts were £25,600.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,335.

Douglas.—The number of passengers on the electric railway averages now about 30,000 per week.

Coventry.—The sum of £1,200 is to be borrowed by the Town Council for electric lighting purposes.

Plant for Sale.—It will be seen by our advertisement columns that some second-hand electrical plant is for sale.

Stroud.—The Local Board of Health are to provide electric calls for their own brigade and for the volunteer fire brigade.

Eastern Telegraph Company.—The receipts for the month of July were £56,753, as against £62,317 for the corresponding period.

Wigan.—Improvements have been made at the Royal Court Theatre, and also arrangements for an installation of the electric light.

Tunbridge Wells.—The Local Government Board have sanctioned the borrowing by the Town Council of £13,000 for electric lighting purposes.

Colchester.—The Town Council have sealed a contract with Messrs. Christy Bros. for lighting the public library building by electricity.

Direct Spanish Telegraph Company.—For the month of July the receipts were £1,400, as against £1,656 for the corresponding period of last year.

Cuba Submarine Telegraph Company.—For the month of July the receipts were £133 less than for the corresponding period of last year.

West India and Panama Telegraph Company.—The receipts for the two weeks ended July 31 were £27 less than for the corresponding period.

Shoreditch.—The Board of Trade have intimated to the Vestry that they will give them another year's grace for the carrying out of the electric lighting order.

Eastern Extension Telegraph Company.—For the month of July the receipts show a decrease of £2,503 as compared with the corresponding period of last year.

Dundee.—The estimates of the Police Commission for the year ending May, 1895, have been submitted. They include the item of £200 for lighting the High-street by electricity.

Sunderland.—The Highways Sub-Committee of the Sunderland Corporation have decided to recommend that the price charged to customers for the electric light shall be 6d. per unit.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending 5th inst. amounted to £1,000, as against £858 in the corresponding week of last year.

Denbigh.—The Lighting Committee of the Town Council have had referred back to them for consideration the subject as to the best steps to be taken for the introduction of electric lighting.

Windermere.—The Local Board have received formal notice from the Windermere and District Electric Light and Power Agency of their intention to apply for power to introduce the electric light within the Board's district.

Perth.—The Town Council have unanimously refused to consent to the application made by the Municipal Electric Light and Power Corporation, Limited, and the Caledonian Electric Supply Company, Limited, under the Electric Lighting Acts, 1882 and 1888.

Matlock Bath.—Business relating to the settlement of the boundaries between the two districts of Matlock has been discussed by the Matlock Bath Local Board. The chairman incidentally stated that they must retain the weir for the purpose of electric lighting.

Worcester.—The Mayor, Mr. G. H. Williamson, has announced that he has been in communication with Mr. Preece, consulting engineer, and with the Brush Company, about the opening of the electric station, and October 11 has been fixed for the opening ceremony.

Change of Address.—Mr. Gisbert Kapp informs us that from the 14th inst No. 31, Parliament-street, Westminster, and "Erba," Wimbledon-park, will cease to be his addresses. Mr. Kapp's new address from October 1 will be 3, Lindenallee, Westend, Berlin.

Winchester.—The Electric Light and General Purposes Joint Committee have resolved to recommend the Town Council to apply for a provisional order to light the city by electricity. The order will cost about £300, and the works will necessitate a loan of about £20,000.

St. Pancras.—In consequence of the demand for current in the district north of the Cobden statue having exceeded that contemplated when the mains were originally put down, the St. Pancras Vestry have decided to expend £2,800 in putting down supplementary feeders and mains.

Bridlington.—The North Cliff has been lighted for the first time by electricity. There are seven arc lamps of 1,200 c.p. each, and they extend from the north end of the Prince's Parade to Trinity Cut. The work has been carried out by Mr. R. Railston Brown, the Board's surveyor.

Burton.—The consumers of the electric light are increasing. Whereas in February a start was made with 13, there are now 40, and there is reason to believe there will be an additional influx in the autumn. Lord Burton has intimated his intention of defraying the costs of electric lighting in the municipal offices.

Walthamstow.—The Local Board have unanimously resolved to take steps to obtain a provisional order for lighting the district with electricity, Mr. J. H. Wildash (the chairman) and other members, commenting upon the attitude of the gas company towards the Board and the high price charged for the gas.

City and South London Railway.—The receipts of the Company for the week ended August 5 were £848, against £804 for the corresponding week of 1893, or an increase of £44. The total receipts for the current period of the present half-year amount to £4,306, as against £4,237 in the corresponding period of 1893.

Salford.—At a meeting of the Salford Town Council Mr. Holland (chairman of the Gas Committee), in reply to Mr. Alderman Dickins and Mr. Alderman Mottram, said he could not give the price at which the electric light would be supplied to residents. He thought the installation would be complete in time for the winter.

Halifax.—Now that the Halifax Corporation are preparing to supply the electric light, it is felt by a section of the Town Council that the installation ought to begin "at home," and are therefore urging the lighting of the Town Hall and its precincts by electricity. A sub-committee has been appointed to consider the matter.

Huddersfield.—An electric light installation has been completed at the premises of the Huddersfield Industrial Society. There are 14 2,000-c.p. arc lamps outside the buildings, and 34 1,500-c.p. arc lamps and 270 incandescent lamps inside. The installation has been carried out by Mr. John Edmundson, of Huddersfield.

Kendal.—Some months ago notice was given to the Town Council by a company of their intention to apply to the Board of Trade for a provisional order to supply electricity in the district

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under the Electric Lighting Act. That notice has now been withdrawn and another substituted by the Windermere and District Electricity Supply Company.

Newcastle.—A special committee of the Corporation on Tuesday decided to invite Prof. Kennedy to visit the city and give his advice on the subject of lighting the streets electrically. At the same meeting a letter was read from the Newcastle Electric Supply Company on the subject. The Eldon Hotel has been reconstructed and is now lighted by electricity.

Tottenham.—The Local Board have decided, on the recommendation of a committee consisting of the whole Board, to apply for a provisional order. A special committee of five members has been appointed to consider the subject, with power to confer with authorities who have adopted electricity for public lighting with a view to obtaining information.

Leeds.—The congregation at the Leeds Parish Church on Sunday night had the opportunity for the first time of seeing the edifice illuminated by means of the new electric installation. In all there are 245 incandescent lamps, and about half that number were in use at the evening service. Messrs. Laing, Wharton, and Down, of London, were the contractors.

Colliery Plant.—Messrs. J. P. Hall and Co., of Oldham, are carrying out an electrical power transmission plant for a colliery, consisting of a dynamo to give 250 amperes at 600 volts when running at 400 revolutions per minute, and several motors for pumping and other purposes. The largest of these motors is of 70 b.h.p., and will be situated at about 900 yards from the surface.

Sunbeam Lamps.—The Sunbeam Lamp Company, Limited, of Gateshead, remind the trade, now the season for electric lighting is approaching, that they are now manufacturing small incandescent lamps as well as their well-known large Sunbeam lamps. The lamps are of English manufacture, and range in small lamps from 8 c.p. to 50 c p., and in the case of large lamps from 100 c.p. to 2,000 c.p.

Sutton (Surrey).—At a meeting of the Local Board the Chairman called attention to the fact that the electric lighting order which was granted by the Board of Trade expired in June last, and asked what the Board intended to do. The Clerk said he understood the Board of Trade would not grant an extension of time, but would not entertain any other application without first communicating with the Board.

Abergavenny. — The chairman of the Improvement Commission, referring to the report as to lighting Abergavenny by electricity, said it was a bulky report which the expert had prepared and sent in, some 40 sheets, and he would suggest that it should be open to the inspection of any ratepayer who might like to see it at the clerk's office any day between ten and five. The chairman's suggestion was adopted.

Oswestry Electric Lighting Company.—Arrangements have been made by the Oswestry Electric Lighting and Power Company, Limited, to guarantee a minimum dividend of 3 per cent. per annum upon the share capital up to £4,000, such guarantee to be in force for a period of three years from the date of the first supply of electricity to the town by the Company, and not to apply to the shares held by the present chairman.

Belfast.—The report of the Electric Committee stated: "Your committee have accepted the tender of Messrs. Marshall, Fleming, and Jack for the supply and erection of an overhead travelling crane for the central station. They have to report that the various contractors are pushing on with the works vigorously, and your committee expect all the contracts will be completed within the specified time." The report was agreed to.

Gravesend.—Gravesend is at last to have a telephone exchange. The directors of the National Telephone Company have decided to commence operations forthwith, and hope to have the system in operation at an early date. In addition to the local systems communication will also be established by means of special trunk wires with Chatham, Rochester, Strood, Maidstone, and numerous towns in East Kent, and London, Liverpool, Manchester, and northern towns can be spoken to.

Darlington.—Mr. Barron, in moving the adoption of the Gasworks Committee's report, at a meeting of the Town Council, referred to the great consumption of gas and the probable necessity of enlargement. This might be obviated if it were decided to introduce the electric light. There was no antagonism to the electric light on the part of the Gasworks Committee, and if it saved the extension of the gasworks money would be also saved by preventing the necessity of obtaining borrowing powers.

Luton.—An installation of the electric light has been carried out at the Public Benefit Boot Company's establishment, Park-square. The lighting is effected by means of a 3 h p. Tangye gas-engine and a three-unit dynamo. These are placed in the cellar beneath the shop. The dynamo will feed two arc lights of 2,000 c p. and 30 incandescent lamps of 16 c p The installation has been carried out by Mr. W. J. Barrett, of Luton, superintended by the General Electric Company, Limited, London.

Royal Lunatic Asylum Aberdeen.—This institution is at present undergoing extensive alterations involving the reconstruction of the old buildings and the erection of a new hospital. When completed, the whole will be lit electrically by generating plant on the premises. Messrs. New and Mayne have secured the first electrical contract placed; this is for the wiring of the new building to the plans and specifications of Dr. R. Mullineux Walmsley, of Edinburgh, the consulting electrical engineer of the Asylum Corporation.

Eastbourne.—The existing gas fittings at the parish church have been in use for nearly 30 years, and the joints and pipes are in a condition to require continual attention and repair. Under these circumstances it has been decided to introduce the electric light. The following is the approximate outlay: for laying the wires in the church and connecting with the mains, £90; for fittings, £85; extras (removing gas standards, etc.), £25; total (approximately), £200. The work will probably be completed and the electric light in use on or about the first week in September.

Cardiff.—A meeting of the sub-committee appointed by the Cardiff Free Library Committee to consult Mr. Massey as to the best plan for lighting by electricity the new free library building has been held at the Town Hall. Mr. Marcus Gunn presided, and Mr. Seaward, Mr. Massey, and Mr. Ballinger were present. Mr. Massey would not give any advice without seeing sketches of the furniture and plans of the rooms, and also full particulars as to the area. This will be supplied to him, and he will in due course give the advice needed and estimate of the cost of the undertaking

Lancaster.—The Town Council have decided to raise the salary of Mr. A. Barnard, the electrical engineer, from £120 to £150 per annum. An electrical cookery demonstration is to be given at the Storey Institute by Messrs. Crompton. The Town Council will provide a room, the current, and the services of the electrical engineer. The Council have resolved not to keep in stock electric ovens, etc., for sale or letting out on hire. The price for the supply of current for cooking purposes has been fixed at 7d. per unit. The question of electric street-lighting is to be considered by a committee.

Yarmouth.—Fair progress is being made with the public electric light installation. The standards for the lamps are already in place along the Parade, in Regent-street, King-street, and in the Hall Quay Gardens. The mains have been placed underground, and are already down for the Parade lamps, while the finishing touches are being rapidly given to those deposited in King-street. In this street the cables are being laid under the pavement on either side of the street. Portions of the dynamos and the engine plant have arrived at the generating station on the South Denes, and the workmen are busy in their erection.

Andrews and Preece, Limited.—Mr. Justice Chitty, in the Chancery Division on Saturday, gave judgment in the action of the Halifax and Huddersfield Union Banking Company, Limited, *v.* Andrews and Preece, Limited. This was a debenture-holder's action, and a receiver and manager has already been appointed, as stated in our issue of the 27th ult. The Company now appeared, and admitted that they had no defence. His lordship accordingly declared the plaintiffs entitled to an account of what is due for principal and interest, and to an enquiry what property was comprised in the debentures, with liberty to apply in Chambers as to a sale.

Crompton and Co., Limited.—An extraordinary general meeting of the shareholders will be held at the City Terminus Hotel, Cannon-street, E.C., on Monday next, the 13th inst., at 3.30 p m., or so soon as the business of the ordinary general meeting convened for the same day shall have been concluded, for the purpose of considering, and if approved of passing, the following special resolution: "That the capital of the Company be reduced from £300,000 to £280,000 by cancelling paid up capital which has been lost, or is unrepresented by available assets, to the extent of £20,000 by cancelling 4,000 ordinary fully paid-up shares of the Company, numbered 2,785 to 6,784 inclusive which have been issued."

Appointments Vacant.—The Corporation of Dewsbury require by the 17th inst. a qualified practical electrical engineer to take charge of the new electric lighting station and works at Dewsbury. Applications, stating age, qualifications, present employment, and salary required, accompanied by not more than three testimonials, are to be sent to Mr. E. Mawdesley, town clerk, Town Hall, Dewsbury, endorsed "Electrical Engineer." The Electricity Supply Company for Spain, Limited, require a thoroughly competent assistant electrical engineer for their Madrid station. He must be able to go out at once. Further particulars are given in our advertisement columns.

Canterbury.—At a meeting of the Town Council the General Purposes Committee reported that they had received a letter from Messrs. Mowll and Mowll, on behalf of the electric lighting company, asking what amount of street and public lighting the Corporation would give to the company. Alderman Mount proposed that a letter be written asking how many ordinary lamps an arc lamp would displace, so that the Council could get at the probable number required, and the cost. Alderman Mason remarked that before the company had some assurance they were not prepared to take over the order and pay the £400. Without it the Council would have to keep their order. The motion was carried.

Clerkenwell.—In our issue of the 27th ult. we recorded the fact that the County of London Electric Lighting Company had given notice to the Vestry that they are about to lay conduits for electric conductors under the County of London (North) Electric Lighting Order, 1892. The Vestry have decided that the company be required to relay the disturbed paving to the satisfaction of the Vestry's surveyor, and to be responsible for its condition for a period of three years. The letter from the Board of Trade, forwarding copy of the regulations and conditions for securing the safety of the public which they propose to issue under the same order, was considered, but the Vestry did not deem it necessary to make any observations thereon, and the Board of Trade has been so informed.

Foliated Brushes for Dynamos.—The Boudreaux Dynamo Brush Company, of 1, Gresham-street, E C, have forwarded us a list of firms who use their new foliated brushes. Among these

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may be mentioned no less than nine English electric supply companies, and some of the most important manufacturing firms, whilst this type of brush has also been adopted in some large private installations. The testimonials contained on the list show the high esteem in which these brushes are held. We are informed that 50,000 of these foliated brushes were adopted by 1,500 users in France alone during the second year of their being brought out. The company are also agents for Labour's self-exciting alternate-current generators and transformers, and direct-current dynamos made under Rechniewsky's patent.

Gloucester.—The minutes of the City Council stated that the town clerk reported that he had received from the undermentioned companies formal notices of intention to apply to the Board of Trade for a provisional order to supply electricity for public and private purposes within the city of Gloucester: the County of London and Brush Provincial Electric Lighting Company, Limited; the Great Western Electric Light and Power Company, Limited. Alderman Holtham, in drawing attention to this, said he understood the Corporation had themselves applied for a provisional order; if not, they ought to oppose the applications of these companies, as if anything was to be made out of supplying the city with electric light the Corporation ought to get the benefit of it. The Town Clerk said it was understood the Council refused the applications made by the companies.

Hastings.—The Roads Committee of the Town Council have reported that they had received from the secretary of the Hastings and St. Leonards-on-Sea Electric Light Company, Limited, formal notices in accordance with the requirements of section 14 of the company's provisional order of the intention of the company to construct in connection with their works two circuit chambers under the public pavements—viz., one opposite the Royal Saxon Hotel at the bottom of London-road, and the other at the upper side of the junction of Silchester-road with London-road—as shown on plans. The plans for the chambers have been approved by the Council, subject to the works being carried out to the satisfaction of the borough surveyor, and to the company undertaking not to remove the upper surface or cover of either of the chambers except between the hours of 10 p.m. and 9 a.m., unless in case of actual emergency.

Aberdare.—On Tuesday evening a meeting was held at the Boot Hotel to arrange for the electric lighting of the centre of the town. Mr. D. Williams, the high constable of Aberdare, presided, and Mr. J. C. Howell, of Llanelly, in an exhaustive speech, explained the present position of affairs. Some 12 months ago Mr. G. George, J.P., consulted them as to the possibility of forming a co-operative scheme for the lighting of the business premises in the town. They found that this project was impracticable, and applied to Parliament for a provisional order to light the centre of the town. This had now been obtained, and the purpose of that meeting was to make arrangements for the formation of a company to carry out the provisions of the provisional order. After a lengthy conversation an influential committee was appointed to visit Pontypool, and to report to a subsequent meeting. Mr. P. T. Rhys acted as the solicitor for the promoters.

Kingston-on-Thames.—The minutes of the Lighting and Market Committee of the Town Council stated that tenders were opened for the supply of a gas or oil engine for the electric lighting works, and it was resolved that the tender of Messrs. Robey and Co., at £126, be accepted. The borough electrical engineer was directed to alter the arc lamps in the Market-place at Mr. Whaley's and Miss Manger's corners at once. The chairman reported that five arc lamps in London-street and three in High-street could be removed, and it was resolved that five arc lamps be extended up London-road as far as they would go, and that two lamps be erected in Eden-street and one in Portsmouth-road. Resolved, that the Council be recommended to draw a cheque for £100 to the borough surveyor, on account of commission, etc., in connection with the erection of the electric lighting works. The borough surveyor was directed to put in the concrete foundations for the new engine and dynamo. The minutes were approved of.

Salisbury.—The General Purposes Committee of the Town Council reported that at a meeting on July 9 the town clerk informed them that he had, by direction of the Mayor, communicated with Mr. R. Hammond, London, consulting electrical engineer, with respect to his consenting generally to advise the Council on the various matters dealt with in the license sought for by the Salisbury Electric Light and Supply Company, Limited, for the inclusive fee of £50 He read letters connected with the matter, and the committee resolved that Mr. Hammond should be engaged. The town clerk was directed to inform him of the engagement, and to forward to him a copy of the proposed license, with a request that he would peruse the same and then make an appointment for a meeting with the committee to discuss the matter. The committee further reported that at a meeting on July 18 Mr. Hammond attended and discussed various matters connected with the application, and they resolved that he should be requested to prepare a written report for personal submission at a committee meeting of the Sanitary Authority. The report was adopted.

Bowness.—The Local Board have received a notice from the Windermere and District Electricity Supply Company to apply for a provisional order to supply electricity for lighting purposes in the district. The Clerk stated that if the Board gave its sanction, it would be tying its hands; though, on the other hand, if a company supplied the district, the Board would have a certain amount of power, and could take proceedings if the work was not done to its satisfaction. He would suggest that the Board should not give its sanction without an equivalent. It was a new company, though it might perhaps be composed of the same people that they were already acquainted with. If the Board sanctioned the application without an equivalent, it would leave itself in their hands The Chairman took it that the position was practically this, that if anyone wished to have electric light introduced into a dwelling in Bowness, he would simply have to come to the Local Board and asked permission to break up the road to the necessary extent, and the Board would grant it. Mr. Harrison proposed that sanction be withheld until they saw what others were doing, which was seconded by Mr. Westlake, and carried.

"Medical Battery" Company.—Messrs. John H. Lile, A. L. Poulter, and L. J. Greenberg, creditor members of the committee of inspection of the "Medical Battery" Company, Limited (in liquidation), have issued the following circular: "We are glad to inform you that the Court has sanctioned a scheme of arrangement for the reconstruction of this Company. The scheme provides, amongst other things, that the new company shall issue to the creditors of the old company fully-paid 7 per cent. preference shares of £1 each to the amount of their debts, and also for the issue by the new company of first mortgage debentures of £10 each to the amount of £3,000 charged on all the property and assets of the Company whatsoever, bearing interest at the rate of £10 per cent. per annum, payable half yearly, and repayable as to principal by yearly drawings of £500, the present debenture-holders postponing their security. The furniture, fixtures, electrical plant (including statical and other appliances). 'Zander Mechanical Exercises,' etc, at 52, Oxford street, and 3, Rathbone-place (exclusive of patents, leases, and goodwill), have recently been valued by Messrs. Baker and Son, of 11, Queen Victoria-street, E.C., to realise at sale by auction £5,405."

Birkenhead.—The Finance Committee of the Town Council recommended the acceptance of plans prepared by Mr. J. N. Shoolbred for the erection of the central electrical generating station, and that the town clerk submit them to the Local Government Board. Alderman Deakin moved, and Mr. Gostenhofer seconded, the adoption of the minutes. Mr. Cook asked if the Council would be committed to all the details of the plans if the resolution were passed, or if they would come up for further consideration at some subsequent period. He had only had the opportunity of looking them over that day, but the inspection he had had did not lead him to think that they were the best adapted for the purpose. He suggested that a little time be allowed the Council to consider the plans. He would have to vote against them if that course were not adopted. Mr. Gostenhofer said it was rather difficult to know what course one was to pursue if plans in all cases were to be left open for reconsideration at the suggestion of any gentleman who did not like them. However, he did not know the public service would suffer very much if the confirmation of the plans were delayed. Alderman Deakin said the committee were in no hurry whatever, and on their behalf he agreed to postpone the consideration of the plans till next Council meeting. The minutes were then confirmed subject to that understanding.

Wrexham.—The Town Council have received a letter from Messrs. Lewis and Son, solicitors to the Electric Supply Company, Limited, stating that, for the information of the Board of Trade, they now asked whether to facilitate matters the local authority would promote a fresh provisional order. The Board of Trade sent down for the observation of the Council the following letter they had sent to Messrs. Lewis and Son: "In reply to your letter of the 30th ult., enclosing a memorial of the undertakers under the above-mentioned order and the Corporation of Wrexham praying the Board of Trade to authorise the transfer of the rights and powers of the undertakers under the order to the Corporation, I am directed by the Board of Trade to inform you that as the undertakers have not constructed any works under the order, they do not appear to possess any undertaking which in the opinion of the Board of Trade, as at present advised, could properly be purchased by the Corporation. I am further to state that the order does not appear to provide for the acquisition by the Corporation of the undertaking authorised by the order before the expiration of the time prescribed by section 2 of the Electric Lighting Act, 1888—viz., 42 years from the date of the commencement of the order. I am to add that if the Corporation desire to obtain statutory powers to supply electrical energy within their district, the Board of Trade will be prepared to consider the expediency of revoking the company's order, and granting a fresh order to the Corporation.—I am, etc., Francis J. S. Hopwood." The Town Council decided to agree to an extension of six months.

Folkestone.—The Town Council have had under consideration the scheme, outlay, and arrangements to be proposed by Mr. Daniel Baker, and matters incidental thereto, in relation to the adoption of the electric light. Mr. Baker was not present. Councillor Tolputt moved that it be adjourned for a month. The Town Clerk stated that Mr. Baker himself said he would be perfectly ready if that meeting was adjourned as usual for a fortnight. It was said in reply that there would be no adjournment. Councillor Thompson made some very strong remarks on the conduct of Mr. Baker. He said he had to draw the attention of the Council to this fact, that Mr. Councillor Baker, in that chamber and elsewhere, stated publicly that he had a scheme ready, all prepared and drawn up, under consultation with an engineer, to submit to the Corporation, but he could not bring it forward till the scheme of the Electric Lighting Committee was withdrawn. He said, moreover, that as soon as the Electric Lighting Committee's report was withdrawn he would produce his scheme. Were they, he asked, going to have that original report treated with any further contempt? If they went on in that way they would see that a company would apply for a provisional

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order, and they would get it. Councillor Pursey thought the best course would be to restore the report on the agenda for next month. They ought to make an effort to let the public see that it was wrecked by Mr. Baker and other gentlemen. After considerable discussion, it was resolved, on the motion of Councillor Payer, seconded by Councillor Tolputt, that both matters be placed on the agenda paper for September.

Dewsbury.—The buildings of the Corporation electric lighting station are now almost completed. The station occupies part of the site of the old gasworks in Bradford-road, and is bounded on the east by Bradford-road, on the north by Mill-street and the beck, by the beck again and another thoroughfare, while on the south are buildings belonging to the Corporation, and at present let for other purposes. The principal structure occupies a site behind the old gas offices. This building is one externally of six bays, and is lighted from the roof, also on the east side, by circular-headed windows, and by windows with square heads at the north end. The structure is divided by a wall running from north to south, which thus forms two large rooms, one the engine-house and the other the boiler-house. The interior walls of the former, with the exception of the southern gable, are constructed of white glazed bricks, and that would have been similarly built had not the committee been of opinion that large as the structure is it may require extension, and such could only be done on the south side. In the engine-house there are to be two engines one of 200 h.p. and the other of 100 h p., made by Messrs. Willans and Robinson. The dynamos are being made by Messrs. Crompton, of London, if not already constructed, and are to occupy a place near the north end of the engine-house, and close to the switchboard. Further north, but still within the building, is the battery-room. Above the room a tank is placed, and below it is the condenser-room. The octagonal chimney is at the north-west end of the main building, and will be 126ft. high. Passing through a doorway in the west wall of the engine-house, the boiler-house is reached. There are three boilers, each 28ft. long by 7ft. in diameter, made by Messrs. J. and J. Horsfield, of Dewsbury. Each is being fitted with a mechanical stoker, by Messrs. Bell Bros., of Manchester, and adjoining is to be an economiser, by Messrs. Green. To work the stokers, two small engines are to be put down. Mr. Preece has designed the installation and advised the Corporation generally, and Mr. A. K. Greener, A.I.E.E., is acting for that body as superintendent of the electric lighting works. Mr. Marks, C.E., the borough surveyor, has designed the building, and Mr. Thomas Kelly is the clerk of works.

PROVISIONAL PATENTS, 1894.

JULY 30.

14570. **An automatic electric contact.** George Hussey, 14, Turner-street, Clitheroe, Lancs.

14580. **Continuous electric brakes for railway trains.** Alexander Young, 2, Merchiston Bank-terrace, Edinburgh.

14602. **Improvements in controlling apparatus for electro-motors.** Jean Baptiste Gustave Adolphe Canet and André Hillairet, 46, Lincoln's-inn-fields, London. (Complete specification.)

14607. **Improvements in electric cable traction apparatus.** Richard Lamb, 53, Chancery-lane, London.

14614. **Improvements in electric-magnetic motors.** Arthur Hopkins Beard, 43, Chancery-lane, London.

JULY 31.

14634. **Galvanic battery.** Charles Edward Buell, 62, St. Vincent-street, Glasgow. (Complete specification.)

14642. **Electrical battery.** Victor Isidore Feeny, 60, Queen Victoria-street, London. (Fred Dubero and Peter Mohrdieck, United States.) (Complete specification.)

14651. **Improvements in electrical heating devices.** George Cecil Dymond, 6, Lord-street, Liverpool. (Joseph Arthur G. Trudeau, Canada). (Complete specification.)

14689. **Improvements in secondary batteries.** Francis Tallack, Francis William Tallack, and Louis Héndlé, 10, Great Turnstile, Holborn, London.

AUGUST 1.

14765. **Improvements in apparatus for electrically effecting the reproduction at a distance of graphic matter or designs written, printed, stencilled, photographed, or otherwise produced.** Rupert Greville-Williams, 22, Southampton-buildings, Chancery-lane, London.

14768. **Improvements in electric arc lamps.** Alfred Lyster Shepard, 8, West Kensington-gardens, London.

14769. **Improvements in or relating to apparatus for the production of sulphuric acid by the aid of an electric current.** Richard William Hill, 54, Fleet-street, London.

AUGUST 2.

14841. **An improved diaphragm for phonographs and similar sound-recording and sound-producing machines.** Walter Edward Hunnex, 19, Morland-road, Croydon.

14847. **Improvements in the means for storing electric energy.** John Evelyn Liardet, 9, Warwick-court, Gray's-inn, London.

14858. **Improvements in the purification of saccharine juices by electrolysis.** James Yate Johnson, 47, Lincoln's-inn-fields, London. (Emile Javaux, Charles François Gallois, and François Dupont, France.)

14850. **Improvements in the manufacture and production of filaments or incandescing media for electric lamps.** Rudolf Langhans, 47, Lincoln's-inn-fields, London.

14859. **Improvements in or connected with means for the supply or distribution of electricity.** William Godson Little and Charles William Godson Little, 47, Lincoln's-inn-fields London.

AUGUST 3.

14922. **Electrically-worked apparatus for regulating signals.** Wilhelm Fiedler, 67, Chancery-lane, London. (Complete specification.)

14926. **Improvements in electric telegraph and signalling apparatus.** Frederick Thomas Hollins, Saltley House, Forest Drive, Leytonstone, London.

AUGUST 4.

14988. **An electrolytic table.** William Lloyd Wise, 46, Lincoln's-inn-fields, London. (Ernest Solvay, Belgium.)

15000. **An improved wind motor for driving electric machinery and other purposes.** Honoré Soifranc, 18, Buckingham-street, Strand, London.

15004. **Improvements in telephone installation.** George Ritter, 76, Chancery-lane, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1893.

13533 **Clip for extracting and replacing electric fuses.** Hutchins.

14056. **Electrolytes for primary batteries.** Longsdorf.

18911. **Electrical contact apparatus worked by passage of railway trains.** Tyer.

18912. **Electrical railway signalling apparatus.** Tyer.

23170. **Electrical transformers.** Miller and Woods.

1894.

8061. **Electro-chemical decompositions.** Carmichael.

8086. **Electric alarm for pressure gauges.** Bradt.

10658. **Electric bells.** Goldby. (Neumann.)

10659. **Suspending incandescent electric lamps.** Goldby. (Neumann.)

11418. **Telephone transmitters.** Kingsbury. (Western Electric Company.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	5	5½-5⅝
Bournemouth Electric Company	—	—
Brighton and Hove Company Original	100	210-215
—— "A" Ordinary	—	162-166
Brush Company, Ordinary	3	2⅞-3
—— Nom. Cum, 6 per cent. Pref.	2	2½-2⅝
—— 4½ Debenture Stock	100	110-113
Charing Cross and Strand	5	4½-5½
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	12½-13½
—— 6 per cent. Cumulative Pref.	10	14-14½
—— 5 per cent. Debenture Stock	115	128-131
City and South London Railway, Consolidated Ordinary	100	36-38
—— Debenture Stock	100	120-122
—— 5 per cent. Pref. Shares	10	12⅞-13½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	96-100
Electric Construction, Limited	2	⅛-⅜
—— 6 per cent. Debentures	—	87-92
—— 7 per cent. Cumulative Pref.	2	1½-1¾
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1-1⅛
Elmore's French Company	2	⅛-⅜
Elmore's Wire Company	2	⅛-1
Fowler-Waring Cables	5	½-1½
W. T. Henley's Telegraph Works, Ordinary	10	7-8
House-to-House Company, Ordinary	5	1-1⅛
—— 7 per cent. Preference	5	5½-5⅝
India Rubber and Gutta Percha Works	10	23-24
—— 4½ per cent. Debentures	100	103-105
International Okonite, Ordinary	—	—
Kensington and Knightsbridge	5	4⅞-5½
—— 6 per cent. Pref.	—	6½-6⅝
Liverpool Electric Supply, Ordinary	5	6½-6⅝
—— Pref.	—	—
Liverpool Overhead Railway	10	8 5/16-8 7/16
—— Pref.	10	13-13½
—— 4 per cent. Mortgage Debentures of £100	100	111-113
London Electric	5	¾-1½
Metropolitan Electric Supply	10	8¼-8¾
—— 5 per cent. Reg. Debentures, 1-10,000 in Bonds of £10, £20, and £40	—	—
National Telephone, Ordinary	5	4¾-5
—— 6 per cent. Cum. First Pref.	10	14-15
—— 6 per cent. Cum. Second Pref.	10	13½-14½
—— 5 per cent. Nom. Cum. Third Pref.	5	5⅜ 5⅝
—— 4½ per cent. Deb. Stock	—	109-112
Notting Hill Company	10	4½-5½
Oriental and Electric Company, £1 shares	1	1-1½
—— £5 Shares	—	6½-6⅝
—— £4½ shares	—	6½-6⅝
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7-7½
—— 7 per cent. Pref.	5	8½-9
Swan United	—	—
Telegraph Construction and Maintenance	12	40-42
—— 5 per cent. Bonds	100	102-105
Westminster Electric Supply, Ordinary	5	6-6½
Yorkshire House-to-House	4½	4¼-4¾

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NOTES.

Market-Lighting.—The new market at Pontypool is to be lighted by electricity.

New Cable.—The Ceylon authorities have decided to lay a new cable to India *viâ* Paumben and Talumannar.

Dynamos in Russia.—It appears from a Russian contemporary that the construction of dynamos is not yet carried out on a large scale, and that those made are extremely high priced.

Burma and China.—It is stated that the construction of the telegraph line between Burma and China is being carried out under the superintendence of a European official in the employ of the Chinese Government.

Electrical Trade Section.—At a meeting of the Electrical Trade Section of the London Chamber of Commerce held on Tuesday last, Mr. E. Garcke presiding, Mr. Sydney Morse was unanimously elected a vice-chairman of the section.

Crystal Palace School of Engineering.—There was a large gathering last week of the friends and students belonging to the Crystal Palace School of Practical Engineering on the occasion of the distribution of the certificates gained during the summer term.

Overhead Travellers.—In connection with the extension of the West India Dock, which was opened yesterday, overhead travellers worked by electric motors have been installed for the purpose of manipulating timber in large logs. The results have been eminently satisfactory.

Carborundum.—The production of this material, to which we have referred on previous occasions, has been undertaken at Benatek, in Austria-Hungary. The results have been so successful that it has been decided by the Landerbank of Vienna to establish large works in Austria and in France.

The Century of Electricity.—M. L. Mascart, in the course of his presidential address delivered last week before the Association Française pour l'Avancement des Sciences in congress at Caen, remarked that whatever our successors may witness, we are able to say that the nineteenth century will be justly called the century of electricity.

Electric Traction in Germany.—Approval has been given to the construction of an electric tramway from the Pillau railway station to Augusta-strasse, Königsberg. The Municipality of Altendorf, near Essen, have sanctioned a proposal for an electric tramway to Essen-Frohnhausen, and its extension to Heissen and Mülheim-on-the-Ruhr.

Obituary.—The death has just occurred, at the age of eighty-one, of Mr. Charles Liddell, a well-known railway engineer. The deceased, as a partner in the firm of R. S. Newall and Co., at one time took an active part in the laying of telegraph cables. During the war in the Crimea it is reported that he laid the cable between Varna and Balaclava.

Electrical Exhibition at Worcester.—An exhibition of electrical appliances is to be held in the Public Hall at Worcester in October, on the occasion of the opening of the Corporation electric lighting works. Those who are desirous of exhibiting are requested to communicate with Mr. F. R. Davenport, secretary, Electrical Exhibition, Guildhall, Worcester.

Lighting at Seville.—A company has been registered in Seville under the title of the Sociedad Sevillana de Electricidad, with a capital of £80,000. The company propose to commence the laying of cables at the end of September or beginning of October, and it is expected that such progress will be made with the installation that it will be possible to supply the electric light at the end of May of next year.

Overhead Copper Wires.—The subject of the strain upon overhead copper wires, and the influence of temperature upon them, is discussed by Mr. Josef Herzog, of Budapest, in the *Elektrotechnische Zeitschrift* of the 9th inst. The author deals mainly with telegraph and telephone wires, and gives a graphic representation showing how to ascertain the strain for given wires over given distances and at different temperatures.

Electric Lighting in Switzerland.—The Rathausen supply station, Lucerne, will be now carried out, a Zurich banking firm having provided the necessary money. The Lucerne Municipality intend to buy the central station at Thorenberg belonging to Messrs. Troller Bros. and Co., which furnishes current to all the present private consumers and part of the public lighting. This station, of about 600 h.p., is, however, not large enough, and the town will erect a second station.

Canal-Lighting.—The great advantage of the electric light in the saving of money and time is illustrated in a return just made of the average time occupied by ships passing through the Suez Canal. With the electric light, the journey is accomplished in eight minutes under 20 hours. Without the light, 31 hours and 24 minutes are required. The percentage of ships using the electric light steadily increases. In 1892 it was 83 per cent. Last year only eight ships out of a hundred dispensed with its use.

Gas and Electricity at Newport (Mon.).—The chairman of the Newport Gas Company (Mr. E. J. Phillips) remarked at a meeting of the company on Monday that it was possible that the electric light installation which the Corporation were about to make would affect the company to some extent, but that the electric light could not be produced to compete with them. It would, he thought, be a luxury to those who wished to use it. Evidently Mr. Phillips has not made himself acquainted with the progress made in electric lighting.

Rope versus Belt Driving.—With a view to deciding the comparative merits of rope-driven and belt-driven plant, the Société Industrielle du Nord de la France instituted a series of experiments to determine the power absorbed in transmission by ropes and by belts. These trials were made last week at the works of M. Dujardin, a compound steam-engine of 200 h.p. driving a dynamo capable of energising up to 1,400 incandescent lamps being used for the purpose. *L'Industrie Electrique*, from which this item is taken, states that it will publish the results of the trials on a future occasion.

Gas and Electricity.—At Wednesbury complaints have been made at a meeting of the Wednesbury Town Council that the quality of the gas supplied is very bad, and one alderman testified to it being sometimes so poor that he had to use a candle. Mr. Griffiths, of the Gas and Water Committee of the Council, mentioned that the question of adopting a system of electric lighting had engaged their attention, but it was, he feared, too big an order to be entertained just now. Under the circumstances, however, we should say that the sooner Wednesbury gets the electric light introduced, the better it will be for the comfort of the inhabitants.

And So Say All of Us.—The report just issued by the North-Eastern Sanitary Association for the year 1893-94 contains the following note concerning the electric light: "The *pros* and *cons.* relating to this subject, as regards the home, were fully stated in last year's report. Con-

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trasted with all other illuminants it is wholly beneficent—it is purity *v.* foulness in air food. It should therefore be adopted by all who possibly can do so, and it pays so to do. Class it as a primary and you must gain by the exchange whatever sacrifice may be necessary to secure it—gain in health, in mental vigour, which inevitably suffer from breathing air vitiated by gas, etc."

The New Blackwall Entrance Lock.—This lock was opened yesterday. A large party proceeded to Brunswick Pier, embarked upon a steamer, and steamed to the entrance lock. The party then entered the lock and disembarked. The chairman of the London and India Docks Joint Committee opened the middle gates, and after inspection of machinery the party re-embarked, and the steamer proceeded through the lock, cutting the ribbon just across the centre. The party next steamed through the cut into the import dock to the west end, landed on the north quay, and worked their way up to the West India Dock Station, returning by train to Fenchurch-street.

Automatic Telephone Exchanges.—In our issue of the 15th June last our correspondent briefly referred to the Nissl automatic telephone exchange system, which was decribed by Mr. F. Ross before the second annual meeting of the Union of German Electrical Engineers at Leipsic. Those who are desirous of learning the details of the method will find an illustrated description of it in the *Elektrotechnische Zeitschrift* of the 9th August, and a similar account in the New York *Electrical Review* of the 1st August. It will be remembered that the principle of the system lies in the use of a single wire for several subscribers to an exchange, but the method has not yet been practically employed.

Electric Lighting in Germany. — In connection with the central electricity station to be erected in Dresden the Municipality intend to keep the plant for lighting purposes separate from that for the supply of power to the electric tramways. The power station in Pfotenhauerstrasse will be extended, and will furnish current to the Blasewitz line of the Deutsche Strassenbahn Gesellschaft. At Steinau-on-the-Oder good progress is being made in connection with the central station; it is expected to be ready by October. The demand for current from the central station at Altwasser, which is owned by Herr Wunder, has largely increased, and the installation is to be extended in consequence.

"Dynamo Attendants and their Dynamos."—Under the title of "Dynamo Attendants and their Dynamos" Mr. Sidney Rentell, of 29, Ludgate-hill, E.C., has published in book form, at the price of 1s., a series of articles which originally appeared in the columns of our contemporary *Electricity* from the pen of Mr. Alfred H. Gibbings, A.I.E.E., electrical engineer to the Corporation of Hull. The booklet is divided into 10 chapters, dealing with the dynamo-room, the dynamo, the dynamo as designed for different purposes, causes and prevention of sparking, principal causes of failure of action, faults, repairs, instruments, compound circuits and dynamo coupling, and economical work. The work should be useful to those attending to dynamos both in private installations and in central stations.

Mysterious Action of Alternating Currents.—An eminent consulting electrical engineer brought an extraordinary case of the mysterious action of alternating currents before Section G of the British Association. Alternating leads were carried into Mappin and Webb's through separate iron pipes, and the consulting electrical engineers were astounded to find there was a drop. After investigation it was found that the iron pipes had some mysterious action. Another case came to our knowledge some years ago. A house was installed with two thick mains with lamps across. The mains were also joined at the far end. It was found that when the dynamo was coupled on there was always a short-circuit. After careful investigation by several consulting engineers it was found that when the leads were separated at the far end things went better.

The "Submarine Sentry."—A correspondent writes to the *Times* as follows: "Notice has been given that, owing to the outbreak of war between China and Japan, lights on the Formosa coast have been extinguished, and no doubt others, both in Japan and China, will also be put out, or false lights substituted, to suit the purpose of either. Under the circumstances it will be necessary for all steamers navigating these waters to be extra careful, and I would suggest that one of the best precautions is to use the 'submarine sentry,' as with its use in nearly every instance a vessel going at 10 knots can be assured that she has at least 20 fathoms of water under her keel, and warning given on board if less depth is reached, thus giving ample time for position to be verified." It will be remembered that the "submarine sentry" is an electrical arrangement devised for giving the warning mentioned.

Electric Traction in Hungary.—It is proposed to construct an electric tramway from Budapest *viâ* Uj-Pest (Newpest) to Rakos-Palota, and the matter is now under the consideration of the Minister of Commerce. At Pressburg an electric line is about to be built both for goods and passenger traffic. With regard to the projected underground electric railway in Budapest, to which we have occasionally referred, it now appears that the Minister of Commerce has approved the principle of the line. In this connection a telegram from Vienna on Monday last states that the Hungarian Minister of Commerce has granted a concession for the construction of an underground electric railway in Pest. This line will be two English miles in length, and will pass from Giselaplatz to the Thiergarten. It will be the first electric underground railway in continental Europe. It is to be opened on April 1, 1896.

New Electric Locomotives.—It is stated that the Compagnie des Chemins de Fer de l'Ouest, as a result of the experiments made with the Heilmann locomotive, have just ordered two new locomotives from the Société de Traction Electrique, who, it will be remembered, work the Heilmann patents. Certain improvements and modifications suggested by the trials of the original engine will be embodied in the new locomotives with a view to the construction of a definite type. The steam-engine chosen as best fulfilling the working conditions is the Willans. It is further stated that Messrs. Willans and Robinson, through their French agent, M. A. H. Crozier, have been commissioned to deliver by January or February next two steam-engines, each of 1,500 h.p. It is intended to conduct experiments with the new locomotives in May, 1895, and if the results are conclusive it is reported that the Heilmann locomotive will be definitely adopted.

Search-Lights on War Vessels.—It appears that search-lights were indiscriminately used during the naval manœuvres, the result of which in the case of actual war would probably be disastrous to vessels belonging to the same nation. For instance, the night alarm early on the 6th inst. at Belfast, when the Red squadron imagined that they were being attacked by Blue torpedo boats, shows the danger there would be in war time of friendly ships firing into each other amidst the confusion of a night attack, and also the necessity for greater discretion in the use of electric search-lights. A search-light properly handled may be

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found of great assistance, but the reckless and indiscriminate flashing of these lights in every direction by every ship of the squadron attacked only has the effect of blinding and dazzling the officers and men in the threatened ships, and of giving additional security as well as a brilliantly illuminated target to the attacking torpedo boats.

Train-Lighting.—With reference to the editorial comments on this subject in our last issue, it is to be regretted that the Midland Railway Company have decided to abolish the use of the electric light on their trains. Mr. G. E. Paget, the chairman of the company, made an official announcement to this effect at a meeting of the company on Friday last. He stated that it was to him a source of great disappointment when this had to take place, for the light was a beautiful one. Unfortunately, he remarked, it was very costly and not sufficiently reliable, and they had been obliged to adopt a fresh system. They had not yet arrived at the perfection of train-lighting, but he thought they would agree with him that oil-gas was an exceedingly good light, and better in every respect than oil lamps. So it is, but it is a most unfortunate step to renounce the electric light, which is still better than gas. The Midland Company have always considered the comfort of their passengers, but on this question of illumination, and after the above decision, they can hardly be considered to be doing so in this respect.

Electric Traction in Switzerland.—An electric tramway has been projected for a long time at Basle, and arrangements have now been made by the Municipality with Messrs. Siemens and Halske, of Berlin, and Messrs. R. Alioth, of Basle-Mönchenstein, to carry out the work. The town will pay the cost of construction, but the two companies concerned will work the line for two years. The overhead system is to be adopted. The first section to be constructed will connect the Badisch railway station with the Central railway station, will pass over the old Rhine bridge, and through the busiest street of Basle-Stadt and Basle-Dorf. The line will be about two miles in length, and for the most part will have a double track. The gradients are as high as 1 in 20. It is proposed to have 12 motor cars, with which a three-minutes' service will be maintained. It is expected that the line will be opened for traffic by next spring.—Some months ago we referred to the proposal brought forward to construct an electric tramway in Fribourg. A committee appointed to consider the subject has now issued its report, from which it appears that the scheme is progressing satisfactorily.

Lighting of the Houses of Parliament.—In the House of Commons a few days ago Mr. H. Gladstone, in reply to a question, stated that the matter of providing the Houses of Parliament with an electric light installation had already received careful consideration. The evidence before him showed that no complete installation of electric lighting machinery and plant could be established within the building without occasional serious interference with its proper ventilation, and they had already some experience with a partial installation which confirmed that view. The generation of electricity within the building had been abandoned both for this reason and because the boilers now existing were no longer strong enough to bear the strain of working both the ventilation and lighting systems. The cost of constructing a complete electric station outside the building in connection with the warming and ventilating arrangements had been considered, and it would probably reach £30,000 or £40,000; while the expense of wages and maintenance would also be very heavy. The subject would receive further attention, but, having regard to all the circumstances of the case, it must be deferred for the present. Taking into account the capital outlay, he was not at all prepared to admit that the saving would be any thing like that suggested.

Electric Lighting at Geelong.—According to the *Melbourne Argus* of July 18, under the heading of Geelong, "efforts have been made by the municipalities to obtain the introduction of the electric light to the streets of the town and suburbs, and matters have so far progressed that the question has now only to be decided by the individual councils interested. Last night a conference of the representatives of the Geelong Town and the Newton and Chilwell and Geelong West Borough Councils was held in the Town Hall in Little Malop street. It was held for the purpose of adopting or rejecting certain recommendations made by a sub-committee from the conference. These, in effect were that the conference should accept the offer of the Crompton Electric Supply Company to give a complete electric installation for the sum of £15,150. Considerable opposition was manifested, many of the councillors present being of opinion that tenders should be called for the electric light service, but the resolution to adopt the sub-committee's recommendation was carried by 12 votes to 8. The next stage in connection with the question is to acquaint the different councils with the determination of the conference, and they will be asked to give effect to the resolution carried adopting the sub-committee's recommendation for the acceptance of the offer of the Crompton Company."

Electrical Measuring Instruments.—A handy price-list of electrical measuring instruments has reached us from Messrs. Nalder and Harrison, of Trafalgar House, Great Newport-street, W.C. The instruments constructed by the firm are the result of several years' practical testing and supervision of all classes of electrical instruments, and the improvements suggested by that experience have been embodied in the types which are illustrated in this list. There are two classes of instruments. The first, or standard type, is claimed to be absolutely free from the errors inseparable from even the best type of meter containing iron; the second comprises those containing iron, and which are made so that an accuracy sufficient for all practical purposes can be guaranteed. The ammeters, which are for alternating and direct current, range in capacity from 20 to 300 amperes. The magnetic movement actuating the pointer is designed according to the Harrison patents, a combination which reduces to a minimum the error due to hysteresis, and at the same time allows of any type of scale being obtained. The voltmeters are similar in action to the ammeters, and they are made in both the gravity and marine types. Among other instruments mentioned in the list is a recording voltmeter for direct current, and which is constructed so sensitive as to record a variation of less than 0·3 per cent. A recording ammeter for alternating or direct current is also referred to, the object being to obtain the maximum amount of force moving the registering pen with the minimum consumption of electrical energy. This object has been attained by an arrangement of the magnetic field which concentrates the force of the movement actuating the recording pen. The remainder of the price-list is devoted to portable testing sets, standard voltmeters and wattmeters, and standard ammeters, switchboards, switches, etc.

Commercial Efficiency of Accumulators.—In *L'Industrie Electrique* of August 10, M. Hospitalier publishes some particulars of the commercial efficiency of accumulators obtained during the present year. These batteries, which are of the Laurent-Cély type, are used by the Paris company having lighting powers in the Place Clichy district, and whose central station is situated in the Rue des

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Dames. There are two batteries installed, each consisting of 250 cells. Each cell contains 23 plates suspended from their upper ends; the positive plates are 8mm. and the negative plates 6mm. in thickness, and the total weight of a cell is 3cwt. The working conditions of the cells are as follow:

	Discharge in amperes.	Capacity in ampere-hours.
Normal	250	2,000
Strong	340	1,700
Maximum	450	1,350

During the working of the generating plant, the power not required for lighting is used for charging the batteries. To obtain at the battery terminals the difference of potential necessary for the total charge, a supplementary dynamo, termed a pressure raiser, is added in series with the large lighting dynamos. The two batteries meet the whole of the requirements of the district during the stoppage of the machinery; they can be connected in quantity in case the discharge becomes too intense for one to deal with. This operation frequently takes place from midnight to about 1 a.m. The batteries are used on alternate days. The writer then gives a tabular statement of the discharge and charge during the first five months of the current year. It appears from the figures that the energy efficiency amounted to 65·5 per cent. in January, 67·9 in February, 70 in March, 69 9 in April, and 71·8 per cent. in May, being an average efficiency of 69 per cent.

Formation of Floating Metallic Films by Electrolysis.—In the *Ann. Phys. Chem.*, Messrs. F. Mylius and O. Fromm deal with this subject. It appears that during the electrolysis of a concentrated zinc sulphate solution, it was observed that the cathode wire became surrounded by a film of metallic zinc floating upon the surface of the solution, the film increasing gradually to a considerable size. A somewhat similar observation has been made by F. Kohlrausch in the case of the electrolysis of a solution of silver chloride in ammonia, and the authors have therefore been led to study the conditions under which the formation of such films takes place. Experiments made with zinc sulphate and ammoniacal silver chloride show that the two principal necessary conditions are an impure state of the surface of the solution, and the presence of oxygen in the atmosphere above the solution. If the surface is perfectly clean formation of a film is not observed, whilst, on the other hand, the addition of the smallest trace of any oily impurity, such as turpentine, which will float upon the surface, favours the film formation. If the air above the liquid is replaced by hydrogen, carbonic anhydride, or nitrogen, the film is not formed. Observations with both the zinc and silver films point to the presence of some trace of oxidised metal in the film, and if the surface of the solution is covered with an oil that has been completely freed from dissolved oxygen the film is not formed. In other cases the formation of a film below the surface of the liquid, as at the boundary between the solution and a heavy oil-like chloroform, is possible. Films were also obtained from copper, cadmium, cobalt, iron, and antimony solutions. When the copper solution is treated with a solution of sulphur in a mixture of benzene and carbon bisulphide, the surface film consists chiefly of cuprous sulphide, and a solution of iodine in benzene on the surface of silver sulphate gives rise to the formation of a silver iodide film.

Alabaster and Others v. Harness.—Judgment was given in this action last week by Mr. Justice Hawkins in the Queen's Bench Division. The plaintiffs are the proprietors of the *Electrical Review*, and the defendant, Mr C. B. Harness, was the manager of the "Medical Battery Company. The plaintiffs were successful in an action brought against them by Dr. Tibbits for alleged libel, but they were unable to recover their costs, and they now sued Mr. Harness, alleging that he was really maintaining the plaintiff in the action. Mr. Justice Hawkins, in giving his decision, said, after the judgment of Lord Chief Justice Coleridge in Bradlaugh *v.* Newdigate, he need not take very much time over the present matter. The counsel for Mr. Harness, Mr. Jelf, did not deny that the defendant did maintain Dr. Tibbits, but contended that the defendant believed he had a common interest. Whether that were so or not was the point. His lordship had to determine the question, What was improper maintenance? The principle was laid down that it was maintenance of a party in a suit where the maintainer was not concerned. An exception was made in the case of aid given out of charity to a poor man. It could not be suggested that the support of Mr. Harness was due to a neighbourly action or to a charitable impulse. The point simply was had he, or did he believe he had, a common interest with Dr. Tibbits in the matter at variance. No doubt the article complained of by Dr. Tibbits attacked Mr. Harness also, but the comments on Mr. Harness and his belts did not make such a common interest in the suit as to justify maintenance. In no proper sense could a libel on Mr. Harness be treated as the matter at variance. It might seem hard that a man could not maintain a man who, in defending his own character, had almost necessarily to defend the character of the maintainer also. Did Mr. Harness reasonably believe in such a state of things as would have justified him in maintaining Dr. Tibbits? His lordship thought not. The verdict would be entered for the plaintiffs for the costs they claimed. Judgment was given accordingly. We congratulate Messrs. Alabaster, Gatehouse, and Co. on the result of this action.

Chloride Cells for Launch Work.—An interesting application of an electric launch took place on the 11th inst., on the occasion of the Goring-on-Thames regatta, when the new electric launch, "Aphrodite," was used by the Thames Conservancy for clearing the course during the day. This boat was built at Goring in Mr. S. E. Saunders's boatyard, and has been fitted up in a very superior style. It measures 35ft over all by 5ft. 3in. beam, and although built for comfort and not for speed, the most satisfactory results have been obtained in the latter respect. The arrangement of the electrical details has been carried out by Mr. H. A. Earle, of Messrs. Mather and Platt, Limited, 16, Victoria-street, Westminster. The novel feature consists in the employment for the first time on the Thames of a battery of chloride cells, a description of which we published some time ago. These cells are manufactured in England by the Chloride Electrical Storage Syndicate, Limited, of 16, Victoria-street, E.C., and the launch has been specially built in order to demonstrate their advantages for this class of work, their large capacity for a given weight enabling distances and speed to be run which were previously impossible without recharging. The cells with which the "Aphrodite" is fitted are capable of being discharged at a very high rate, and on the measured mile a speed of nine miles per hour has been obtained, and this rate, we are informed, can be continuously maintained for about three hours, being a record performance for an electric launch of this size. At slower speeds—namely, 6½ miles per hour, which is the usual rate of travel, and which is still considerably above the average speed of electric launches of this size—a day's run of nine hours can be undertaken, inclusive of the time taken through locks. One feature of the chloride cells is that although at very high rates of discharge their

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capacity for a given weight exceeds that of other types, their increased capacity at low rate is still proportionately greater, and on this account, with the reduced speed of 5½ miles per hour, the battery power with which this launch is provided is said to be capable of covering a distance of approximately 110 miles without recharging.

The Kiew Electric Tramway.—Although some time has elapsed since the construction and setting in operation took place of the electric tramway at Kiew in Russia, the first line of its kind in that country, some information concerning its principal features, more especially as the generating plant is driven by gas-engines, should prove interesting. The tramway commences at the Alexandrowski Place and connects the Padol, the commercial part of the town, with Krestchatique, the principal street of the holy city. The line is about two miles long, with gradients as high as 9·3 per cent. The generating station is situated about half-way between the termini, and as the tramway is a single line, turn-outs have been provided at various points. The station contains two direct-current bipolar dynamos, each having an output of 30 kilowatts. At a speed of 900 revolutions a minute each generator gives 30 amperes at 500 volts, and it is possible to overload them to the extent of 30 per cent. without abnormal heating. These machines, which were constructed by the Allgemeine Elektricitäts-Gesellschaft of Berlin, are each belt driven by an Otto two-cylinder gas-engine of 60 h.p., fitted with a double flywheel and running at 140 revolutions. There is also installed a 2-h.p. gas-engine, which is employed for starting the two large motors. The arrangement adopted for this purpose deserves notice. The small engine drives by belt a countershaft arranged under the floor of the station. This shaft carries two pulleys, which transmit a rotary movement by means of belts to two other pulleys, on the axes of which is arranged a friction cylinder. By means of a lever this cylinder is pressed strongly against the face of the flywheel and forces the latter to turn. This arrangement allows of the motors being started easily and rapidly. The gas required for the engines is obtained from the local gasworks; it is a mixture of coal-gas and of gas derived from the distillation of naphtha residuum. This mixture is good for illuminating purposes, but is not so suitable for gas-engines as is ordinary gas, consequently it has to be used at a higher pressure. The working of this tramway has been very satisfactory, and, as stated in a previous issue, extensions are shortly to be made.

Transmitting Pictures by Electricity.—One of the most interesting subjects before scientific societies at the present time is the problem of transmitting images to a distance by electricity. In this connection Mr. C. Francis Jenkins, in the New York *Electrical Engineer*, offers for what it is worth a theoretical device which may be added to the methods already suggested for the accomplishment of this object. His scheme contemplates the use of selenium for a receiver, and the apparatus is substantially as follows: A rectangular or circular non-conducting plate is set up behind a lens in such a manner as to receive the image or scene to be transmitted. This plate or board has upon its back a number of small short wires of selenium or sulphur, one end of each of which is thrust through the non-conducting board and immediately turned back, coming out again upon the same side and very near where it was thrust through. The face of the board is covered with these little loops, one end of each of which is joined to a common conductor, the other ends having separate conductors extending over the distance intervening between the transmitting and receiving stations. At the receiving end is a large flat electric lamp of ground glass with filaments in number and position corresponding with the loops at the transmitting station—a filament for each loop and in circuit with it. We now have a number of selenium loops, each upon a separate circuit, which are affected by the light passing through the lens at the transmitting station, and in circuit with these loops, filaments in a lamp common to all the circuits. As the conductivity of each circuit is affected by the light impinging upon the selenium loop at the transmitting station, each circuit carries a different quantity of the electric current generated by a dynamo in the wire common to all the circuits. The result is that all of these little filaments glow, but each with a different intensity, and the light diffused over the flat surface of the ground-glass lamp at the receiving station appears brighter in some parts than in others, the bright parts corresponding in position to the bright parts of the image projected upon the board by the lens at the receiving station. The scheme, if practicable when necessary modifications are made, is objectionable in that it contemplates a multiplicity of conductors, but as a basis for study Mr. Jenkins considers that the method has its merits.

Economy of Incandescent Lamps.—A paper on "Incandescent Lamps: Their Use and Abuse," was read by A. D. Page at the recent meeting of the North-Western Electrical Association, St. Paul, U.S. In referring to several diagrammatic curves and a table, the author stated that in considering these curves and table it should be remembered that the result would have been much less favourable to the higher-economy lamps had the test been made and the curves plotted with poorer quality of lamp, and also that satisfactory results with lamps of higher economy than 3½ watts per candle can only be obtained by exercising the greatest care in maintaining a constant voltage at the lamps. The table demonstrated that even at 600 hours lamps of the highest initial economy show the best average result as to average watts per candle and average candles per horse-power; and that at 900 hours three-watt lamps show better average results than lamps of 3·6 or four watts. The greatest objection which can be urged against the high-economy lamp is that while at 900 hours the four-watt lamp reaches a minimum candle-power of 13¼ candles and the 3½-watt lamp about 12 candles, the three-watt lamp reaches 10 candles, and the 2½-watt lamp at 600 hours reaches eight candles. At the present price of lamps, where fuel is high and the customers' bills are made up on the basis of lamp hours, it would, he submitted, pay the station to use high-economy lamps, breaking them at a point which would insure satisfaction as to average light and keeping the average life comparatively short. The author opined that whatever economy or make of lamp is used, by no means can the efficiency of the station be so greatly increased, as by making every possible effort in the direction of maintaining a constant voltage at the lamps. This can only be accomplished and maintained by constant use of reliable portable instruments. No switchboard instrument should be relied on without often checking it by some reliable standard, and it should also be borne in mind that, owing to the varying drop at various loads, constant voltage at the station is just what is not wanted. If a reliable portable voltmeter is not possessed, such an instrument should be the next purchase, then by constant use on the circuits at different loads, and profiting by the knowledge thus obtained, a marked improvement would soon be found in the lighting, and engineers would be in a position to judge which make and what economy of lamp is the best for them to purchase.

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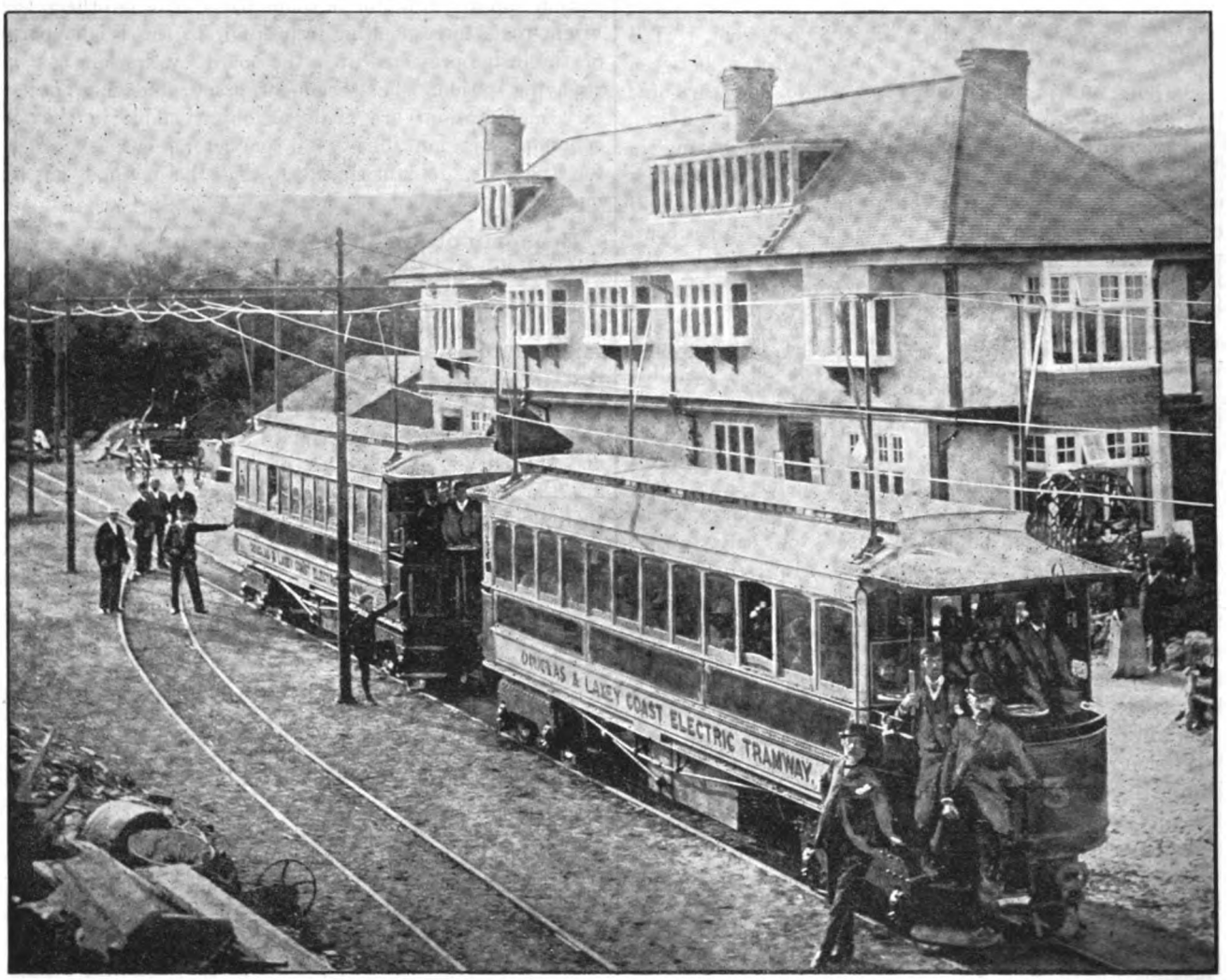
THE DOUGLAS AND LAXEY ELECTRIC TRAMWAY.

General Remarks.

The opening to public traffic of this electric tramway throughout its whole length, and to which we referred in our issues of 3rd and 10th inst., is an event of considerable importance. The line not only opens up a new and populous district which has hitherto remained in a great part excluded from the progress made by other parts of the island, but from the novel features of the work itself it will form a most interesting attraction to visitors. The line has been constructed under the Douglas and Laxey Electric Tramway Act passed by the Legislature of the Isle of Man on May 30, 1893, and promulgated by the Governor, Council, and Keys in Tynwald assembled on November 17, 1893. As mentioned in previous issues, the line was been constructed by Messrs. Mather and Platt, Limited, of the Salford Ironworks, Manchester. It was designed by Dr. Edward Hopkinson, who has also acted as consulting electrical engineer for the tramway company. Mr. Ramage and Mr. Wood have been the resident engineers for Messrs. Mather and Platt. Messrs. Galloways have been the sub-contractors for the boilers and engines, and Messrs. G. F. Milnes and Co., of Birkenhead, supplied the cars.

The tramway, of which illustrations are annexed, comprises a double line throughout; it is of 3ft. gauge, seven miles long (double)—or 14 miles in all—and extends from the end of the promenade in Douglas at Port-e-Vada to Laxey. Commencing at a point 20ft. above mean high water, the line rises in a distance of about 1½ miles to Lagbirrah, where it is 258ft. above the sea-level. It then falls to the Groudle Glen, at a height of 128ft. above sea-level, which it crosses by a fine stone bridge of three arches,



Douglas and Laxey Electric Tramway—View of Cars, Overhead Conductors, and Inn at Groudle Glen.

inspected by Colonel Rich, late chief inspector of the Board of Trade, and Major Cardew, on behalf of his Excellency the Governor, on 27th ult., and they gave their certificate the same day that the requirements of the Act and all precautions necessary for the safety of the public had been complied with. The line was accordingly opened for public traffic throughout its entire length the following day. The rapidity with which the tramway has been constructed and equipped with electrical plant is remarkable. Although involving heavy rock cuttings, several embankments, and a massive stone bridge, only seven months have been occupied in construction, a fact which reflects great credit on Mr. F. Saunderson, the engineer, and on Mr. Alex. Bruce, J.P., of Douglas, the chief promoter and chairman of the company. The contract with Messrs. Mather and Platt, Limited, was not let until the beginning of March of the present year, from which it will be understood that the electrical plant was designed, constructed, and erected in under five months. The whole of the electrical plant has

55ft. to the crown from the stream, and 130ft. in length. Rising again, the line reaches the highest point when it crosses the public road at Laxey at the Halfway House, at a height of 337ft. above sea-level. After crossing Glen Gawne at a height of 236ft., it again ascends and recrosses the public road 297ft. above the sea, and then descends to Laxey, where the terminus is just below the town, at a height of 115ft. above the sea, as shown in the section. The steepest gradient is 1 in 20, and the sharpest curve 100ft. radius.

The Power Stations.

There are two power stations—one at Port-e-Vada, the Douglas terminus, and the other near the Laxey terminus. The former contains three Lancashire boilers, 20ft. long by 6ft. diameter, working at 120lb. pressure, and three compound side-by-side high-speed vertical engines, which drive by link belts with jockey pulleys two Manchester dynamos, each for an output of 100 amperes at 500 volts, and a Mather and Platt dynamo of the same output. A separate

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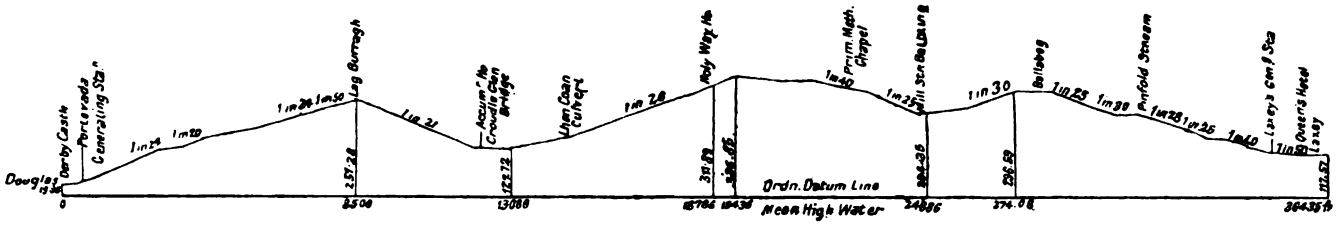
condenser is provided for the exhaust steam, the steam-pipes are duplicated throughout, and the boilers have alternative feeds by injector and donkey pump.

The current is conveyed from the dynamos to the switch-board, which is arranged for coupling any of the dynamos to the feeder circuit or to any of the working conductors. A Kelvin electrostatic voltmeter is provided for each dynamo, and an ampere-meter for each circuit. The switchboard is also fitted with a subsidiary board for measuring the currents returning through the earth, in compliance with the requirements of the Board of Trade.

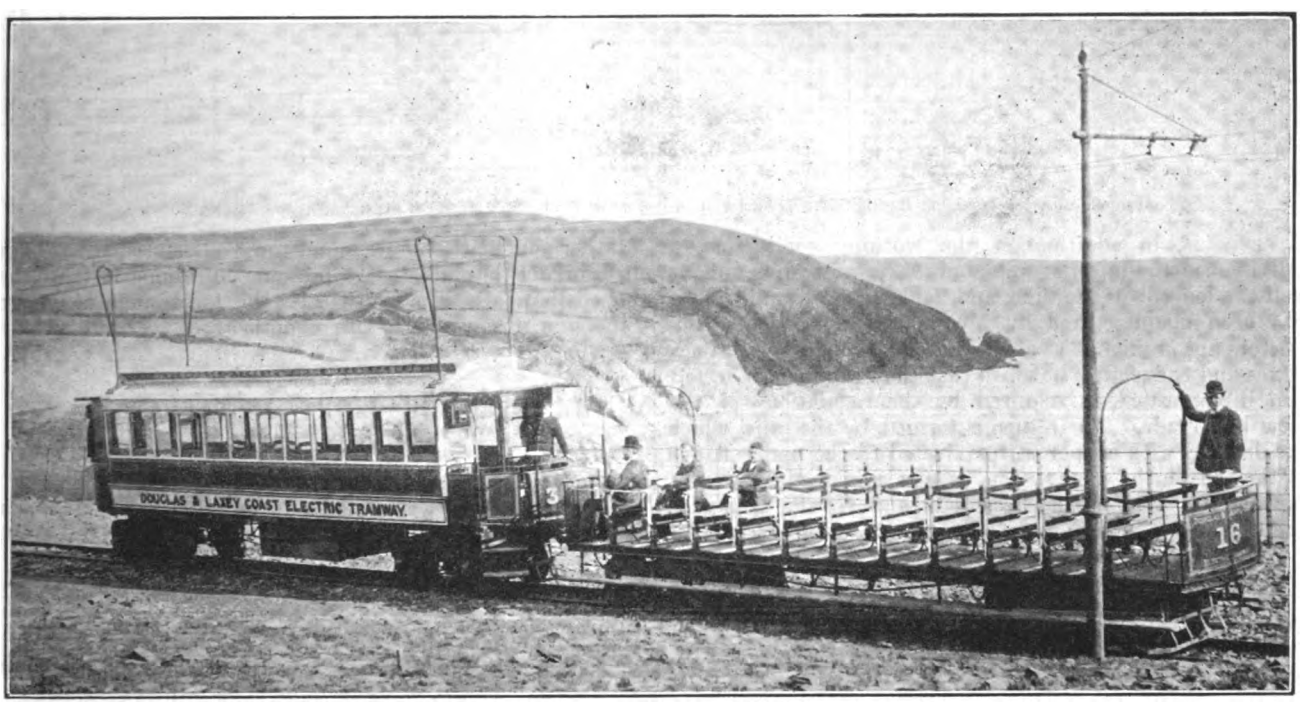
70 amperes for nine hours, and are remarkable for the exceedingly level curve E.M.F. which they maintain up to the end of discharge, and for the very high rate at which they can be discharged without detriment. Half the cells of the battery are of the Chloride Company's patent protected type, with teak separators and asbestos diaphragms, similar to those now being used on the Birmingham tramways, and the other half unprotected. The cells are charged direct from the line or from a motor generator, which is of special design by Messrs. Mather and Platt, which gives the required additional E.M.F.



Douglas and Laxey Electric Tramway—Longitudinal Section of Line.

This station, as is also the adjoining carriage shed, is lighted by incandescent lamps supplied from the power dynamos, and it likewise contains a motor-alternator of 30-kilowatt capacity, 1,000 volts, which is used for lighting some of the large hotels, theatres, and dancing saloons in the immediate neighbourhood. The power plant, in addition to providing the current for the motor-alternator, is also used for energising 20 arc lamps erected in Derby Castle, and for a distance of 1,000 yards along the roadway. The

This is the first instance of accumulators being used as a fixed battery for tramway or railway work in this country, although a similar step has been taken in the case of the Zurich-Hirslanden tramway referred to in the *Electrical Engineer* of July 20 last. The battery at Groudle Glen serves not only the function of supplying the extra power required at times of maximum demand, but it is intended during the winter months to work the light cars, which will then be sufficient for the traffic, after the close of the



Douglas and Laxey Electric Tramway—View of Motor Car and Trailer.

latter lamps are fixed on the same poles as are used for carrying the overhead conductors of the tramway. The station is arranged for the accommodation of a fourth engine and dynamo, and additional motor alternators.

The Laxey power station is similar to that at Douglas, but is equipped with only two boilers and engines of the same size, and two Mather and Platt dynamos of a similar output.

The Use of Accumulators as an Auxiliary.

One of the most noteworthy features in connection with the line is the use of accumulators. At Groudle Glen, situated 2½ miles from Douglas, a battery of 240 cells has been erected in a building specially constructed for the purpose. These cells were manufactured for Messrs. Mather and Platt, Limited, by the Chloride Electrical Storage Syndicate, Limited, of 16, Victoria-street, London. They have a capacity of 140 amperes for three hours, or

tourist season, entirely from the battery, which will be charged only once or twice a week as occasion may require.

The Overhead Conductors.

The conductors are on the overhead system patented some years ago by Dr. John Hopkinson. The current, instead of being taken from the overhead conductor by a trolley wheel, as in the case of American and other lines, is collected by two bars, each of the width of the car, and placed at each end. This arrangement will be readily seen from the illustrations. The bars rub along the under surface of the wire and make an excellent contact, much superior to the trolley system, as is shown by the entire absence of sparking. The bars clear the insulators in passing under them by about 2in., the forward bar making contact before the trailing bar breaks contact. The collecting bars are specially constructed with a hinged joint, controlled by a spring, devised by Dr. Edward Hopkinson.

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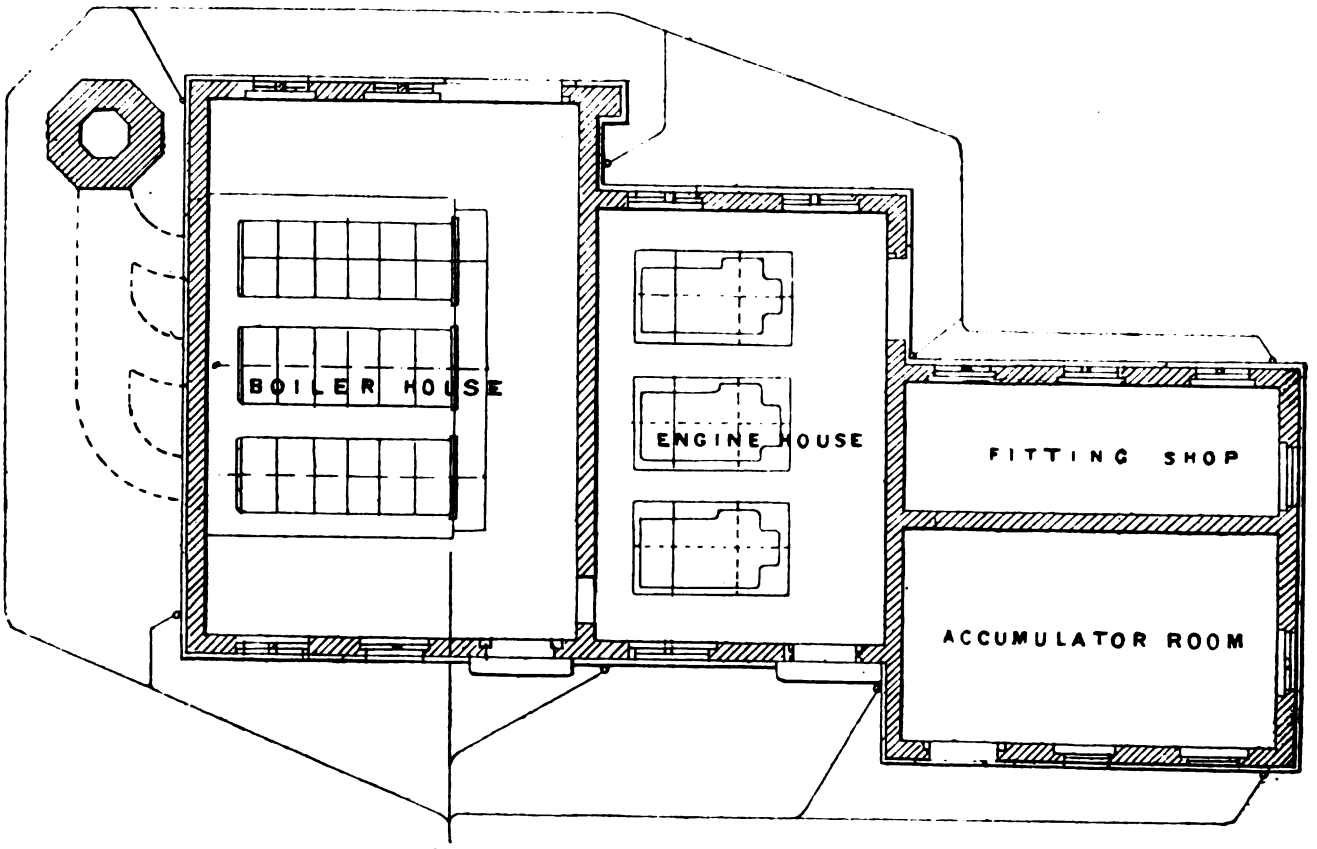
This regulates the pressure of the bar against the wire, entirely gets rid of all vibration, and allows the bar to pass any unexpected obstacle without injury, such as, for instance, a broken insulator. The conductors are of high-conductivity hard-drawn copper wire, carried from insulators fixed to the cross arms of steel poles, erected with concrete bases midway between the two lines of rails.

The nine cars can maintain a service every 15 minutes in each direction, and they can therefore provide for a traffic of at least 320 passengers per hour. Since the opening of the line already 30,000 passengers have been carried in one week.

The successful completion and setting in operation of this electric tramway redound to the credit of Messrs.



Arundel Castle Electric Light Installation.—Ground Plan of Boiler and Engine House, and of Fitting Shop and Battery Room.

There is, in addition to the working conductors, a heavily-armoured feeder cable of $^{37}/_{14}$, extending about half the length of the line, and laid underground. This has been manufactured by Messrs. Callender. The conductors are broken at various points and fitted with fuse-boxes and connecting links, so that they can be connected and disconnected, as required by the regulations of the Board of Trade. The return is formed by the rails, which are bonded with copper strips riveted to the under flange of the rail, on the same system as that employed by Messrs. Mather and Platt on the Bessbrook and Newry Tramway, the City and South London Railway, and elsewhere.

THE ROLLING-STOCK.

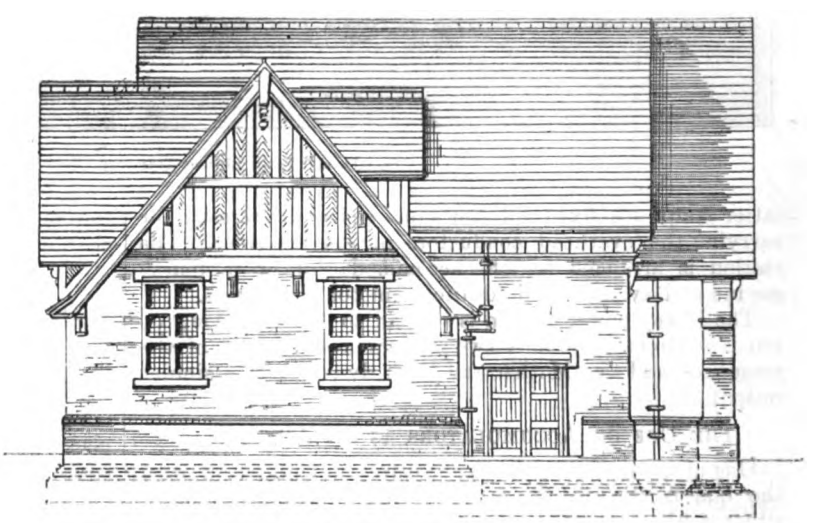
The rolling-stock comprises nine saloon motor cars, 36ft. long over the buffers, and 12 trailer cars of the "toastrack" type. The motor cars have longitudinal seats, and accommodate comfortably 38 persons. They are provided with two motors, single-reduction geared, working one on to each axle of each bogie. These motors are capable of together giving 3,000lb. tractive force at the periphery of the wheels. The motor cars, with their electrical equipment, weigh 9½ tons, whilst the trailer cars weigh four tons and will seat 44 passengers; hence a fully-loaded train of one motor car and one trailer car weighs 19 tons. The cars are equipped with powerful hand-brakes, and also with Milnes's patent continuous automatic emergency brakes, which can be worked by hand or come automatically into action if a train parts its couplings. They are also fitted with Milnes's patent coupling and buffer combined.

The cars are lighted by electricity, the current being taken from the working conductors. The absolute steadiness of the light shows the success with which the E.M.F. is maintained constant on the line.

Mather and Platt, Limited, and those associated with them in bringing the line to its present position. It is to be hoped that this tramway will be the forerunner of many others on this system in this country.

THE ELECTRIC LIGHT INSTALLATION AT ARUNDEL CASTLE.

An important electric light installation has just been completed for the Duke of Norfolk at Arundel Castle,



Arundel Castle—East Elevation of Generating Station.

Arundel. It is one of the largest private installations in the country, and is intended to light not only the castle, but also the grounds. This week we give plans and elevations of the station buildings, but hope in a future issue to

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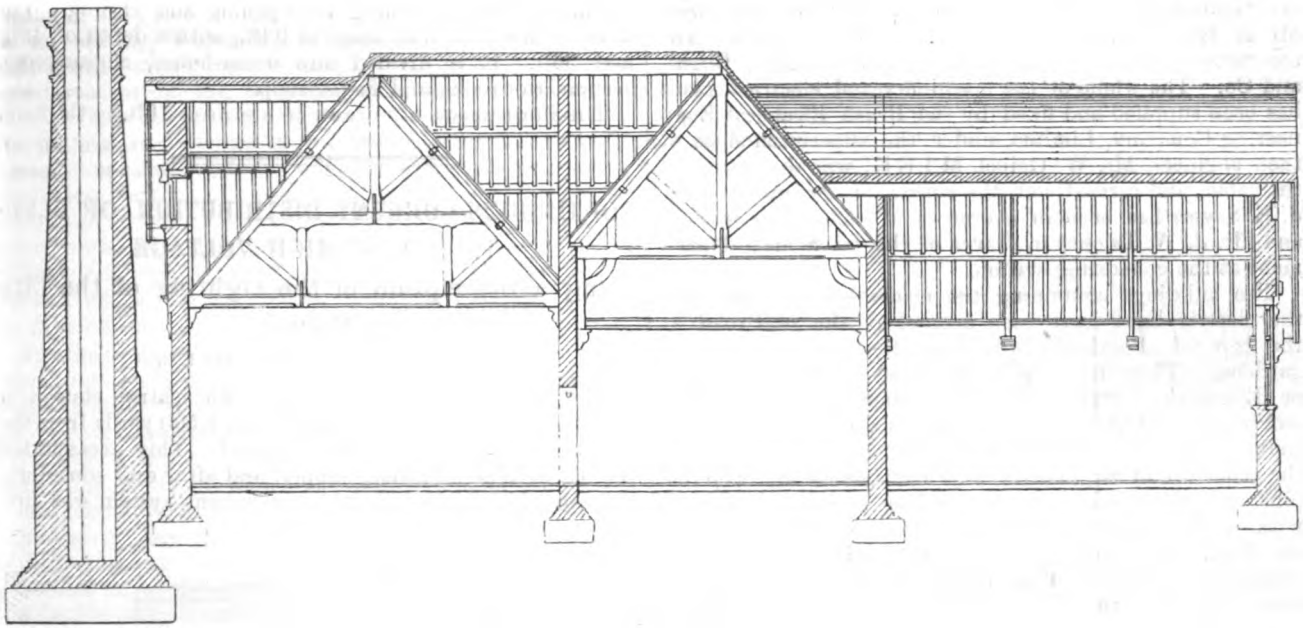
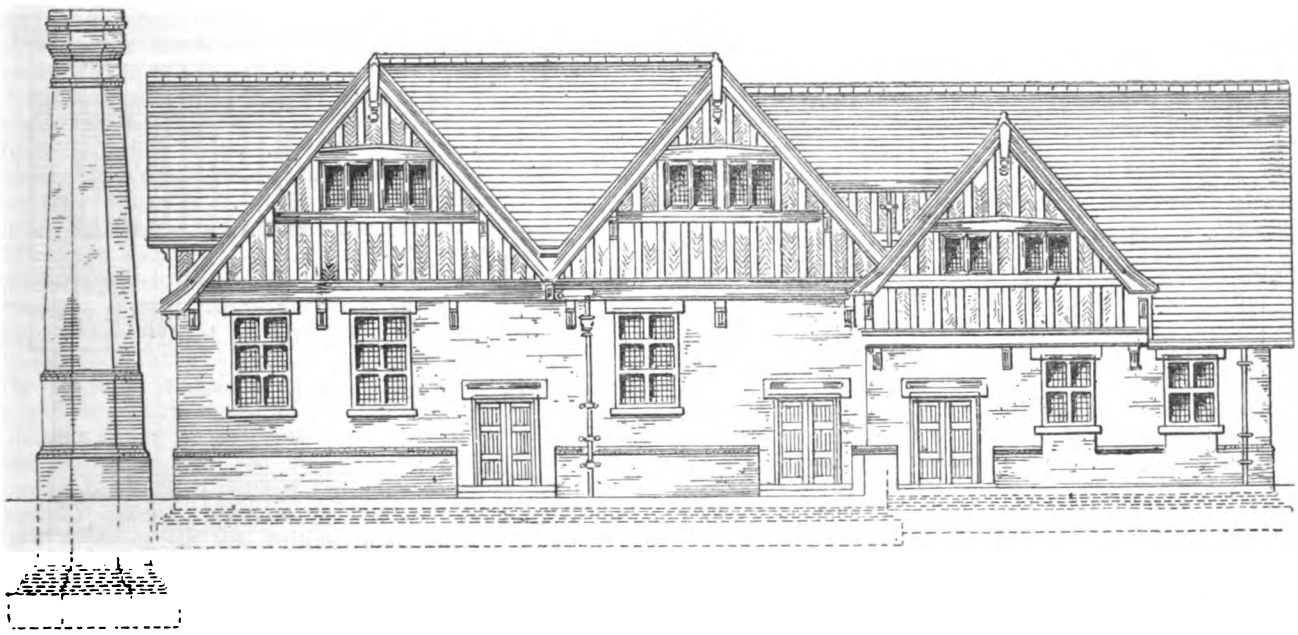


Arundel Castle.—Longitudinal Section of Generating Station.

Arundel Castle Electric Light Installation.—North Elevation of Generating Station.



Arundel Castle.—South Elevation of Generating Station.

illustrate and describe the electrical plant in detail. The buildings and the general arrangements of the plant have been carried out according to the designs of Mr. A. F. Phillips, C.E., of 31, Great George-street, Westminster,

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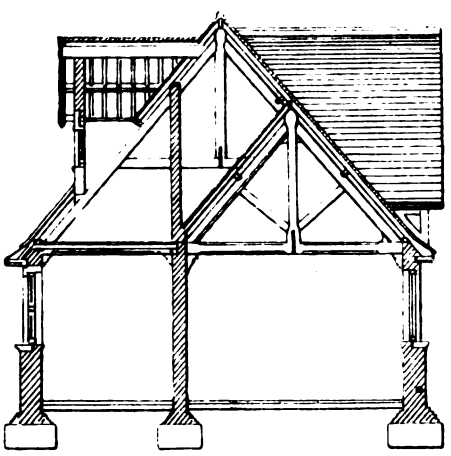
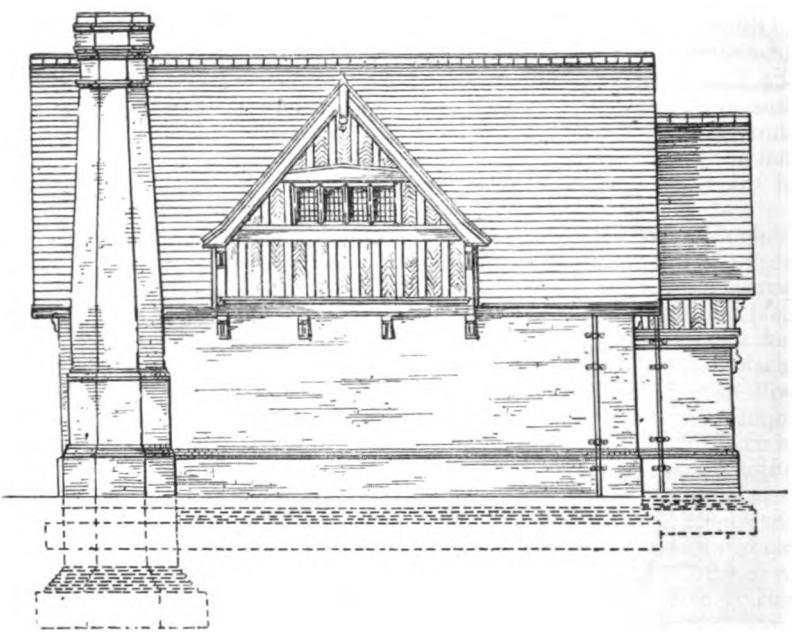
Mr. Gisbert Kapp acting as consulting electrical engineer. Mr. A. Bard, C.E., has acted as the resident engineer. The contractors for the buildings were Messrs. Reed, Blight, and Co. The whole of the machinery and electrical plant has been supplied and fixed by the Brush Electrical Engineering Company, Limited, under the superintendence of their engineer, Mr. W. Geipel, M.I.E.E., who has also laid the cables and carried out the wiring of the castle. Mr. J. E. Sayers has been in charge of the electrical section, and Mr. J. W. Donnet in charge of the mechanical department at the generating station.

The buildings containing the machinery for supplying the electric light have been erected in the new road at the top of Poorhouse-hill, near the entrance to the gardens. They have been designed in Early English or Elizabethan style, with Perpendicular reminiscences, looking as unlike an engine-house as possible. The half timbering and all external woodwork is in English oak; the roofs are of fir, and all internal timbers are of pitch pine, wrought and varnished. The roofs are boarded with wrought pitch pine. The whole of the doors are of oak strongly framed with chamfered edges. The brickwork has been carried up with dark Fareham bricks externally, and lined throughout with French grey glazed bricks internally, chamfered on the edges with a chocolate moulded skirting. The roof is covered with Ruabon tiles. The lintels and sills are of Portland stone moulded. The floors of the engine and accumulator rooms are paved with geometrical tile paving, and those of the boiler-house and fitter's shop with blue Staffordshire bricks. The chimney has been carried up in accordance with the building, its height being kept down so as to avoid its being conspicuous. The casements are all of wrought iron, with gunmetal fittings, glazed with fluted sheet glass in lead work, with special gearing for opening and closing. The building has a total frontage of 92ft., with a depth of 48ft. and 36ft. It is divided into boiler-house, engine-room, accumulator-room, and fitting-shop.

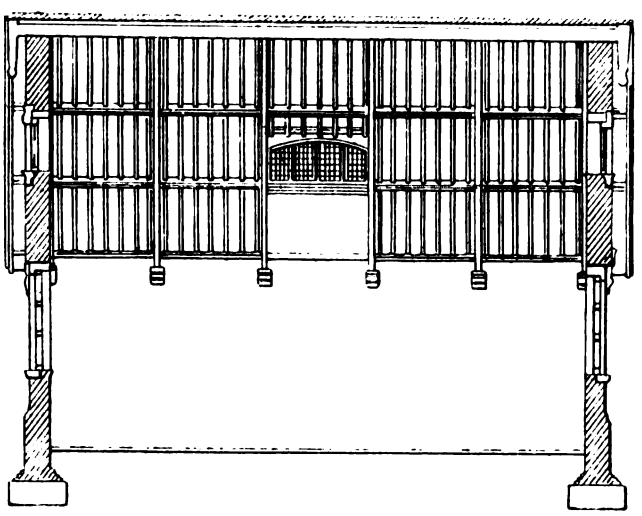
The illustrations are drawn to a scale of 16ft. to the inch.



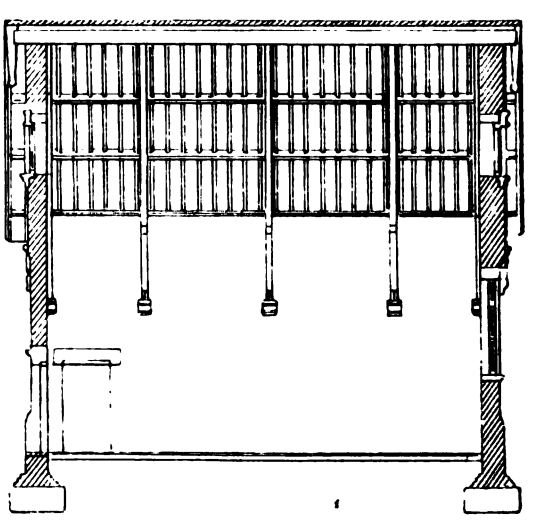
Arundel Castle—Section of Fitting Shop and Battery Room.



Arundel Castle—West Elevation of Generating Station



Arundel Castle - Section of Boiler House.



Arundel Castle—Section of Engine House.

CONTINUOUS-CURRENT DISTRIBUTION OF ELECTRICITY AT HIGH VOLTAGE.

Being a Description of the Lighting of the City of Oxford.*

BY THOMAS PARKER, M.I.E.E.

The site determined upon for the central station is situated on the banks of the Isis, some 1,500 yards from the centre of the area to be first lighted. This necessitated the use of a high-tension supply, and after due consideration the high tension continuous-current system was preferred to the alternating, as giving the decided advantage of being able to supply the light day loads with batteries when the main generating station is shut down, and also of being able to use efficient motors. At the central station high-tension continuous currents are generated at an E.M.F. of 1,050 to 1,100 volts. The current is conveyed to a central switch station, situated in Broad-street, by means of two pairs of cables, each having a sectional area of ·2 square inch, thoroughly insulated with india-rubber vulcanised and strongly braided. The insulation

* Paper read before the British Association at Oxford.

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resistance is 3,000 megohms per statute mile. These cables are drawn into iron pipes. The cables are led to double-pole switches in the switch station, and by means of omnibus bars to the transformer boards. Each of these boards has an ammeter, a double-pole patent automatic cut-out combined with a switch, and a multiple contact regulating switch and resistance in the main primary circuit in series with the transformer armature. These are mounted on slate bases. Above each board is a pilot voltmeter, connected to the point in the secondary network at which the low-tension armatures supply current for distribution.

For the complete control of the whole of the transformers supplying the district, only one man is required in the switch station; if the nature of the district had allowed of the central station being placed within the city, all the switching would be done by the engineer on watch at generating station. The pilot voltmeters in the switch station show the pressure on the network, and as the load increases in any district indicates when to put on an additional motor generator. In putting a fresh motor generator on to the network, the first operation is to close the double-pole automatic cut-out which conveys the high-tension current to the transformer. The current is taken through a resistance of about 40 ohms before leaving the station and passes into the high-tension side of armature of the motor generator, and excites the field by a few turns of series wire on the magnets. The brushes on both commutators are kept permanently down, and the machine begins to revolve as a motor, the shunt, which is connected across the low-tension armature, rapidly energising the field magnets to the full saturation, so that the speed does not exceed the normal 550 revolutions. So soon as the machine is fully excited, the high-pressure primary current will have fallen to about 3½ amperes, which is the actual input with no current on the secondary. The transformer is now running "light," and the secondary E.M.F. can be adjusted by means of the multiple-contact switch and resistance coils above mentioned; when this corresponds to the pressure at that time on the network connection is made with the secondary armature and the mains. This is accomplished at the central switch station by momentarily opening and closing a small switch, which, short-circuiting the voltmeter, causes an increase of current to flow through a magnetic switch placed in the sub-station. The latter switch has its magnet coil always in circuit with the pilot voltmeter, the small current constantly passing being insufficient to affect the switch. When the voltmeter cable is short-circuited at the switch station, the resistance is so arranged that the full current required to operate the switch is allowed to pass through the wires and causes the magnet to ascend and actuate switch to complete the circuit between the low-tension armature and mains. On the switch at the switch station being again broken, the magnet drops and revolves a cam wheel to a position suitable for breaking the circuit, when the magnet is again energised from the switch station; the voltmeter now reads as before, having been only momentarily short-circuited. The E.M.F. on pilot voltmeter is kept constant by means of the regulating resistances in the primary circuit, as before explained. When the load has fallen again, which is indicated by the pilot voltmeter, the transformer is disconnected in a similar manner. First of all, the resistance is inserted until the ammeter shows that no current is being supplied from the transformer to the network, then the switch short-circuiting the voltmeter is again made and broken, causing, as before, a quarter of a revolution of the cam wheel, which this time allows a spring to pull out the contact-piece which joins the transformer to the mains. As the switch is not under ordinary circumstances broken while there is current passing, there is no sparking at the brushes, and consequently the switch requires no attention. A cut-out arrangement is provided so that in the event of too much current being supplied from the transformers to the mains, a magnet is raised, knocking the cam wheel round and breaking circuit, but leaving the switch ready to be worked again from the switch station. This cut-out also protects the transformer in event of the machine being placed on the circuit without the E.M.F. being properly adjusted, or in case a hot bearing should cause the transformer to pull up. Each transformer consists of an ordinary horseshoe magnet with a single armature, the secondary winding being placed on the top of the primary with a commutator at each end. The brushes are always left down, and as the action of the two windings neutralise each other, no alteration of lead is required for change of load. The bearings are fitted with automatic oil-pumps, which, drawing their supply of oil from a chamber contained in the dynamo pedestal, use the same oil again and again, and transformers have been working for a period of six months without changing the oil.

The low-tension distributing network consists of armoured cables. The cables consist of two sizes—*i.e.*, ½in. and ¼in. section—and are laid in a trench under the footpaths, being provided with disconnecting branch boxes, so that any section or street can be cut out. Here again, owing to the use of continuous currents, a saving is effected, there being no loss due to induction, and a pair of steel-armoured flexible cables can be used. This makes a difference in the cost and trouble of connecting up new consumers; also, as the cables themselves are flexible, a good deal of trouble and expense is saved when first they are laid where gas and water pipes are found at varying depths beneath the footpaths. The high-tension feeders to the transformers are a similar class of cable to the trunk mains, being drawn into iron pipes. At the present time there are seven transformers in use and five sub-stations. At some sub-stations two transformers are used. It was thought advisable to keep to one standard size. At the switch station at Broad-street there are installed two transformers and a battery capable of discharging at the rate of 120 amperes for eight hours. This battery will supply about one-twentieth of the load that the present station was designed for, and is capable of taking the load from about one o'clock in the morning until half an hour after sunset. The battery is charged by a small motor generator, which gives an output of 33 volts 100 amperes from the secondary armature, being supplied from the network at an E.M.F. of 103 volts on the primary. The 33 volts obtained from the secondary armature is put in series with the network, giving a total E.M.F. of 136 volts, which is sufficient to charge the cells. This may appear to be an inefficient method of charging cells, but only a small portion of the charging energy passes through the machine, and the total efficiency is 92·5 per cent. This is more economical than charging from the network with a regulating resistance, besides saving the trouble of having to arrange the cells differently for charging and discharging. The Broad-street switch station is also the offices of the company. The generating station is a brick building, some 80ft. long by 60ft. wide, built by Messrs. Kingerley, of Oxford, under the supervision of Mr. A P. Brevitt, Wolverhampton, architect. The two ends are only temporarily built in to allow for extension. In the boiler-house, which is divided from the engine-house from a party wall, are placed three steel locomotive multitubular boilers, made by Messrs. McLaren, of Leeds; these are constructed for a working pressure of 160lb. per square inch, and have proved themselves to be thoroughly satisfactory. A Green's fuel economiser is also fixed in the main flue, having 192 tubes, 4½in. diameter by 9ft. long. The engine-room is built in two spans, the engines being placed in the one next to the boiler-house, and the dynamos, which are driven by belts, are put on the opposite side, well away from dampness or dirt coming from engines, and are electrically insulated from them. At the present time three inverted triple-expansion surface condensing engines are at work; these are made by Messrs. McLaren, of Leeds, and each have cylinders 9in., 14¼in., and 22½in. diameter, with 24in. stroke. The high-pressure and intermediate cylinders are steam jacketed, and drain through a steam-trap into the hot-well. Each engine has automatic expansion gear, and runs at 125 revolutions per minute. At some exhaustive tests made in Leeds, the following figures of the boilers and engines combined were obtained:

	Jackets not in use.	Jackets in use.
Total brake horse-power	112·8	106·85
Water per brake horse-power per hour	17·671b.	15·5131b.
Coal per brake horse-power per hour	1·7671b.	1·5341b.

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These figures show remarkably economical results; they have been obtained also in practice, and conduce to the low coal consumption obtained per Board of Trade unit metered.

The three Elwell-Parker dynamos, made by the Electric Construction Corporation, Limited, have an output of 1,100 volts 80 amperes at a speed of 400 revolutions, and are fitted with a third bearing outside the pulley. They are separately excited by independent small dynamos, each driven from a rope pulley keyed on to main generator shaft. The exciters are wound to give 135 volts, and are of sufficient capacity to charge a small set of cells which are used for lighting the station as well as supplying current to a small ½-h.p. motor which drives the economiser scrapers. The main dynamos are connected to a double-pole automatic cut-out and switch combined, by means of which they can be paralleled. This is a very easy matter, as no synchronising arrangement or artificial load is required. From these switches the main omnibus bar is taken to the trunk mains, each of which is controlled by a double-pole switch, so that either pair, or both together, can be used at will. The E.M.F. at the station is measured on a Kelvin electrostatic voltmeter, which is connected across the omnibus bars. The whole plant was started on July 18, 1892, and has run continuously since then, giving every satisfaction.

By the figures hereafter given it will be seen that owing to the use of continuous currents, and the contingent advantage of being able to shut down the station for such long periods, that the Oxford system is in the front rank in adaptability and economy of working. The efficiency of the transformers varies from 87 per cent. at half load to 92 per cent. at full load, and as it should not be necessary to work a transformer with less than half load the efficiency should not be less than 87 per cent. In actual practice at Oxford, as the consumers are somewhat scattered and few, it is necessary to run the transformers at less than half load during a portion of the time which has somewhat reduced the efficiency. No doubt during the next few years the gaps in the district will be filled up and then the all-round efficiency will be increased.

The figures for the year from July 1, 1893, to June 30, 1894, inclusive show that the total efficiency of the system was 62·6 per cent., the Board of Trade units generated being 195,022 and the total units metered 122,081, of which 18,303 were supplied for public lighting. There were also an additional 2,019 units used at the switch station and sub-stations. Out of the 195,022 units generated 149,668 units were obtained from the secondary of the transformers, giving an all-round efficiency for the transformers of 76·7 per cent., which includes all losses in mains and resistances. Out of the 149,668 units supplied by the transformers, 114,721 units were supplied to consumers, and 34,947 units for charging the battery. The total number of units obtained from the battery was 16,357, which makes the battery efficiency of the year 43·9 per cent. Adding the 16,357 units obtained from the battery to the 114,721 units obtained from the transformers, we get a total output of 131,077 units supplied to circuits. The total metered was 124,101, including those used at switch station, so that there remains 6,976 units unaccounted for, or not quite 5½ per cent. As the current is supplied at 102 volts, and metered at 100, 2 per cent. is thus accounted for, and the rest is probably due to error in instruments or observation of reading, these having been taken half-hourly throughout the year, the tendency being naturally to over-read than to under-read the instruments. In all the following figures of cost, the units metered have been taken as the basis, leaving out as losses the difference of supplying at 102 volts and metering at 100, and also the current used at the works. The actual coal used during the 12 months was 6·43lb. per unit sold. During this period the cost of coal, which was best Welsh, averaged 21s. 10d. per ton, working out to ·752d. per Board of Trade unit. The cost of coal increased during the coal strike and still remains high. In comparing this cost with that of other stations, due consideration must be given to the total output, being only just over 100,000 units, whereas Newcastle and Bradford, which I believe are the only stations which spend less per unit on their coal, have a total output in 1893 of 360,000 and 480,000 units respectively.

The total number of 8-c.p. 35-watt lamps installed on June 30, 1894, was 7,774, whereas on July 1, 1893, there was only 5,060 connected to the mains. As in Oxford the colleges form a large portion of the supply, the term time is the only part of the year when a load can be obtained, so that last year only for about eight weeks was even half the plant required at the maximum load, and the system has to be very elastic to cover it and show good results. The total cost of all generating expenses, including all rates, taxes, and rent, was 3·715d. per unit delivered to consumers. The cost is divided up as follows:

Coal	·752
Oil, waste, water, and engine-room stores	·042
Wages, including engineer	1·221
Repairs and maintenance of public lamps	·366
Repairs and maintenance	·907
Rents, rates, and taxes	·427
	3·715

Management and office expenses cost 1·534d. per unit, making a total of 5·249d.

In the above figures, due regard must be paid to the fact that for the greater part of the year only about half load for one engine was ever required, so that more than double the output could have been supplied with slight increase in wages, and little extra on maintenance. Thus, with double the output, the figures would have been somewhat as follows:

Coal	·752
Oil, etc.	·042
Wages	·650
Repairs	·450
Public lamps	·183
Rents, etc.	·214
	2·291

which figures are good with so low an output as 240,000 units.

The revenue for the year from lighting was £3,715. 8s. 2d., giving 10s. 11d. per 35-watt lamp installed, the number of units used being 18·2 per lamp throughout the whole year, and the average price obtained 7·3 pence per unit.

The load-factor at Oxford only works out to 5·93 per cent. By the expression "load-factor," is meant the ratio of the units sold to the units that could be sold with all the lamps always on—viz.:

$$\frac{\text{Metered watt-hours} \times 100}{\text{Mean watts installed} \times \text{number of hours in the year.}}$$

I have to thank Mr. J. H. Woodward, A.M.I.C.E., and Mr. E. S. G. Rees for their assistance in the designing of the system; also to Mr. J. H. McLean, who has put down the plant, under my direction, for the Electric Construction Corporation. He is now engineer to the Oxford Company, and has given us his assistance here to-day.

SOME ADVANTAGES OF ALTERNATE CURRENTS.*

BY PROF. SILVANUS P. THOMPSON, D.SC., F.R.S.

Amongst electrical engineers there remain a few, chiefly of the old pioneers, who have not grasped the advantages possessed by alternate currents over continuous currents in systems of electric supply. Superstitions still linger that alternate currents are less easy to manage, or are less economical, or are more dangerous, or are less readily measured than continuous currents. There is a special superstition that they cannot drive motors. Such superstitions once set afloat die hard, and, sad to relate, they are sedulously fostered by a few interested persons who ought to know better. The present paper is intended to point out a few of the more salient advantages attendant on their use, and to add a few points that have recently claimed the writer's consideration and are not generally known.

It is well known that the economic transmission to a distance of electric energy depends for its success on the use of high voltages or pressures. The reason is that power depends on the product of two factors—current and pressure, and that of these two factors

* Paper read before the British Association at Oxford.

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the former, current, involves some waste in the conductors. If large currents are transmitted at low pressures, there will be either much power wasted as useless heat in the copper conductors, or else the conductors must have such large cross-section that the interest on their prime cost involves a still more serious waste. If small currents are used at high pressures—1,000 volts, 5,000 volts, 10,000 volts, as the case may be—the copper conductors may be small and the interest on their cost a trifling quantity. Now, this all-important fact to the electrical engineer is absolutely independent of the nature of the current as to whether it is continuous or alternating. The advantage of alternating over continuous currents come in in the circumstance that high pressures cannot be used in houses without being transformed down to low pressure. Hence the system which admits of transformation by a stationary transformer, consisting merely of two coils wound upon a common core, is to be preferred over that requiring running machinery for transformers.

Again, it is an advantage not only for high-voltage systems, as distinguished from low, but in all systems, whether high or low, in which currents of considerable magnitude have to be collected and delivered, that there should be no necessity for employing either in the generating plant or in motors any commutators or sliding contacts, with their adjustable brushes and the like paraphernalia. The commutator, the indispensable adjunct of the continuous-current dynamo and motor, has long been known to be its weakest part from the engineering point of view. It is complex and costly as compared with other parts. It requires far more attention than any other part of the machine. It undergoes greater wear; and the circumstance that under conditions not far removed from normal it may give rise to serious sparking, is also a disadvantage.

Alternate-current generators have no commutators. Those types of alternators in which the armature revolves require, indeed, collecting rings (for sliding contacts) and brushes, a device to which the foregoing remarks on commutators scarcely apply, seeing they need no adjustments nor give rise to sparks. But the type of alternator now coming most in favour do not even require these (except on the exciting circuits, where their disadvantages are nil), since in them the high-voltage armature parts are stationary. The only parts that need revolve are most substantial masses of iron and copper needing no special insulation in their construction, or attention in their operation. To be spared all the troubles arising from commutators and brushes is no small advantage in itself to the central-station engineer.

Another advantage of an entirely different character is the greater safety of the alternate currents. With them there is far less likelihood of trouble from leaks in the distributing circuit than if continuous currents were used at the same voltage. This arises from the circumstance that the electrolytic action of the alternate current is so extremely small. If there is a weak point in the insulation of a main or branch conductor where damp can get in to form a path for leakage, the continuous current will find it out and promptly set up chemical corrosion. Corrosion sooner or later ends in setting up an arc, and an outbreak of fire results. The corrosion of water and gas pipes complained of in many districts where a continuous-current supply is maintained are unknown where alternate currents are used. The danger to life for equal voltages is, I think, now established to be greater with continuous currents than with alternating, as their destructive action on the tissues is greater.

Again, it is no light matter that while in a continuous-current supply there is but one way of moderating or regulating the strength of the current which flows to a lamp or motor from the supply mains at a given pressure, there are two modes of regulation possible if the supply be one with alternating current. In the continuous-current case we regulate by introducing resistances, which regulate by wasting power. It is as though when we wanted to put a slow speed on to a power lathe we did it, not by changing the gearing, but by putting a grindstone on the same piece of shafting and slowed it down by grinding something that would waste the power. But in the case of alternate currents—though we may still, if we please, regulate by wasteful means—we have another and non-wasteful way available in regulation—viz., the use of so-called choking coils, or reaction coils, which operate by setting up opposing E.M.F.'s in a purely automatic way—damming back the currents instead of wasting them. The use of choking coils is destined to find a very great increase in services of this kind.

It would be travelling too far from the range of this paper to enter to any great length upon the work that has been done during the past five or six years with combinations of two, three, or more alternate currents in different phases. Two-phase and three-phase combinations of alternate currents, using three or four wires for their transmission instead of the ordinary two-wire system of conductors, are now quite well known, and their advantages in special cases are fully recognised. Of course, it will be at once replied that any phase system of currents—that is, a combination of two or three alternate currents, and require three or four wires instead of two—cannot be entirely an advantageous system as compared with simple continuous currents, being more complicated. This is very obvious, and yet the fact remains that with two-phase and three-phase systems of current one can accomplish results which the simpler systems cannot accomplish, and meet conditions which the simpler systems cannot meet. Without attempting any complete exposition of the phasal systems, let one or two points suffice for remark. It has been found essential, or, at least, advantageous, in those districts where continuous currents are used on a large scale, to depart from the sweet simplicity of the two-wire system, and in order to economise in the total cost of copper in the mains to adopt a three-wire, or a four-wire, or even a five-wire distribution, so that sweet simplicity is not always on the side of continuous currents. Again, if a three-wire three-phase system of alternate currents is used, the total weight of copper needed in the conductors (at equal voltage) is less than in the ordinary two-wire system for an equal amount of power, whether that two-wire system be with continuous currents or with alternate currents. The main advantage of three-wire polyphase alternate-current systems (whether three-phase or two-phase) is, however, the greater facility that they offer in the handling of motors, since they are more readily made self-starting than is the case where merely single alternate currents are supplied on a two-wire system of distribution.

At the Electrical Congress of Chicago, in the debate on a paper by Mr. Scott, of the Westinghouse Company, on polyphase systems, the writer expressed the opinion that while a polyphase system was adopted to the case of the transmission of power from a single generator to a single motor in the generality of cases in which the power was to be not only transmitted, but distributed to a number of motors at independent points, the great simplicity of the simple alternating current, greater simplicity of the simple alternating current, would render it preferable now that self-starting motors were in the market. Bearing, however, in mind the advantages to be derived in the possibility of using two and three phase motors, the author gave considerable thought during the winter to the problems of transformation, and particularly to the question whether it might not be possible to transform alternating currents from two-phase to three-phase, or from either of these to single-phase, or *vice versâ*. No mode of doing this was known save by the combination of motor-generators as running machines. As one result of his cogitations, he found that such transformation might very readily be effected by stationary transformers, or in the least easy case by stationary transformers with a revolving iron core. The simplest case—that of transforming three-phase currents into two-phase (or *vice versâ*)—involved no moving parts, being effected by using a ring coil (or its magnetic equivalent) with connection made appropriately. For example: if a Gramme ring is connected, as shown in Fig. 1, to a two-phase system with 100 volts

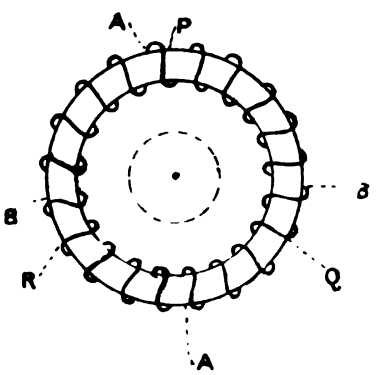

FIG. 1.

between A A, and 100 volts in quadrature between B B, a three-phase set of alternate currents may be taken off from the same winding at three equidistant points, P, Q, R, at pressure of 66 volts between each of the three wires. The magnetic field across the coil revolves, and it is preferable to provide a laminated core to complete the magnetic circuit. Such a core may be stationary, or may revolve. A simple ring transformer like the above (without revolving coil) was shown by the author at his lecture on the transformations of electric currents, at the Royal Institution on February 23, 1894. It is of some interest to note that on March 7 Mr. Scott read an elaborate paper to the American Institution of Electrical Engineers, in which he gave an independent solution to the very same problem, using two sets of winding (instead of one), but working out in detail many possible applications. It is no exaggeration to say that an electrical engineer starting, let us say, with three-phase alternate currents as the method of supply, is in a position to furnish any customer who may desire either two-phase currents or single-phase currents with what he desires by merely putting in a small appropriately connected transformer. Another advantage, about which even electrical engineers are as yet almost wholly unenlightened, arises in the application of alternate currents to electromagnets. Great as

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have been the services of electromagnets as used with continuous currents since their invention in 1825, they are destined to fulfil wider services than ever in the practical problems of an electro-mechanical nature now that their properties, when supplied with alternate currents, are becoming known. In 1887, Prof. Elihu Thomson discovered a number of singular properties of alternate-current magnets in producing repulsion of copper discs and rotation of cylinders and balls by reason of the eddy currents induced in them. During the past winter the author has been studying the design, construction, and properties of alternate-current magnets, and recently, in conjunction with his assistant, Mr. Miles Walker, read a paper on the subject before the Physical Society of London. A few words on this topic will emphasise the advantages offered by alternate currents in this application. It has long been known that the magnetic forces of a magnet fall off very rapidly at small distances from their poles. For steel magnets in those cases in which the poles can be considered as points, the force falls off inversely as the square of the distance, other things being equal. In the case of soft iron electromagnets operated by continuous currents, the pull on their armatures falls off much more rapidly than this. The forces when in contact may be relatively enormous, and yet the magnet may have no range of attraction worthy of mention. A pull of 150lb. in contact may dwindle to a few ounces at a distance of a couple of inches. But with alternate currents supplied at constant voltage from the mains, the author finds all this to be different. With a properly-designed and well-constructed electromagnet, the pull on its armature can be kept fairly constant over a considerable range—nay, in some cases can be caused to be greater at a distance than when near. For example, the author has lately had an alternate-current magnet constructed for him by Mr. Walker, the pull of which, when excited at 50 volts, was 8oz., when the armature was closely in contact with the core, but which exercised a pull of 32oz. when the space between them was 3in. This obviously introduces into electric mechanism a new element hitherto undreamed of.

The secret of these things is that in the case of alternate-current electromagnets, the self-induction reaction of the system, and not the mere electric resistance of the wires, is that which governs the flow of current, whereas Ohm's well-known law for continuous current is

$$\text{Current} = \frac{\text{Electromotive force}}{\text{Resistance}}, \text{ or } C = \frac{E}{R}.$$

The rule that governs the alternate current in these cases is different, being

$$\text{Current} = \frac{\text{Electromotive force}}{\text{Reactance}}, \text{ or } C = \frac{E}{pL},$$

where p is the pulsation of the alternate current—*i.e.*, the number of radians per second in the revolutions of the circle of reference—and L the inductance.

As the armature of the alternate-current magnet is withdrawn from the core, the reactance diminishes and more current flows, making the pull greater at a distance instead of less.

Another curious point about alternate-current magnets relates to their winding. In the case of electromagnets supplied with continuous currents, it is well known that the more turns of wire that are wound on the core the more powerfully is it magnetised. But with alternate-current magnets this is not so. There is one particular number of windings for each magnet (generally a small number) for which the magnetism is a maximum, and any additional wire wound on above this number diminishes instead of increasing magnetic power.

Returning from this digression respecting magnets to the general question of the supply of alternate currents, the author has finally to point out one further set of advantages hitherto both neglected and unknown in this country, though known to a few and actually in use in the United States.

One of the difficulties which beset the distribution of electric currents on the large scale is that of maintaining constant, at all points of the network of conductors, the voltage or pressure at which the current is delivered to the consumers. Between the generating station and the centre of distribution there occurs a loss of pressure (comparable to the loss of head in the case of water power), and beyond the centre of distribution, between it and the points of consumption in the house lamps, there is a further drop in the voltage. The former drop in the voltage can be compensated for by due arrangements at the central station, but the further drop between the distribution centre and the consumers' houses, though it may be guessed at and partially compensated by some system of over-compensating at the distribution centre, cannot be accurately compensated. The result is that the consumers' lamps do not receive their supplies of current at an unvarying pressure. Now in the case of continuous-current distribution the only cause for drop in the voltage at distant points is the resistance offered by the conducting wires leading o those points. The drop due to such resistance—or ohmic drop—is proportional to the ohms of resistance and to the amperes of current. Suppose a group of lamps requiring 20 amperes at some outlying point, the wires to which have a total resistance of only one-tenth of one ohm. The drop in voltage due to the ohmic resistance will be $20 \times 1\text{-}10 = 2$ volts. The lamps, which ought to receive their currents at a pressure of 100 volts only, return it at 98, and burn dimly in consequence. But in the case of alternating currents there is a second or additional cause of drop, which has hitherto been held to be a serious disadvantage in their use—namely, a drop due to the self-inductive action of the lines reacting and setting up back E.M.F.'s and tending to choke the current. In general, this second or inductive drop is not serious, the mains and branches being arranged concentrically for the purpose of avoiding it as far as possible; but it may become serious when motors as well as lamps are employed upon the circuit, because of the considerable inductive reactions that are set up in the electromagnetic operations of these machines.

Alternate-current motors are of many sorts, but may be grouped under two chief classes—the synchronous and the asynchronous. Synchronous motors are those which only run at one fixed speed, determined for them irrespective of their load—a speed determined solely by the number of their own poles and the number of the alternations imposed upon the current by the generating machinery at the station. They must either run in synchronism with the pulsations of the current or else not run at all. The other class, the asynchronous, are mostly polyphase machines requiring two-phase or three-phase currents to operate them. The phase currents led into a suitable armature, there combine to produce a rotating magnetic field, and in this rotating field masses of iron or iron carrying closed circuits of copper are set into rotation, being magnetised inductively, and dragged round by the reaction of the eddy currents induced in them. The rotor, or rotating part, of the asynchronous motor may be regarded as a revolving field magnet not magnetised by any special exciter or initially, but magnetised only by the eddy currents induced in it. Now, if it could spin at the same rate as the revolving magnetic field that surrounds it, there would be no relative motion, no eddy currents, no reactions, and no driving force. It is driven by forces which depend for their existence upon the rotations not being synchronous with the pulsations of the currents in the circuits. Within certain limits it adjusts its speed so that its magnetic slip is proportional to the turning moment which it is called upon to exert.

Now, owing to these necessary reactions, the asynchronous motors produce upon the mains which supply them an inductive drop, and cause the pulsations of current to lag in phase behind the impressed pulsations of voltage. Whereas the ohmic drop is not accompanied by any lag of phase in the current, the inductive drop is so accompanied. Happily, with alternate currents, there exists more than one remedy. It has long been known that a condenser exercises a reaction of another kind, which, though it tends to choke the current, does so not by retarding the phase of the pulsation, but by accelerating it. This precious property has long been known and used in submarine telegraphy to compensate, by the use of condensers, the retardations of the signals. But to apply condensers to systems of alternate-current supply for the purpose of counteracting the inductive drop when motors are used, would be a rather formidable task; the remedy is too heroic for the malady. A remedy of a different kind is, however, possible, and must before long become general when its advantages are known. To explain it we must return to the subject of synchronous motors, about which little has been said. It was shown in 1868 by Wilde, and in 1879 by Hopkinson, that two alternate-current machines could run together synchronously, one as generator, the other as motor, the one which served as motor adjusting itself so that its pulsation of E.M.F. tended (as in all motors) to oppose those of the impressed E.M.F. In 1884, Dr. Hopkinson further predicted that an alternate-current machine could run as a motor even if its mean E.M.F. was higher than that of the circuit, a result verified in practice by Mr. Mordey in 1890. In 1892, Mr. Mordey gave at the Institution of Electrical Engineers some further results of alternate-current working, including a very remarkable curve, here reproduced, showing the dependence of the armature current upon the excitation of the field magnets of the motor when loaded with a given load. To this curve and its meaning the author directed attention at the time, and he has since given much thought to it. It will be found to be most significant. The curve presents the form of a letter V. The lowest point corresponds to a particular state of things—namely, that the motor having its magnetism excited to a practical degree, draws a certain minimum amount of current from the mains in order to drive its mechanical load at the speed imposed upon it. But to do the same work, drive the same load at the same speed, will take more current from the mains if the excitation of the magnets is either more or less than this particular amount. This seems very strange, but the explanation and its consequences are no less so. The particular stage of excitation which makes the armature

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current a minimum for the particular load in question, is that stage which corresponds to there being no difference of phase between the pulsations of impressed voltage and those of the resulting current. Suppose, for example, the armature had a resistance of ½ ohm, and that the current was supplied at 100 volts, and that a current of 10 amperes was found the minimum current that would drive the load. It would be found (approximately) that the excitation corresponding to this minimum current would be such as would make the motor work with a back E.M.F. of 95 volts, for then by Ohm's law $(100-95) \div \frac{1}{2} = 10$ amperes. But now suppose the excitation is lessened, the machine, acting at the same unalterable speed, will generate less than 95 volts. Suppose it drops to 90 volts.

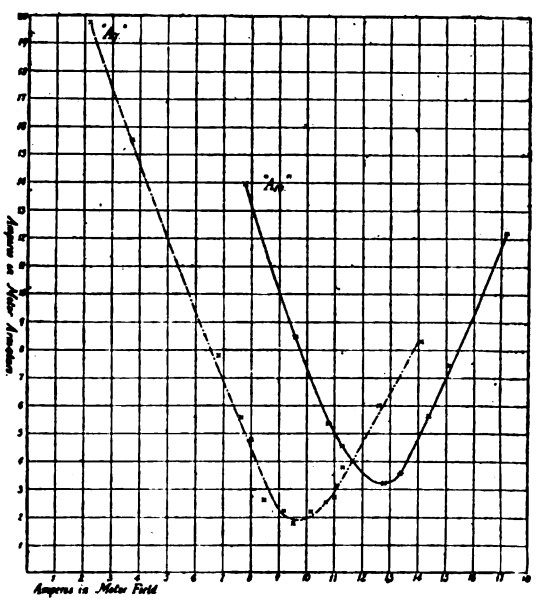

FIG. 2.

Then, if nothing else happened, the current would increase to $(100 - 90) \div \frac{1}{2} = 40$ amperes. But 40 amperes at 90 volts is much more power than 20 amperes at 95 volts, and is more than is wanted for the load. What must happen? The machine is synchronous and cannot—physically cannot—run faster so as to take up this power. It tries to do so, with the result that it shifts the phase of its readings, the current now lagging in phase behind the impressed E.M.F.—choked down, in fact, from the 40 amperes to something more than 20. Choked down, in fact, in such an amount as would, if multiplied by the cosine of the angle of lag and by the 90 volts, come up to the same product as the original volts and amperes—viz., $95 \times 10 = 950$. The synchronous motor, if *under*-excited, acts, then, as a choking coil, producing a reaction drop. But continue the experiment the other way. Suppose the excitation is increased so that the 95 volts becomes 100 volts $(100 - 100) \div \frac{1}{2} = 0$, and there would be no current at all to drive did not an adjustment of phases come into play. Instead of the current dropping to zero, more current than before now comes into play, and that current has its pulsations in advance of those of the impressed voltage, there being now an angle of *lead* in the phase relations. In other words, the synchronous alternating motor, if *over*-excited, acts as a condenser, and instead of producing a drop in the voltage tends to raise it by compensating the inductive drop due to self-induction in other parts of the circuit. When the importance of this deduction from Mr. Mordey's curve dawned upon the author, he began to prepare to test it upon the mains of the City of London Electric Light Company. But before any experiments could be even arranged he learned that the same conclusions had been arrived at by the officials of the General Electric Company at Lynn, Massachusetts, and that they had found it in practice to work out favourably. By the courtesy of Mr. W. F. Parshall, one of the engineers of that company, who has been associated for long with Prof. Elihu Thomson, Mr. Steinmetz, and other engineers, the author is able to state the following particulars. They found that in a line where self-induction played the part of a choking coil, it did not matter very much whether the voltage needed for driving the current through the line and machine were situated mainly in the generator or in the motor, as the mean voltage in the line was not far from a mean between that of the two. Accordingly, in a three-phase power transmission at Hartford, Conn., of 300-kilowatt output the motor was arranged to be over-excited. Later, after Mr. Steinmetz had submitted the question to calculation, this feature was introduced into the synchronous motors used in all their recent power transmissions, so that by proportioning the armature reaction and the over-excitation to the self-induction likely to arise, the voltages on the circuit remain quite constant regardless of load within the capacity of the machines. In thanking Mr. Parshall for his information, I may add two points of comment. The advantage so to be derived from over-excitation have indirectly another advantage—viz., that for single transmission cases the motor and the generator may be designed and constructed as identical machines, instead of the motor being made smaller than the generator. Further, the regulation of the voltages in such a network as that of the City of London Electric Light Company, instead of being made more difficult when motors are much used—as was feared by some engineers—will be more easy, provided the motors are of the over-excited synchronous type. For the acceleration of phase these produce in the current, not only tends to compensate for the inductive drop in mains and transformers, but tends to reach right back through the system to the generators in the central station, acting on them as a compound winding would, and assisting them, not only to counteract the inductive drop, but also the ohmic drop, both between the consumers' lamps and the distributing points, and also between these points and the generating station.

So manifest is this advantage, that it would seem worth while to erect at one or possibly more points of the network, as remote as possible from the generating station, synchronous motors over-excited to act as condensers in compensating the inductive drop, or in the primary circuit, also to furnish the idle currents for magnetising the transformer primaries.

With such possibilities open in the future for alternate-current working, and with such advantages in respect of motive power over continuous-current working, it can hardly be doubted that, save in a few special cases, the vast majority of central stations will henceforth be operated by alternate currents.

EXCURSION OF THE ELECTRICAL COMPANY'S EMPLOYES.

The employés of this company, together with their wives, met recently at 122, Charing Cross-road, at 10.30 a.m., where light refreshment was served. Mr. C. R. Fownes, of Montague-street, Montague square, W., supplied two four-in-hand coaches, which started at 11 a.m. Mr. F. T. Eggers, the general manager of the company, tooled one coach, and Mr. Fownes the other. After an enjoyable drive the party arrived at the Thames Hotel at 1.15, where dinner was served. Several toasts were then given, and a speech was made by the general manager, Mr. F. T. Eggers.

Mr. Eggers, in the course of his remarks, stated in reference to the passage-at-arms which took place lately in the House of Lords between a former and a present Prime Minister concerning the aliens, that he would welcome those foreigners into England who conducted themselves in a proper manner, and give those who did not a free pass back to their native land. Concerning electricity, he remarked that when properly manipulated it provided the necessaries for our natural life. If occasionally they met with a loss, it was no doubt only to remind them that their racer, although first favourite, required extremely careful handling. They must not forget their directors, as they had to thank them for the handsome way in which they voted the funds for the outing, besides contributing personally in a very liberal manner. The speaker took the opportunity of thanking all the employés of the company for the considerate way in which they had rendered his task of conducting the firm's business a pleasant and an agreeable one. Friction could of course not altogether be avoided, but in an engineering firm, more so than any other, they ought not to forget that they were all in the same boat, and that they were expected to pull together. Two years ago they were still in the midst of difficulties, which every young concern had to overcome. To-day, with English foresight and German perseverance, they had obtained a place among the most responsible and successful concerns of the electrical world in the United Kingdom.

The toast of "Success to the Electrical Company, Limited," having been honoured, Mr. Eggers was complimented on the successful manner in which he had conducted the firm's business, and his health was drunk with musical honours. The engineer, **Mr. Buhler**, who had just returned from the Continent, proposed the toast of "The Company's Headquarters—The General Electricity Company of Berlin." After dinner some of the party went for a trip up the river in a steam-launch, on the way picking up others who had previously gone to the Vernon Club. Tea was served at six o'clock, and at seven o'clock the coaches started home, reaching Charing Cross-road about 9.30. The weather was everything that could be desired, and a very enjoyable day was spent.

Thomson-Houston System.—The Laing, Wharton, and Down Construction Syndicate, Limited, have acquired for the United Kingdom the patent rights of the Thomson-Houston system for electric lighting and transmission of power, and they will in future carry on business under the new title of the British Thomson-Houston, Limited.

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NATIONAL TELEPHONES.

The long-expected blow has at last fallen—and no one is seriously hurt. For many months, reaching even into years, there have been protracted negotiations going on between the Post Office and the telephone interests: and naturally enough the longer the delay in reaching some definite conclusion or final working arrangement, the greater was the pitch of expectation to which we were all worked up. Rumour indeed was rife to the effect that, after suffering a pretty heavy set-back when the New Telephone Company secured advantageous arrangements with the Post Office two years ago under the auspices of the late Duke of Marlborough, the National Telephone Company had obtained on that nobleman's death such a strong position that the Postmaster-General was practically under their thumb, and nothing less than absolute autocracy in every detail was to be expected in the telephone service for the remainder of the company's existence.

Probably these reports were prompted by a fear of the worst—at any rate, they were hardly founded on fact. The real reason for the delay has more likely been because the National had nothing to gain by hurry, but rather might hope to secure their position in every minute detail by careful discussion of the final agreements which required drafting and accepting in view of the provisional trunk line arrangements already made.

It was, however, hardly to be expected that any serious opposition could be presented by the National Company towards proposals emanating from a Government office. Of course it is quite possible (as was shown by the Board of Trade draft regulations for electric tramways) for Government officials in their zeal for the general welfare to draft rules which might conceivably give temporary advantages on one side or the other; but the reputation of any department for impartiality would prevent such rules from being finally adopted if their effect is pointed out. The shareholders in the National Company might therefore have every confidence that their interests would not be overridden.

Can the same be said of those who, after all, are the mainstay of any telephone service, whether National, New, or Post Office? We mean the subscribers, who too often have just cause for complaint as regards the manner in which their money is taken without an adequate service being rendered. On the whole, it would appear that they will not at any rate be worse off than has been so far the case; and to those who read between the lines, the present parliamentary return just issued (containing what is practically a *précis* of the draft agreements and heads of arrangement already signed) may fairly be said to mark another prominent step towards the final surrender of all telephone business to the State when the National Company's license expires in 1910—that happy day when the question of metallic circuits will not be left for solution to directors or dividends, but will be regarded more as an essential of sound telephone engineering.

At present, however, the agreements now drawn up are concerned mainly, if not entirely, with the

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trunk lines, which, according to the arrangements made two years ago, are to be taken over by the Postmaster-General, and the matter of supreme importance is that of the terms upon which such transference is to be made. These, speaking generally, are in substance identical with the working arrangements outlined in 1894. For instance, the trunk lines already constructed by the National Company are to be taken over at a price equal to the estimated cost thereof to the company (including in such cost all reasonable incidental expenditure), together with a further sum of 10 per cent. of the amount of cost (an item added in respect of cost of administration), and this estimated cost is to be ascertained by two experts in telegraphic engineering, one to be appointed by the Postmaster-General, and the other to be appointed by the company. All differences between such experts are to be settled by arbitration in a summary manner upon the respective statements of such experts, or upon such other materials as the arbitrator may require, but *without the aid of counsel*. It was at first proposed that the purchase-money for these lines should be the cost price thereof as shown by the company's books, plus 10 per cent.; but, "strange to say," the company's books do not show in detail such cost price. The initiated would not wonder at this, but we let the fact pass for the time being.

This arrangement appears to be of a thoroughly business like nature, and those who have no fondness for the law and its intricacies—its quips and cranks, not to say quodlibets and quillets—will feel no great displeasure at the italicised words of the above paragraph. To argue out any matters thus in dispute—especially of so technical a nature—does not require lawyers but engineers, and this procedure might be adopted with advantage elsewhere.

There are, however, two points which require comment in this draft arrangement as to payment for the trunk lines, which, after all, is the most important feature to be discussed. Much will depend upon the experts who are thus to be appointed. We shall in the meantime assume that men of the first calibre will be chosen, men whose decision will be arrived at conjointly and remain unquestioned; but there need be no scruple in calling an undesirable appointment into question.

The next point is that no specific mention is made as to the election or choosing of an arbitrator, unless it be understood that the experts themselves are to decide and call him in to settle matters disputed between themselves. Doubtless this point will be amicably settled in any of the well-known methods: but we would fear difficulties in these directions rather than others.

The National Company is now provided with a definite list of exchange areas within which—and nowhere else—its business may be developed; the Post Office takes over the trunk lines upon terms which may and ought to prove satisfactory, and so we enter upon the second and last stage of the telephone monopoly's existence. When that is ended we shall probably send our complaints (much fewer, let it be hoped) to St. Martin's-le-Grand instead of to Oxford-court. In any case, we can only exchange King Stork for King Log.

THE BRITISH ASSOCIATION.

In another part of this issue we publish some of the papers read before the association, and below we give abstracts of other papers which were also read at the meetings.

Preliminary Experiments for Comparing the Discharge of a Leyden Jar through Different Branches of a Divided Channel.

BY LORD KELVIN, P.R.S., AND ALEX. GALT, B.SC., F.R.S.E.

In these experiments the metallic part of the discharge channel was divided between two lines of conducting metal, each consisting in part of a test-wire, the other parts of the two lines being wires of different shape, material, and neighbourhood, of which the qualities in respect to facility of discharge through them are to be compared.

The two test-wires were as nearly as we have been hitherto able to get them equal and similar, and similarly mounted. Each test-wire was 51cm. of platinum wire of ·006cm. diameter and 12 ohms resistance, stretched straight between two metal terminals at the ends of a glass tube. One end of the platinum wire was soldered to a stiff, solid brass mounting; the other was fixed to a fine spring carrying a light arm for multiplying the motion. The testing effect was the heat developed in the test-wire by the discharge, as shown by its elongation, the amount of which was judged from a curve traced, by the end of the multiplying arm, on sooted paper carried by a moving cylinder. Two of Lord Kelvin's vertical electrostatic voltmeters, suitable respectively for voltages of about 10,000 and 1,500, were kept constantly with their cases connected with the outer coatings of the Leyden, and their insulated plates with the inside coatings of the Leyden.

1. In the experiments hitherto made the two wires to be tested have generally been of the same length. When they were of the same material, but of different diameters, the testing elongation showed, as was to be expected, that the test-wire in the branch containing the thicker wire was more heated than the test-wire in the other branch. In a continuation of the experiments we hope to compare hollow and tubular wires of the same external diameter, and same length and same material.

2. With wires of different non-magnetic material—for example, copper and platinoid—of the same length, but of very different diameters, so as to have the same resistances, the testing elongations were very nearly equal.

3. In one series of experiments the tested conductors were two bare copper wires, each ·16cm. diameter, nine metres long, and resistance ·985 ohm, which, it will be observed, is very small in comparison with the 12 ohms in each of the platinum test wires. One of the copper wires was coiled in a uniform helix of 40 turns on a glass tube of 7cm. diameter. The length of the helix was 35cm., and the distance from centre to centre of neighbouring turns therefore $\frac{7}{8}$cm. The middle of the other copper wire was hung by silk thread from the ceiling, and the two halves passed down through the air to the points of junction in the circuit. The elongation of the test-wire in this channel was more than twice as much as that of the test-wire in the channel, of which the helix was part.

4. One hundred and seventy-one varnished pieces of straight soft iron wire were placed within the glass tube, which was as many as it could take. This made the testing elongation 10 times as great in the other channel.

5. The last comparison which we have made has been between iron wire and platinoid wire conductors. The length of each was 502·5cm. The diameter of the iron wire was ·034cm., and its resistance 6·83 ohms. The diameter of the platinoid wire was ·058cm., and its resistance 6·82 ohms. Each of these wires was supported by a silk thread from the ceiling attached to its middle (as in 3 and 4 for one of the tested conductors). Fourteen experiments were made, seven with the test-wires interchanged relatively to the branches in which they were placed for the first seven. The following table shows the means of the results thus obtained, with details regarding the electrostatic capacities of the Leyden jars and the voltages concerned in the results.

In each case four Leyden jars, connected to make virtually one of capacity ·02742 microfarad, were charged up to 9,000 volts, and discharged through divided channel. The energy, therefore, in the Leyden before discharge was $11{\cdot}105 \times 10^6$ ergs. In each of the first three cases 1,450 volts were found remaining in the jars after discharge; in each of the last four 1,400.

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Energy remaining in Leyden after discharge.	Energy used.	Elongation of testing wires in cms.			
		In channel containing platinoid.		In channel containing iron.	
			means.		means.
·29 × 10⁶ ergs	10·82 × 10⁶ ergs	·01794	·01829	·01226	·01239
,,	,,	·01861		·01247	
,,	,,	·01832		·01244	
·27 × 10⁶ ergs	10·84 × 10⁶ ergs	·01823	·01836	·01276	·01261
,,	,,	·01828		·01280	
,,	,,	·01828		·01244	
,,	,,	·01865		·01244	

The mode of measuring the elongation of the test-wires was, as may be understood from the preceding description, somewhat crude, but it is reassuring to see that the mean results in the cases of 10·82 and 10·84 megalergs of energy used are so nearly equal. The ratios for the two circuits are, in the two cases, respectively 1·48 and 1·46. The conclusion that the heating effect in the test-wire in series with the platinoid wire is nearly one-and-a-half times as great as that of the test-wire in series with the iron is certainly interesting, not only in itself, but in relation to Prof. Oliver Lodge's exceedingly interesting and instructive experiments on alternative paths for the discharge of Leyden jars, described in his book on "Lightning Conductors and Lightning Guards," which were not decisive in showing any general superiority of copper over iron of the same steady ohmic resistance, but even showed in some cases a seeming superiority of the iron for efficiency in the discharge of a Leyden jar. Our result is quite such as might have been expected from experiments made eight years ago by Lord Rayleigh, and described in his paper "On the Self-Induction and Resistance of Compound Conductors."*

Preliminary Experiments to Find if Subtraction of Water from Air Electrifies it.

BY LORD KELVIN, P.R.S., MAGNUS MACLEAN, M.A., F.R.S.E., AND ALEXANDER GALT, B.SC., F.R.S.E.

Experiments with this object were commenced by one of us in December, 1868, but before any decisive result had been obtained, circumstances rendered a postponement of the investigation necessary. A glass U-tube with vertical branches, each 18in. long and about 1in. bore, with the upper 8in. of one of the branches carefully coated outside and inside with clean shellac varnish, was held fixed by an uninsulated support attached to the upper end of this branch. The other branch was filled with little fragments of pumice soaked in strong pure sulphuric acid or in pure water; and a fine platinum wire, with one end touching the pumice, connected it to the insulated electrode of a quadrant electrometer. A metal cylinder, large enough to surround both branches of the U-tube without touching either, was placed so as to guard the tube from electric influences of surrounding bodies (of which the most disturbing is liable to be the woollen cloth sleeves of the experimenters or observers moving in the neighbourhood). This metal tube was kept in metallic connection with the outside metal case of the quadrant electrometer. The length of the exposed platinum wire between the U-tube and the electrometer was so short that it did not need a metal screen to guard it against irregular influences. An indiarubber tube (metal metallically connected with the guard cylinder would have been better) from an ordinary blow-pipe bellows was connected to the uninsulated end of the U-tube. Air was blown through it steadily for nearly an hour. With the sulphuric pumice in the other branch the electrometer rose in the course of three-quarters of an hour to about nine volts positive. When the pumice was moistened with water instead of sulphuric acid no such effect was observed. The result of the first experiment proves decisively that the passage of the air through the U-tube gave positive electricity to the sulphuric acid, and therefore sent away the dried air with negative electricity. A corresponding experiment with fragments of chloride of calcium instead of sulphuric pumice gave a similar result. In repetition of the experiments, however, it has been noticed that the strong positive electrification of the U-tube seemed to commence somewhat suddenly when a gurgling sound, due to the bubbling of air through free liquid, whether sulphuric acid or chloride of calcium solution, in the bend of the U-tube, began to be heard. We intend to repeat the experiments with arrangements to prevent any bubbling of the air through liquid. We have repeated our original experiment with pumice moistened with water in the insulated U-tube, and with an uninsulated U-tube filled with sulphuric pumice between the bellows and the insulated tube, so that the air entering it is artificially dried. With this arrangement the insulated U-tube was negatively electrified by the blowing of the air through it; but this electrification may have been due to the negative electrification of the dry entering air to be expected from the result of our first experiment. We intend to repeat the experiment with artificially-dried and diselectrified air blown through the U-tube containing pumice moistened with water.

* *Philosophical Magazine*, vol. xxii., 1886, p. 469.

Discussion.

The discussion on these papers was neither lengthy nor convincing. The following took part in it: Profs. Quincke, O. Lodge, FitzGerald, Schuster, S. Thompson, and J. J. Thomson. Perhaps, the most important statement came from **Prof. O. Lodge**, who said under the conditions named in the paper, he should not have formed the same conclusions; he should rather have inferred that the results obtained were due to friction, and ventured to predict that by using a metal tube and filtering the air through cotton wool similar results would not be obtained. **Prof. FitzGerald** suggested getting rid of the chemical action by cooling the tube. **Prof. S. Thompson** mentioned analogous phenomena in the voltaic arc, while **Prof. J. J. Thomson** referred to Prof. Stokes's view that the large raindrops in a thunderstorm were a cause and not a result. **Prof. Schuster** thought the differences observed when air was passed through sulphuric acid and water pointed rather to the same conclusions as those indicated in the paper. He had experimented with artificial clouds, but to obtain satisfactory results it needed much larger clouds than could be obtained. His results were of a negative character. The second paper was briefly discussed by **Lord Rayleigh**, **Prof. O. Lodge**, and **Prof. S. Thompson**, Prof. Lodge explaining further his experiment referred to in the paper and page 336 of his book on lightning conductors.

On the Construction of Delicate Galvanometers.

BY PROF. A. SCHUSTER.

Maxwell has shown how a galvanometer must be wound in order to produce the maximum magnetic field for a given resistance. The present communication is intended to show what the advantage gained would be if the winding, which is theoretically best, could be adopted. Assuming the cavity in which the magnet is suspended to be cylindrical, the sensitiveness of the galvanometer will vary with the square root of the resistance, and inversely as the square root of the radius of the cavity. The smallest angle which can be read without making the system astatic, will also depend on the diameter of the mirror—a point which has been neglected in the construction of some recent galvanometers. Taking the resistance of the galvanometer to be one ohm, the diameter of the cylindrical cavity to be one centimetre, and the width of the reflecting mirror to be also one centimetre, the smallest current which a galvanometer will show with a horizontal force of ·17 is, under different conditions, as follows:

If wound in the theoretically, but possible, way, $1{\cdot}60 \times 10^{-8}$ amperes;

If wound on a bobbin of rectangular section of the best dimensions, the wire being uniform in each layer, but changing from layer to layer so as to give the best possible results, $2{\cdot}00 \times 10^{-8}$ amperes;

If wound on a bobbin of rectangular section with uniform wire, the dimensions of the bobbin being the most favourable, $2{\cdot}14 \times 10^{-8}$ amperes.

The advantage gained by having the winding in the way which is theoretically the best is, therefore, not very marked.

A Special Chronograph.

BY HENRY LEA, M.I.C.E., AND ROBERT BRAGGE.

In his capacity as electric inspector for the city of Birmingham the duty of one of the writers is to test the accuracy of the electric meters used in that city. The test involves an accurate measurement, on the one hand, of the current of electricity passing through the meter, and, on the other hand, of the period of time during which the current of electricity effects a certain number of revolutions of the meter armature. For the electrical measurements he selected a Crompton potentiometer, but as his chronograph was not accurate enough he drew up a specification upon which the English Watch Company built the chronograph exhibited to the meeting. The ideal chronograph is one with a perfectly divided dial, an absolute prompt start, a definite stop at zero, and a continuous or running motion of the hand. The test-room chronograph under notice is not intended for use as a watch; it is purely and simply a micrometer applied to time, and therefore it has only two pointers—one from the centre, giving seconds and their fractions, the other placed halfway between the centre and circumference, showing minutes up to 60. The dial of aluminium, being engine divided, is mechanically perfect; and being of large size, 2½in. of sight, the divisions of 10 to the second are clearly defined. The prompt, absolute start is obtained by dispensing with all intermediate gearing and relying on the main train of wheels impelled by the ordinary mainspring. The starting lever not only releases the balance-wheel, but at the same time

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by the momentary contact of a light spring blade impels the wheel in the required direction. The absolute stop at the end of an observation is obtained by the frictional contact of the aforesaid spring blade with the edge of the balance-wheel. The absolute stop at zero is obtained by fixing upon the axis of the seconds wheel a collet carrying a blade. Upon the top of the movement there is a lever, which, during the period of an observation, is held back; but when the observation is concluded it is set free by a push of the button, and falls to a point where it crosses the path of the blade already referred to, and stopping the wheels brings about the absolute stop we require. The last thing requisite is for the seconds hand to have a continuous run. Everything tried up to the present has had a tendency to accelerate its rate, and is therefore inadmissible. The lever escapement has been adhered to, and by using hard stone jewellings, and by observing great accuracy in the angles of the pallets, the makers are enabled to double the ordinary number of beats—36,000 instead of 18,000—and although in every beat there are three processes, the whole follow so smoothly that the progression of the hand is practically continuous.

The Most Economical Temperature for Steam-Engine Cylinders; or, Hot v. Cold Walls.

BY BRYAN DONKIN, M.I.C.E.

Summary.—The author calls attention to the important question of the most suitable temperature of cylinder walls to obtain the maximum economy by reducing condensation in steam-cylinders to a minimum. To diminish condensation his experiments prove that it is essential to reduce the difference of temperature between the incoming steam and the cylinder walls. In most cases the cylinder walls are much colder than the steam, and often one-half the weight of steam is condensed during admission. Many experiments show that the nearer the temperature of the cylinder wall is to that of the entering steam the greater is the economy. With walls 40deg. to 60deg. F. colder than the steam, as is often the case, the consumption is greatly increased, owing to the large amount of condensation. On the other hand, the cylinder metal can be made too hot and heat wasted at exhaust. This has also been experimentally proved by the author. The best results in steam economy have been obtained when the temperature of the internal surfaces is a little higher than that of the entering steam. Cylinder walls can be heated in various ways. The most usual is to raise their temperature and that of the covers, by means of boiler steam introduced into the jacket spaces. Another method, and one used a good deal on the Continent, is to work with super-heated steam. This steam has been employed in some cases with advantage in the jackets as well as in the cylinders. Smoke jackets have generally proved a failure. When the jacket is connected to a condenser having a good vacuum, economy of steam is also obtained, but not so much as with steam in the jackets. To secure the maximum economy also, it is important not only to diminish the volume of the clearance spaces, but especially to reduce as much as possible the area of the clearance boundary surfaces. In this way the weight of iron heated and cooled per stroke so many degrees can be materially diminished. The character of the internal surfaces, whether rough from the sand or turned, and their position, horizontal or vertical, have also some influence on the transmission of heat and condensation of steam, as verified by recent trials. Experiments have also shown that the cylinder wall in any working steam-engine is divided thermally into two parts; the outer portion remains at a constant temperature and the inner or periodic portion is heated with each steam, and cooled with each exhaust stroke. The relative proportion of these two parts, or the depth to which the heat penetrates into the metal, depends largely upon the speed of the engine, and on the temperature of the cylinder relatively to that of the entering steam. In a non-jacketed engine, with 1in. cylinder walls, working at 35 revolutions per minute, the depth to which the heat penetrates and fluctuates per stroke is at least about eight to nine millimetres from the internal surface. The depth of heat penetration for the same speed is much less with hot than with cold walls; a less weight of metal is heated per stroke, and condensation is found to be much reduced. The author gives some of the results of 80 experiments on a small vertical engine, with cylinder 6in. diameter and 8in. stroke, made expressly for experimental research. The details are to be published in the *Proceedings* of the Institution of Mechanical Engineers. The engine was worked with very different temperatures of walls, and many tests were made, condensing and non-condensing, jacketed and non-jacketed, single and double acting, at different expansions, and with both saturated and superheated steam in the cylinder and jackets. Care was taken in these experiments only to vary one set of conditions at a time. Results of two experiments are added, one with hot and the other with cold walls, or one with steam and the other with air in the jackets. Both tests were made condensing, double-acting, with 50lb. steam pressure, 3-16 cut-off, and at a speed of 220 revolutions per minute. The walls were some 30deg. F. hotter with than without steam in the jackets; the steam consumption per indicated horse-power hour was reduced from 41¼lb. to 28⅓lb., or about 31 per cent.; the thermal efficiency was increased from 5·7 to 8·1 per cent., or 40 per cent.; and the rate of initial condensation was reduced from 460lb. to 217lb. per square foot per hour, or by more than one-half. The percentage of steam present in the mixture during expansion was also increased by about 50 per cent. Throughout these experiments an increase of economy with the hotter walls was always verified; the thermal efficiency was higher, the initial condensation less, and the percentage of steam present during expansion always increased. The tests on this engine point to the practical conclusion that the range of steam temperature in the cylinder per stroke has much less effect on the steam consumption than the temperature of the walls. The paper may be shortly summarised thus: The most uneconomical results were always obtained with the cylinder walls colder than the entering steam. Under these conditions considerable initial condensation was produced, drops of all sizes up to 3mm. diameter being formed and running down the cold surfaces. The heat also penetrated into the colder walls to a considerable depth, a certain quantity being given up by the steam at every stroke, to raise the temperature of the internal surfaces after exposure to the condenser temperature. Both at cut-off and release there was a great deal of water in the cylinder compared with the weight of steam present. On the other hand, the most economical results were always obtained when the cylinder walls were at about the same temperature as that of the entering steam. Under these conditions the rate of initial condensation was very much lower, and the drops of water formed much smaller in size. The heat penetration into the walls was also much less, a smaller amount of steam sufficing to heat the internal surfaces after being cooled by the condenser. The percentage of steam present in the mixture, at cut-off and release, was also very much increased. If engineers and others using steam-engines wish to work economically and with smaller boilers, they must arrange to keep their boilers and covers as hot as the steam entering the cylinder; otherwise the cylinder becomes unintentionally an efficient condenser, with a large area of cooling surface. Properly applied steam-jackets are economical, because they raise the temperature of the walls touched by the steam. Those who cannot steam-jacket the whole cylinder should at least jacket the two covers, which are the most important surfaces. Well-arranged jackets with properly-sized pipes for entering steam and exit water, without places for air to collect, are an excellent investment, and pay a good interest on the small additional cost.

On Engineering Laboratory Instruments and their Calibration.

BY DAVID S. CAPPER, M.A., PROFESSOR OF MECHANICAL ENGINEERING, KING'S COLLEGE, LONDON.

The reliance to be placed upon observations made with measuring instruments evidently depends primarily upon the accuracy with which those instruments record. Neglect of this fundamental truth often leads to inaccurate and erroneous deductions from experiments which are themselves of the highest scientific value; not infrequently the whole value of observations may be destroyed by insufficient care in the calibration of the instruments used. The subject is therefore one of some importance. The author describes the chief sources of error in some of the most common engineering investigations and their probable value, and points out some of the possible methods of correction where such exist. For example, in engine trials there are many possible sources of error. Most of these may be reduced in percentage value by continuing the trial for a sufficient period. But this is not the case with errors which may occur in the indicators, gauges, or spring balances used in the determination of power. In these, unless properly calibrated before trial, very serious errors may be introduced, amounting in some cases to 5 and 6 per cent. of the total power indicated. It is therefore absurd, even if proper precautions have been taken, to rely upon horse-power measurements to two places of decimals. Similarly with regard to tension and compression experiments with standard 10in. bars. Here calibration of the testing machine is extremely difficult, and can in general only be carried out over a small portion of the range of the experiments. Deductions have therefore to be made from the less to the greater, with the result that small errors in the calibration will tend to be magnified. Vertical testing machines have fewer sources of error, and can be calibrated with more certainty, than horizontal machines. Extensometers are, however, much more easily applied to a horizontal bar than a vertical, and variable jockey weights, which are requisite if the same accuracy is to be maintained at low loads as at high, are also more readily adapted to horizontal machines. Extensometers can be made and calibrated well up to the accuracy of the testing machine. With standard bars and a measuring instrument true to the ten-thousandth of an inch, the modulus can be relied upon to the

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second significant figure. It is doubtful if more can be obtained without very special construction and calibration of the testing machine. The difficulty in bending experiments, again, lies in the accurate application of load. Unless the beams are very short, or of unmanageable cross-sections, the load measurement must be very delicate if readings approaching the accuracy of those in tension are to be obtained. It is possible that some of the discrepancies in published beam experiments may be due to this cause. The paper deals shortly with other cases where calibration is specially needed, to which the limits of this abstract do not permit a more extensive allusion.

Lighthouse Apparatus and Lighthouse Administration in 1894.

BY J. KENWARD, F.S.A., LIGHTHOUSE ENGINEER.

The writer referred to the principles that govern the establishment of modern lights, and described the chief forms of apparatus now best available for the optical engineer—*e.g.*, the single-flashing or the group-flashing holophotal revolving; the fixed and occulting; the lenticular revolving, having refracting centres alone, extended to high vertical angles; and the quick-flashing lights of recent French types called *feux-éclairs*. He compared the dimensions or "orders" of various apparatus, and the radiants of gas, oil, and electricity, and discussed the question of fog in relation to these. He called attention to the need of good ship-lights on the dioptric system, having equality of power in the beam. He suggested certain reforms in lighthouse administration and in lighthouse statistics. The paper was illustrated by drawings, photographs, and tables.

The Electrolytic Methods of Quantitative Analysis

Report of the Committee, consisting of Prof. J. EMERSON REYNOLDS (chairman), Dr. C. A. KOHN (secretary), Prof. P. FRANKLAND, Prof. F. CLOWES, Dr. HUGH MARSHALL, Mr. A. E. FLETCHER, Mr. D. H. NAGEL, Mr. T. TURNER, and Mr. J. B. COLEMAN.

The first work undertaken by the committee has been the compilation of the bibliography of the subject, with which some progress has been made. In addition, the plan on which the experimental part of the work is to be carried out has been arranged. This is to include the investigation of the methods for the determination of the following metals: silver, lead, mercury, bismuth, cadmium, tin, antimony, iron, zinc, manganese; and subsequently of the methods for the separation of these metals both from one another and from other metals. This is all the committee undertook to do when they were appointed without a grant of money. They now ask to be reappointed, and with a grant of £40.

SIGNALLING THROUGH SPACE.*

BY W. H. PREECE, C.B., F.R.S., ETC.

Whenever an electric current rises or falls in a circuit another current is simultaneously induced in every neighbouring conductor, if it form part of a circuit and be separated from the former by some insulating medium or dielectric, such as air. This secondary current flows only during the period of rise or of fall of the primary current.

Hence, if the primary current rises, falls, or changes its direction regularly and repeatedly a given number of times per second, the induced secondary currents will alternate with the same regularity and frequency. The intensity of these secondary or induced currents, among other things, will depend upon the character, form, and direction of the circuits, and upon the distance which separates them from each other. That such secondary currents, or electromagnetic disturbances, as they are called, existed has, of course, been known since the days of Faraday; but that they could be observed, measured, and utilised at a distance of some miles from the primary circuit was not suspected before the introduction of that marvellous, sensitive instrument—the telephone.

When these disturbances are rhythmic, musical sounds are produced in telephones fixed in the secondary circuits, but when they are irregular unpleasant noises alone are heard. If the sounds are preconcerted and directed, like the dots and dashes of the Morse code, then telegraphy is possible, and we have a means of signalling through space without wires. The distance to which we can signal is limited only by the distance to which these electromagnetic disturbances, in their transit through space, retain sufficient energy to actuate our apparatus. The ether is supposed to be the real medium of transmission, and not the air. The disturbances through the ether take the form of undulations or waves, and in character they are similar to those radiations which at other frequencies gives us heat, light, and photography. They move with the same velocity; they are subject to the same operations of reflection and refraction; and they differ only in the number excited per second.

Thus, to deal with the subject of signalling through space we must have a primary conductor in which alternating electric currents can be excited at will. They must alternate with a frequency that will pleasantly affect the ear—say, about 600 per second. They must be manipulated so as to produce preconcerted signals. The primary circuit must be freely exposed in the ether, and the secondary circuit, which it is desired to excite, must not be screened from the primary by means of magnetic or conducting matter. The object of this lengthened enquiry has been to determine the best form of primary and secondary circuit, the function performed by the earth as a part of the circuit, and the distance to which communication is possible with the ordinary practical means at our disposal.

The telephone as an instrument of precision is scarcely sufficiently appreciated. The ear can be trained by its aid to measure graduations of sound as accurately as the eye determines the calibrations of engraved scales. In Hughes's induction balance we have a well-determined absolute zero of silence, and there are many well-defined nodes of sound which may be taken as fiducial points in a telephonic scale. The limit of speech where articulate sounds cease to be comprehensible is one, the limit of Morse signals where telegraphic reading becomes impossible is another. It is quite easy to determine the similar intensity of two sounds, as in photometry the eye determines the similar intensity of two illuminations. The ear, however, requires to be educated, and it is subject to fatigue; but when properly trained, and when assisted by the telephone, it can be used to observe effects with as much reliability as the eye.

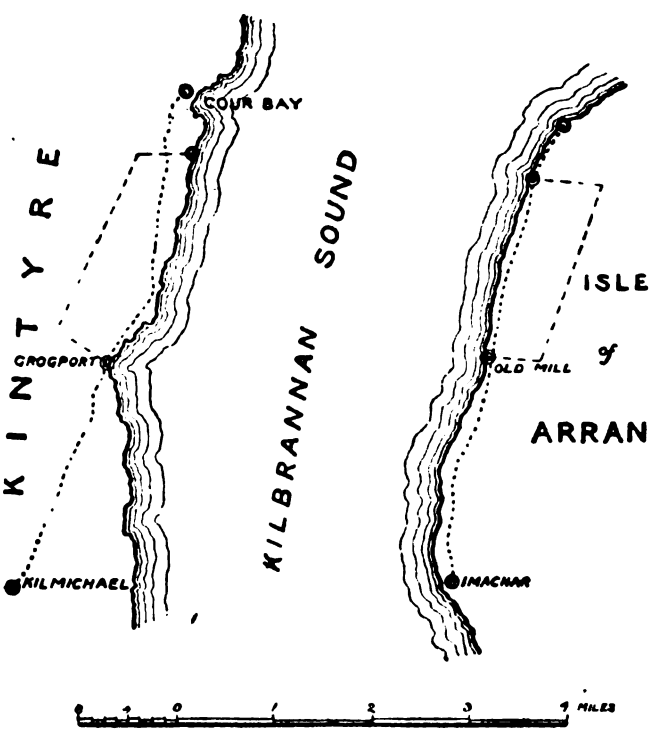

FIG 1.

My attention was first directed to the subject in 1884. In 1886 I brought it before this association at Birmingham, and again at Manchester in 1887. In August, 1893, I reviewed, before the Electrical Congress at Chicago, the whole of my previous nine years' work. Much experimental work has been done during the past 12 months. In 1884 electromagnetic disturbances were detected between telegraph circuits and telephone circuits 80ft. apart, the former in the streets underground in London, and the latter on the housetops; but in 1885 these effects were perceptible between parallel lines of telegraph 10¼ miles apart. The permeability of stone walls and buildings to electric waves was shown by Henry in 1842, when the discharges of a Leyden jar in the top floor of his house induced sparks in a circuit in the cellar. Sonorous vibrations were reproduced in a telephone circuit in the basement of the G.P.O. in 1886 by the induction of a primary circuit excited by the voice in the upper corridor, 80ft. away. Speech was found possible between insulated coils of wire a quarter of a mile apart. Telegrams in 1893 were transmitted across a distance of 31 miles on the Bristol Channel. Regular communication was held last winter across Loch Ness, a distance of 1¼ miles, and recently at a much greater distance, between Arran and Kintyre, across Kilbrannan Sound. Across Loch Ness speech was maintained.

But this is not all. There is every reason to believe that

* Paper read before the British Association at Oxford.

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we have detected distinct disturbances in our telegraphic circuits due to great electrical storms in the sun's photosphere 92,000,000 miles away.

The fact that these signals across space are effects of induction, transmitted through the air or the ether as the dielectric, is beyond the region of doubt, for they were produced between isolated and insulated coils, each forming a complete metallic circuit; but the part played by the earth at short distances when the earth was used to complete the circuit was not so clear. Very exhaustive experiments were made on the sands in the Conway estuary in 1893, and again at Frodsham on the estuary of the Dee in 1894. These experiments were conducted for me by Mr. Gavey and Mr. H. R. Kempe. Further experiments were made by Mr. Gavey and Mr. Cooper on opposite sides of Loch Ness, a distance of 1¼ miles, and between the Island of Arran and Kintyre, where parallel wires four and five miles apart were available for use.

In the Conway estuary and at Frodsham, squares and rectangles were formed of insulated wires, and numerous measurements were made, both with reflecting galvanometers and with telephones, of the effects due to varying currents in the primaries, and at varying distances between these and the secondaries.

At Loch Ness two parallel wires on opposite sides of the loch were taken. Between Arran and Kintyre, Fig. 1, two parallel lines on opposite sides of the Sound, and four miles apart, were taken; and, in addition, two guttapercha wires were laid along each coast at a height of 500ft. above the sea-level, and five miles apart horizontally.

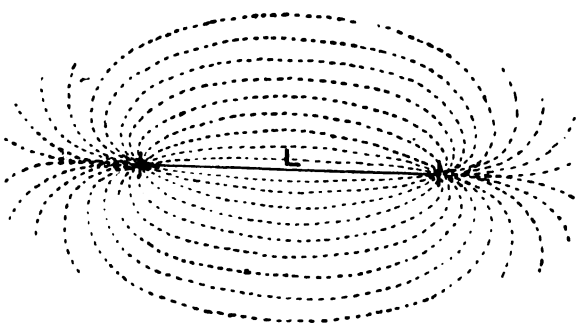

FIG. 2.

The general results and the conclusions arrived at may be briefly summed up as follows: The earth acts simply as a conductor, and *per se* it is a very poor conductor, deriving its conducting property principally, and often solely, from the moisture it contains. On the other hand, the resistance of the "earth" between the two earth-plates of a good circuit is practically nothing. Hence it follows that the mass of earth which forms the return portion of a circuit must be very great, for we know by Ohm's law that the resistance of a circuit increases with its specific resistance and length, and diminishes with its sectional area. Now, if the material forming the "earth" portion of the circuit were, like the sea, homogeneous, the current-flow between the earth-plates would follow innumerable but definite stream lines, which, if traced and plotted out, would form a hemispheroid. These lines of current have been traced and measured. A horizontal plan on the surface of the "earth" is of the form illustrated in Fig. 2, while a vertical section through the "earth" is of the form shown in Fig. 3.

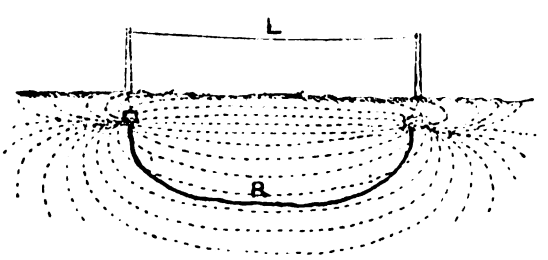

FIG. 3

With earth-plates 1,200 yards apart these currents have been found on the surface at a distance of half a mile behind each plate, and in a line joining the two transversely they are evident at a similar distance at right angles to this line.

Now this hemispheroidal mass could be replaced electrically by a resultant conductor, R, Fig. 3, of a definite form and position; and in considering the inductive action between two circuits having earth returns, it is necessary to estimate the position of this imaginary conductor. This was the object of the experiments at Frodsham.

If the material of the earth be variable and dry the hemispheroid must become very much deformed and the section very irregular, the lines of current-flow must spread out further, but the principle is the same, and there must be a resultant return. The general result of the experiments at Frodsham indicate that the depth of the resultant earth was 300ft., while those at Conway are comparable with a depth of 350ft.* In the case of Frodsham the primary coil had a length of 300ft., while at Conway the length was 1,320ft. At Loch Ness and between Arran and Kintyre, where the parallel lines varied from two to four miles, the calculated depth was found to be about 900ft. The depth of this resultant must therefore increase with the distance separating the earth-plates, and this renders it possible to communicate by induction from parallel wires over much longer distances than would otherwise be possible.

The first and obvious mode of communicating across space is by means of coils of wire opposed to each other in the way familiar to us through the researches of Henry and Faraday. All my illustrations of the principles involved in effecting this object have consisted in opposing two similar coils of wire having many turns, the one coil forming the primary circuit and the other coil the secondary circuit.

Vibratory or alternating currents of considerable frequency were sent through the primary circuit, and the induced secondary currents were detected by the sound or note they made on a telephone fixed in the secondary circuit.

The distance to which the effective field formed by a coil extends increases with the diameter of the coil more than with the number of turns of wire upon it. A single wire stretched across the surface of the earth, forming part of a circuit completed by the earth, is a single coil, of which the lower part is formed by the resultant earth return, and the distance to which its influence extends depends upon the height of the wire above the ground, and the depth of this resultant earth.

Obviously in establishing communication by means of induction there are three dispositions of circuit available—viz. (*a*) single parallel wires to earth at each extremity; (*b*) parallel coils of one or more turns; (*c*) coils of one or more turns placed horizontally and in the same plane.

The best practical results are obtained with the first arrangement, more especially if the conformation of the earth admits of the wires being carried to a considerable height above the sea, whilst the earth-plates are at the sea-level. By adopting this course the size of the coil is practically enlarged, and even if it be necessary to increase the distance between the parallel wires to effect this object the result is still more beneficial. In a single-wire circuit we have the full effect of electrostatic and electromagnetic induction, as well as the benefit of any earth conduction, but in closed coils we have only the electromagnetic effects to utilise.

In one experiment two wires of a definite length were first made up into two coils forming metallic circuits, then uncoiled and joined up as straight lines opposed to each other, with the circuit completed by earth. The inductive effects, and the distance between which they were observable, was very many times greater with the latter than with the former arrangement.

Incidentally some extremely interesting effects of electromagnetic resonance were observed during the experiments in Arran. A metallic circuit was formed partly of the insulated wire 500ft. above the sea-level, and partly of the ordinary line wire on the water-level, the rectangle being two miles long and 500ft. high. Wires on neighbouring poles, at right angles to the shorter side of the rectangle, although disconnected at both ends, took up the vibrations, and it was possible to read all that was signalled on a telephone placed midway in the disconnected circuit.

I have not succeeded in determining satisfactorily the general law which regulates the distance to which one can speak, and I scarcely hope to do so. There are so many disturbing elements introduced, geological as well as electrical. In practice we have to deal with two complete circuits of unknown shape and in different planes. We have obtained some remarkably concordant and accurate results in one locality, but we have met with equally discordant results in another locality. I fear we are beyond the reach of the mathematician. In the appendix I have shown the formulæ that gave the most reliable results.

The mechanism of the mode of signalling across space is not difficult to follow. Its analogue is a flash of light seen at a distance. Energy is expended, say, in a lighthouse on some dangerous rock, or in a gun firing some warning signal, or in a bonfire on some mountain top. The energy assumes the luminous form exciting the ether to undulate with a frequency of many millions per second, which, acting upon the retina of the eye, produce the sensation called light. The burning of the oil lamp of the lighthouse is the primary source of energy; the rapid undulations of the ether propagated in straight lines at a velocity of 186,000 miles per second are the radiation, transmitting this energy in a wave form to the distant ship; the eye is the apparatus which transforms the energy of the light-waves into a form which excites consciousness in the brain.

In our electrical experiments the primary energy is in the current form, the comparatively few alternations per second excite waves in the ether of a few hundreds per second only. But these oscillations of the ether or electric waves are of the

* These figures are obtained from the use of the formula $Q = K\left\{\log\left(\frac{l^2}{d^2}+1\right)\right\}$ which is given in Appendix I.

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same character as those of light, they move with the same velocity, and when they fall on a sympathetic secondary conductor, they excite in that conductor currents of electricity of the same frequency; and if a telephone be inserted in that circuit and applied to the ear, sounds and musical notes are distinctly heard, which, by preconcerted measures, such as the use of the Morse code, can be utilised for the transmission of messages. Thus messages were sent across the Bristol Channel between Penarth and Flat Holm Island, 3·1 miles away. Speech was maintained in the Highlands across Loch Ness, 1¼ miles broad, and telegrams were transmitted from Kintyre to Arran, across distances of four and five miles, and thus we could readily communicate between England and France, or between outlying islands and the shore, when the conditions admit of the erection of the necessary circuits.

A somewhat fascinating branch of this subject is the possibility of signalling across planetary space. Signalling between one planet and another is merely a question of degree. Magnetic storms and earth currents have some intimate connection with the sun, although Lord Kelvin has questioned the reality of the fact. The great storms and sun spots of March 30 and 31, 1894, were accompanied by very marked and peculiar sounds in telephones inserted in our long telegraph circuits. The storm of July 20 was not so distinguished. Strange, mysterious, weirdlike sounds are frequently heard on long lines of telegraph in the calm stillness of the night, but whether due to terrestrial or to cosmic causes remains to be discovered. The sun's photosphere, when disturbed by spots, may be subject to violent electrical storms, and those vast clouds of incandescent hydrogen that flame up with terrible velocity may excite electrical oscillations through etherial space of such a frequency as to influence our terrestrial circuits. We may thus hear on earth the electric storms of the sun. But this is mere speculation, and the evidence before us at present is not sufficient to justify positive deduction. We shall continue to watch and record, and it is hoped that observers in other parts of the world will assist by making use of the telephones and telegraph lines at their disposal.

The practicability of this method of effecting communication is now solved, but the subject possesses great scientific interest from the views it imparts of the mechanical character of electrical waves, of the molecular theory of electricity, and of the great distances at which electromagnetic disturbances are perceptible.

Appendix I.

The following are the formulæ on which the foregoing calculations are based:

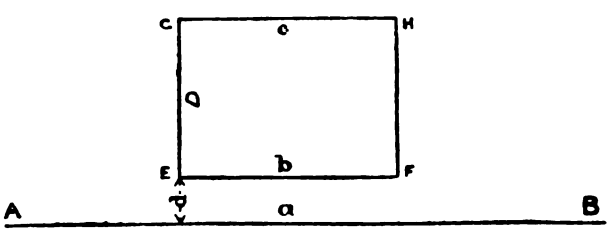

Fig. 4.

Let A B (a), Fig. 4, be an infinitely long wire, and b and c be two wires forming parallel sides of a rectangular circuit, E F G H; then, if a current be set up in A B, the lines of force cutting E F and G H will cause a momentary current to be set up in the rectangle, so that

$$Q = K\{\log (D+d) - \log d\} = K \log \frac{D+d}{d},$$

where Q is the quantity induced.

K is a constant depending on the length of the sides G H, E F of the rectangle in centimetres, the current strength in amperes in the wire A B, and the total resistance in ohms of the rectangle.

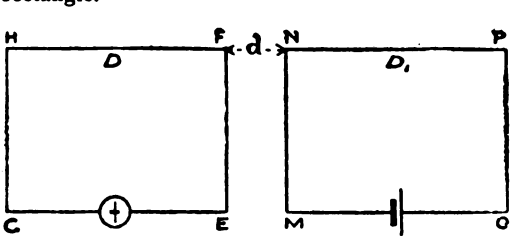

Fig. 5.

Within certain limits this formula is approximately correct even if the wire A B is not infinitely long, but makes one face of a second rectangle similar in form to the induced rectangle E F G H, and set either in the same plane with, or at right angles to, the first rectangle; but in such cases the formula has to be corrected to allow for the influence of the second face of the inducing rectangle as follows.

With two rectangles in the same plane, Fig. 5, the total effect produced by the two faces, M N, O P, of the inducing rectangle is

$$Q_1 = K\left\{\log \frac{D+d}{d} - \log \frac{D_1+d+D}{D_1+d}\right\}.$$

If the two rectangles are at right angles to each other, Fig. 6, and l is large compared with D, then the formula becomes

$$Q_2 = K\left\{\log \frac{D+d}{d} - \tfrac{1}{2}\log \frac{D_1^2+(D+d)^2}{D_1^2+d^2}\right\}.$$

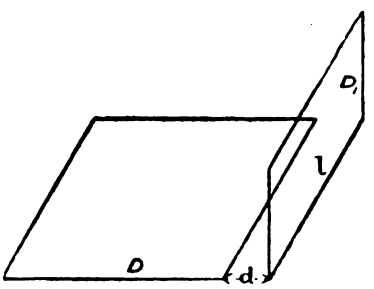

Fig 6

Again, if the two rectangles are parallel and equal, Fig. 7, and l is large compared with D, then

$$Q_3 = K\left\{\log\left(\frac{D^2}{d^2} + l\right)\right\}.$$

These formulæ take into account the effects on the wires in the secondaries which are parallel to the primaries, but not the effects of those at right angles to them. The latter oppose the main induced current, so that in practice this current diminishes more rapidly with the distance than the log law indicates.

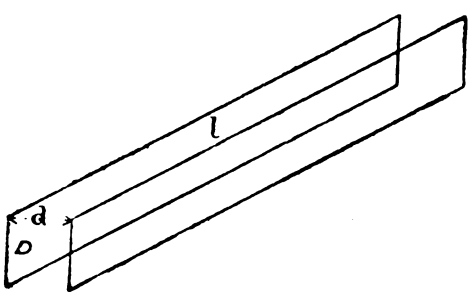

Fig. 7

The problem is very intricate, but Mr. Kempe, to whom I am indebted for the formulæ, still hopes to obtain a final and accurate solution.

Appendix II.

The following letter appeared in *Nature*, April 12, 1894:

Earth Currents.

The Astronomer Royal was kind enough to show me the permanent photographic records of earth currents during the great magnetic storm on February 20-21, and they indicated so unmistakably such rapid and violent alternations that I supplied our principal relay stations with telephones, and with instructions to insert them in circuit whenever they observed indications of disturbances. This happened on March 30-31, during the display of the aurora borealis. Mr. Donnithorne, in Llanfair P.O., Anglesea, reports: "At 2 a.m. (Saturday) the telephone receiver was again tried, and then 'twangs' were heard as if stretched wire had been struck, and a whistling sound. The strength of the earth current was 17·7 milliamperes." Mr. Miles, in Lowestoft, reports: "Noise on 408 (Liverpool-Hamburg) wire seemed like that heard when a flywheel is rapidly revolving," and "sounds in telephone appear like heavy carts rumbling in the distance." Mr. Scaife, in Haverfordwest, reports: "March 31, 2.5 a.m. Earth currents on all wires; wires completely stopped. . . . Peculiar and weird sounds distinctly perceived, some highly-pitched, musical notes, others resembling murmur of waves on a distant beach. . . . The musical sounds would very much resemble those emitted by a number of sirens driven at first slowly, then increased until a 'screech' is produced, then again dying away. Duration of each averaged about 20 seconds." These experienced observers, situated at three distant points, and perfectly acquainted with the ordinary inductive disturbances on telephone circuits, simultaneously observed and independently recorded their own impressions of peculiar sounds exerted in telephones by very rapid alternations or pulsations of currents which accompanied or were consequent on sun spots, earth currents, and the aurora borealis. W. H. Preece.

G.P.O., April 9.

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THE HUNTING OF GOVERNED ENGINES.*

BY JAMES SWINBURNE, M.I.C.E.

Lord Rayleigh pointed out some years ago† that the ordinary explanation of the action of the electromagnet in an electrically-driven tuning fork is incorrect, and that such a mechanism works in virtue of the self-induction of the electromagnet. As far as the action of the contact goes, it is the same whether the leg of the fork is receding from the magnet or approaching it; and if the force depended only on the contact, and was symmetrical, no power would be supplied to the system. It would be like a pendulum which is acted upon by gravity equally whether the bob is going up or coming down. To make the pendulum work continuously, gravity would have to act more when the bob was coming down. As this cannot be arranged a clock has to do the work instead. In the case of Lord Rayleigh's tuning fork, the magnet pulls harder when the leg is coming towards it than when receding, and thus gives power to the fork. In other words, the effect of the magnet lags, and thus becomes unsymmetrical. This is a most important principle, and it applies to a large number of varied cases of great importance, and of more interest to engineers than even electrically-driven tuning forks. Broadly speaking, all kinds of continued vibration may be said to depend on this principle. Among these cases is that of the hunting of governed engines.

If a governor really behaved as it does in most text-books, and admitted steam in exact accordance with the speed of the engine, there would be no such hunting; but, unfortunately, a governor does not follow the variations of speed instantaneously. Apart altogether from questions of friction or movement of heavy valve or expansion gears, many forms of governor, especially what may be described as the relay kind, alter the steam admission with some delay. The friction of the various parts and their tendency to remain in one position until the disturbing force comes up to a certain value, and to then move suddenly and overshoot the mark, increases this action. The result of this time lag in the action of governers is that in many cases engines, especially on light loads, get into a state of vibration known as hunting.

The orthodox way of treating such a subject would be to begin with the discussion of an engine with a flywheel and a frictionless governor with a dashpot or something of the sort, following a simple law. A system might thus be imagined which would fit a differential equation such as that used to find the current when an electrical condenser is discharged through an inductive circuit; and it might be possible to calculate the load which would just prevent permanent hunting, or any hunting at all. There are immense difficulties, however, for there are so many small causes of disturbance that such treatment would probably give no useful information. It may be best, therefore, to discuss the question verbally only, without expecting to arrive at very definite results.

When the load of an engine varies, for instance, by decreasing, if the steam supply remains the same, the extra energy goes to increasing the speed of the flywheel. Whether the speed of the engine follows the steam supply quickly or not thus depends on the flywheel. It also depends on the load. If 1,000 h.p. is working at full load, and 900 h.p. is suddenly thrown off, and the governor does not act instantly, 900 h.p. is devoted to increasing the velocity of the flywheel, and unless the wheel has an enormous moment of inertia, or is turning very quickly, this power will increase its speed, say, 2 per cent. in a very short time. On the other hand, if the engine is only doing 100 h.p., and this load is suddenly reduced to 10 h.p., there is only 90 h.p. to increase the speed of the flywheel, and to increase it 2 per cent. will take 10 times as long as in the former case. Putting the matter the other way, the engine obeys variations of steam supply more slowly at light loads, or, in other words, it obeys its governor more tardily at light loads. In practice, many engines which run steadily at full load hunt terribly when worked light.

Turn now to the governor. It is generally treated as complete in itself, without reference to the flywheel or engine load. A simple Watt governor and most of the governors on small engines have no appreciable time lag, except a certain sticking, due to friction, or to the absurd practice of putting a comparatively small governor to work direct on to a heavy expansion gear, or a stiff stuffing-box. These matters have been discussed in an able paper by Ransom‡ recently. There is not very much tendency to hunting with such governors. Their drawback is that as the steam must be nearly shut off at no load, and full on at full load, the valve gear must be in different positions, and the governor must, therefore, be in different positions too. This means that the engine will be governed at a considerably higher speed at light loads. To cure this the obvious course is to make the governor isochronous. The drawback to this is that an ordinary isochronous governor is not powerful enough if it has to move through a long range with a very small percentage of speed variation. It is likely to stick until the speed has varied a good deal, and then to move to its fullest extent. The result of this would be that the engine would be governed by having full steam and none at all alternately. I do not know why this method of governing should not be employed. If the governor works some light gear, such as the various modifications of the Corliss, this form of governor should work very well with a large flywheel. The cylinder would either get a charge of steam which would correspond to the full engine load, and which would, therefore, be expanded and worked in an economical way, or it would get none. This alternation of full load and no load is common in gas-engines, and, for distinction, may be called the hit-and-miss method of governing. The only steam-engine I know which employs it is the Parsons steam-turbine. Of course, the great difficulty is the flywheel, especially in a slow-speed engine. If working at a tenth of its load it gets steam only every tenth revolution, and the flywheel must carry it round for nine. As high speeds are gradually coming in, it may be worth while to keep this method of government in mind, as it is most economical of steam, and as there is no time lag in the governor, there is no hunting.

Returning to the isochronous governor, the obvious method of overcoming the friction or weight of valve gear is to use some relay—to use a convenient electrical expression. The governor does not then act directly on the valve gear, but puts some screw or other mechanism into gear, which works the expansion or throttle valve. Willans used a water relay. The governor worked a minute water-valve, controlling a cylinder which worked the throttle valve. Such an arrangement can be made very accurate, as a very small movement of the governor, opposed by a very slight force, can be made to work the most obstinate valve gear. But we have at once danger from hunting, as there is considerable time lag in the governor. Suppose the load is suddenly decreased, the engine speeds up and the governor begins to increase the expansion, but effects this slowly, and by the time the valves are right for the reduced load the engine is much above speed. The governor, therefore, goes on reducing the steam until the engine has far too little. It therefore slows down again. But the governor continues reducing the steam until the engine is slowed down to its normal speed. By that time the engine has far too little steam, so it goes on falling in speed. The governor then begins to turn on steam again, but it does it so slowly that the engine has fallen far below speed before the normal steam supply is given, and the governor goes on turning up steam till the engine arrives at its normal speed, when it has far too much steam and is again rapidly increasing in speed. This cycle of operations is repeated over and over again. It depends on the lag of the governor, the flywheel, and the load, whether the hunting is temporary, so that the variations of speed are less and less every time; or permanent, in which case the engine alternates between no steam and, perhaps, full supply. An engine which hunts permanently at very light loads often works perfectly over half-load.

An ordinary governor is thus apt to be insensitive and to allow the speed to vary with the load if designed not to hunt; and if arranged to work a relay, hunting results. An isochronous governor with a dashpot has, of course, a time lag too.

It is easy to make a governor which combines the advantages of both systems and avoids the drawbacks.

A governor made by Messrs. Weyher, Richemond, and Co., of Pontin, may be cited as a good example. It is not isochronous, and it works directly on the steam control. I may mention that even in small engines the French arrange the valve gear so that it is very easily controlled. The variable detent is very common. In addition to working the steam control direct, any movement of the balls from the normal position puts a screw gear into motion, which slowly alters the intermediate gear, so that the engine finally runs at the normal speed, whatever the load is. It is unnecessary to describe the particular gear employed; a typical case may be imagined. Suppose the expansion link is in connection with the middle of a lever, and the governor with one end, the other end being fixed; an increase of speed raises the first-mentioned end of the lever and the middle, and you have an ordinary non-isochronous governor which gives a higher speed at light loads. Suppose, however, that any rise of the first-stated end of the lever sets a train to work which slowly raises the other end, it will go on till the governor is in its normal position. We thus get a governor which does not hunt, and gives the same speed at all loads. If the valve gear is heavy or stiff, the governor may work one end of the lever by means of a relay, but it must be a following relay, such as those employed in steam steering gear, so that the extent, as well as the direction of the movement of the governor end of the lever, is controlled by the position of the governor, and this gear should act as promptly as possible to avoid hunting. The other, or relay gear, then works slowly. In such a governor it will be seen that the first-mentioned end of the lever eventually comes to its normal position in all cases, and only moves to counteract sudden variations of speed. The real control is effected by the slow-moving relay moving the other end.

* Paper read before the British Association.

† Royal Institution, March 15, 1878.

‡ *Proceedings* Inst. Civil Engineers, vol. cxiii., p. 194.

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Instead of using one governor, a pair may be employed, one of which works direct on the valve gear, and the other by means of a slow-working relay. This method does not seem so simple as using a simple governor to do both.

These matters must have been worked out thoroughly by many engineers, and they appear so simple that one almost feels ashamed to bring them forward here, but in looking the matter up I find the governor is generally treated by itself, without reference to the engine. I have, therefore, thought it might be worth while to bring this subject forward, and trust you will bear with me for having put it in such a very elementary manner.

ELECTRIC LIGHTING OF ECCLES.

A report on this subject was recently presented to the Town Council by Dr. J. Hopkinson.

In the course of the report it is stated that the site for the generating plant—very near to the district which the order requires the Corporation to light—is a proper one. For a small station like Eccles would require there would be a very great advantage in the use of accumulators. It followed of necessity that the system must be that with a continuous current. As high a pressure as can conveniently be employed should be used, as thereby the expense of conductors is diminished. This is effected by the three-wire system. For the supply of consumers under the order, exclusive of the lighting of the streets, he advised the use of two Willans or similar engines, each of 100 i.h.p., and each driving its own dynamo, and two locomotive boilers, each competent to supply steam for one engine. One of these boilers and engines would be ordinarily at work, and the others spare in case of accident to the first. The boiler and engine would run each night for one shift, and during the time of working would charge the accumulators whilst the demand for electricity was small, and would supply current to the consumers with the assistance of the accumulators when the demand was large. The accumulators would supply current to consumers at all times when the engines were standing, so that the supply would be absolutely continuous for the whole of the 24 hours. The engines should be provided with condensers, and as there is no means of obtaining a cheap supply of water on the site, means must be provided for cooling the water used for condensation. This can be done in a simple and compact manner, effecting a considerable economy of steam, and will diminish the nuisance caused by throwing the steam directly out into the atmosphere. One set of boiler, engine, and dyname will be capable of supplying a maximum of about 60 units, to which must be added the supply obtainable from the accumulators, an additional 30 units, making in all 90 units. The borough is supplied with gas from an outside source, and therefore has no interest in maintaining any branch of the gas consumption. Dr. Hopkinson understood that the supply of gas for the street lamps cost £890 per annum, and that the wages of the lighters amount to £380 per annum. He had made an estimate of the additional cost to the borough of lighting the whole of the streets. The estimate was not an estimate of the cost of lighting the streets irrespective of carrying on a supply for domestic purposes, but it was an estimate of how much the cost of the electric light station would be increased if the duty of lighting the streets in addition to maintaining the domestic supply were thrown upon it. In preparing the estimate he had the advantage of having recently carried out a scheme of lighting in the borough of Whitehaven. In that town the conditions were very similar to those of Eccles. The estimates proceeded on the assumption that the whole of lights of the borough are replaced by electric lights, and that the power of these lights is a little, but not much, in excess of the present gaslights. The supply would be effected by precisely similar machinery to that which would be used for the supply of ordinary consumers, and the result would be substantially the same as that which has been attained in Whitehaven. He strongly advised the Corporation to undertake the lighting of their streets by electricity. If the remoter district can still be lighted by gas, he should only light those nearest to the station, but if the supply of gas from Salford were cut off he should undertake the lighting of the whole of the streets by electricity. By doing this they could make quite certain that the loss, if there were a loss, would be materially diminished, and a profit, if there were a profit, would be materially increased. Without the street-lighting it is quite possible that the demand for current in the borough would be exceedingly small, and that although the actual cost in running the station would not be considerable, yet it would give a bad proportion between receipts and expenditure. If the street-lighting is added to the scheme they might be certain that even if the light were hardly taken up at all by the general public the actual loss in working, after paying interest and sinking fund, would be very small, and the percentage, when reckoned upon the running expenses of the station, would be quite insignificant, and that a very small demand from the general public would serve to obliterate the loss and show a profit.

Dr. Hopkinson's estimate for the supply of private consumers is as follows: Capital outlay—buildings, with space for more boilers and engines, £1,500; two locomotives, each for 100 i.h.p., with feed pumps and steam water-pipes, £1,160; two "Willans" engines, with condensers and water-cooling apparatus, two dynamos erected, £2,140; accumulators, £800; switchboards and instruments, £250; conductors, £1,500; total, £7,350; engineering and legal expenses, sundries and contingencies, £735; making £8,085. Running charges—wages, £350; cost, £100; water and stores, £25; maintenance of accumulators, £80; maintenance of machinery, £200; interest and sinking fund at 6 per cent., £486; total £1,241. Receipts from one engine, 300 anperes plus 200 volts, equal to 60 units; from accumulator, 30 units; total, 90. Say, 60 units for 800 hours, at 6d. per unit, 1,200. Note.—Sixty units will light 1,000 16-c.p. lamps for one hour. Additional charges for supply of street lights: capital outlay—conductors in street, with lamps and fittings, but exclusive of lamp-posts, £6,000; one boiler, with pumps, pipes, etc., £580; one engine, with condenser and dynamo, £1,070; switchboard, £50; total, £7,700. Engineering and legal expenses, sundries, and contingencies, at 10 per cent., £770; grand total, £8,470. Running charges—wages, £50; coal, £100; water and stoves, £25; maintenance of machinery, £100; interest and sinking fund at 6 per cent., £510; total, £785. Receipts—lighting street lamps, £1,270; less lamp removals, £170; £1,100. With regard to the estimate of the receipts by sale of current, the report states that it is impossible to say with certainty either that the estimate of demand would be reached or doubled. It was therefore an exceedingly doubtful one. The estimates for capital outlay, for running charges, and receipts from street-lighting could be trusted pretty closely, and it would be seen that they left a balance, after paying the interest on sinking fund, of just over £300.

ELECTRIC LIGHTING AT HARROW.

It is difficult to understand why any hesitation should arise on the part of the Harrow Local Board in finally deciding upon an electric lighting scheme. As long ago as October of last year, a report on the subject of introducing a supply of electricity was prepared for the Board by Mr. W. C. C. Hawtayne, of 3, Princes-mansions, Victoria-street, S.W. According to this report, the capacity of the proposed station would be 4,440 10-c.p. lamps; the expenditure on the undertaking, £11,600; and the annual working expenses, labour and supervision, and depreciation, £2,092 Already promises for the lighting of the schools and other premises have been received to the extent of some 3,000 lamps, so that there is no necessity for delay or hesitation in bringing the matter to a successful issue. Some criticism has been passed by Mr. Saunders, Mr. King, and Mr. Howard on the figures given by Mr. Hawtayne in regard to the working cost, etc., the former asserting that instead of £2,092, the amount would be much higher. In this connection, Mr. Hawtayne, in the course of a letter to the Local Board, says:

"I have looked through the figures put before you by Mr. Saunders with reference to the Harrow electric lighting scheme, and can only say that I consider he is entirely wrong. He appears to have submitted my figures to Mr. King, of the Electric Power Storage Company, and to a Mr. Howard, a resident in Harrow, and both these gentlemen have furnished him with counter figures, but it is very evident that neither Mr. King nor Mr. Howard have troubled to prepare independent estimates, but have contented themselves by adopting the most extraordinary unprofessional course of pulling to pieces the report presented by me without having given a moment's thought to the conditions which obtain at Harrow on the size and nature of the undertaking. This is shown from the fact that they question nothing in my report till they come to the question of 'working cost.' This section is divided into three heads—viz., materials, labour and supervision, and maintenance and depreciation. Under the heading of 'materials,' they have accepted all my figures with the exception of that amount estimated for 'oil, waste, etc.' This sum they have doubled without any apparent cause, and in direct opposition to the actual ascertained working cost shown by the returns published by all the principal electric lighting stations in the kingdom. Under the heading 'labour and supervision,' I find that Mr. King proposes to saddle the small undertaking, such as this, with the services of a manager and assistant manager. He also proposes to pay his engine-drivers 42s. per week, and his stokers 35s. per week. Now, Mr. King knows perfectly well that he would never think of paying this rate of wages, and anyone with any knowledge of Harrow will wonder what work the manager and assistant manager could possibly find to do. The average amount paid at Bradford, Brighton, St. Pancras, Hull, Manchester, and Dublin (where the local authority owns the works) in wages, etc., amounts to 0·99 of 1d. per unit delivered to the consumers. I have allowed 1·35d. per unit for Harrow, so as to be well on the safe side, but Mr. King and Mr. Howard are going to pay 2d. per unit, or more than double the amount that any other local authority pays. Under the heading 'maintenance and depreciation' Mr. King remains dumb, but Mr. Howard steps nobly to the front, and without giving any details of how he arrives at his figures he just nearly doubles my figures. He cares nothing about the published returns from other similar undertakings. He evidently wishes to just wipe out my estimated revenue account of £2,950 by showing the annual working cost at £2,990. Mr. Saunders, without any apology for his previous mistake, has, I see, now come down to a more reasonable figure for the repayment of the loans. One word, in conclusion, as to street-lighting by incandescent lamps. Mr. Saunders assures us that wherever they have been tried they have proved a failure, and instances Basinghall-street, London. Two or three streets in the City were lit by incandescent lamps by way of experiment, but the light is no good for such a locality. At each end of

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Basinghall-street are streets brilliantly lit by arc lamps of 2,000 c.p. each, and to come from one of these streets into Basinghall-street one naturally regards the incandescent lamps of the latter street as a failure. In comparison with the arc lamp, the incandescent lamp is of course a failure, but by itself it is doing street-lighting in many towns in the kingdom, and is an unqualified success in country towns and scattered districts such as Harrow. The following are a few amongst many towns that have been using incandescent lamps for some time now: Chelmsford, Weybridge, Whitehaven, Windermere, Prescot, and there are many others that I cannot call to mind at the moment."

The Harrow Local Board on Thursday of last week instructed Mr. Hawtayne to apply to six firms for tenders for the construction and maintenance of an electric light station in Harrow. Mr. Hawtayne is now getting out a specification, and tenders for the work will then be invited, when it is to be hoped a final decision will be arrived at.

SUBMARINE CABLES AND TELEPHONES.

We are glad to note that the *Pall Mall Gazette* has raised its voice on the questions of cables and telephones. The following extracts from our contemporary are to the point:

Roughly speaking, the cable system of the world belongs to, or is controlled by, a group of British shareholders, who have entrusted the management of their property and interests to Sir John Pender, M.P. Sir John is a man of consummate ability, and has made the fortunes of those who appointed him. On reference to a map, it will be seen that from the offices of the Eastern Telegraph Company (of which he is chairman), in Old Broad-street, he is in telegraphic communication with every important British possession. His company, and its subject or allied companies, charge us what they like for a cablegram to India, the East, Australia, and South Africa, and have powerful influence over the tariff to America. The shortest message to Australia costs from £2 to £3, and a single message has been known to cost £1,400; while the shares of the companies have paid as much as 14 per cent. It is obvious, therefore, that a poor man has no more chance of using the cable to communicate with his emigrant son or daughter than he has of riding a blood horse in the park or of being elected a member of the Royal Yacht Club. There are no degrees in impossibility. A few rich men use the cables sparingly for their private affairs, but the messages are mainly sent by merchants, who, of course, recoup themselves by making their customers pay higher prices, while a smaller but growing number of despatches is exchanged between the Home and Colonial Governments, at the expense of the taxpayers.

In one year our Indian and Australian trade has been compelled to contribute as much as £400,000 to the profits of the companies. The evils of monopolies are always the same, and supply Socialistic teachers with delightfully "shocking examples." The monopolist is not to blame, any more than the possessor of any other kind of property. The real offender is the statesman who confers or confirms the right to hold property under conditions which are injurious to the interests of the State. There are two methods of rectifying the mistake thus committed. The first is that of introducing competition. On this principle the Ottawa conference has sanctioned the construction of an alternative cable to Australia, running across the Pacific from Vancouver. The second, and as we hold preferable, plan is that the Home and Colonial Governments should combine to buy out the companies. It is estimated that the capital required would not exceed £30,000,000, and with such security, and the certainty of cheap cabling in the bargain, the amount would be subscribed in the City a dozen times over. Any morning, in fact, we may wake up and find that Lord Rothschild—repeating his Suez Canal *coup*—has lent Sir William Harcourt the sum required for the operation. In any case, the high tariff system is doomed. Within two or three years, instead of paying 4s. a word to India, 4s. 9d. to Australia, 8s. 11d. to the Cape, and 12s. 2d. to British Guiana, we shall probably have a uniform charge of 6d. a word to Egypt, India, the East, Canada, and other colonies equally distant, and 1s. a word to Australia and South America.

The question of securing the telephones for the nation is one of the gravest moment; and, unfortunately, it has to be decided at a time when men's minds are absorbed in political controversy. The state of affairs is shortly this: one association, the National Telephone Company, owns nearly all the wires and exchanges in the towns, and transacts 95 per cent. of the business. The Post Office has rival telephones, but attracts little custom, and finds its revenue from telegraphs rapidly declining. It has, therefore, persuaded the Government to set aside a million for the purpose of buying the existing trunk lines (of the company) connecting various towns, and of constructing new trunk lines. As has been pointed out, this will be a worse bargain than was entered into on purchasing the telegraphs. All the remunerative business will be left to the company, while the Government will pick up the bones which the company flings to it The profit of telephony, as of telegraphy, or postage, or any other business is made in the large centres of population, and this profit the Post Office ought to secure for the benefit of the taxpayers. If the company (or companies) did the work well and cheaply, there would be less to complain of. But by the confession of the chairman of the National Telephone Company, this is not the case. He admits that the service is defective, and lays the blame on the owners of property, who will not facilitate the necessary works of construction and repair. While private monopolies are concerned there will always be friction and defective service. The obvious duty of the Government is to assert its monopoly for the public benefit, and acquire the property of the companies before its constant development shall make the cost prohibitive. In place of paying from £12 to £20 a year, the charge for a private telephone should not exceed £3 to £5 a year. In the Australian cities of Melbourne, Adelaide, and Sydney telephones are in the hands of the Government, and the charge in Adelaide is only £6 a year to subscribers.

THE GOVERNMENT AND THE TELEPHONE COMPANIES.

SUMMARY OF THE DRAFT AGREEMENT.

A copy of a memorandum of the Postmaster-General, dated 7th August, 1894, setting forth agreements (in draft) with the National Telephone Company, Limited, and the New Telephone Company, Limited, to give effect to the heads of arrangement signed in August, 1894, has this week been issued as a parliamentary paper. We extract the following from the memorandum:

"(1) On the 27th May, 1892, there was presented to Parliament a copy of a Treasury minute describing certain proposals which had been adopted by her Majesty's late Government for the development of the telephone system of the United Kingdom. (2) Amongst the proposals was one that the telephone companies should connect their exchanges with post offices, to enable their subscribers to telephone messages for transmission over the public telegraphs, or through the post as letters, or for delivery as express letters, and to obtain the services of messengers, or the use of the trunk telephone wires of the State. It was also proposed that the companies 'should abandon their right to construct trunk wires, and that the Post Office should purchase from them such as they had already erected, and that in addition to this the Post Office should gradually provide additional trunk wires, so that there may ultimately be a complete system of communication between all the important towns in the kingdom.' (3) To enable the Post Office to carry out the scheme a Bill was introduced, and on the 3rd June, 1892, it was read a second time and referred to a select committee. The committee reported the Bill to the House on the 16th June. At the same time they submitted a special report, in which they expressed the opinion that the responsibility for the details of the agreement for the purchase of the trunk lines of the telephone companies must rest with the Government, but they thought that the agreement should be laid before Parliament. (4) The Bill, after amendment, passed both Houses, and on the 28th June, 1892, it received the Royal assent. (5) On the 11th August in the same year heads of arrangement were signed by Sir James Fergusson on behalf of her Majesty's Government, by Mr. J. S. Forbes on behalf of the National Telephone Company, and by his Grace the late Duke of Marlborough on behalf of the New Telephone Company. (6) After protracted negotiations draft agreements to give effect to these heads of arrangement have now been settled. (7) The Stanhope Telephone Company will surrender their license, with an endorsement under the seal of the company."

The draft of the proposed agreement first refers to the license granted to the National Telephone Company on January 1, 1881, for 31 years, and to the works which the company were empowered to undertake. It then proceeds: "It has been agreed between the Postmaster-General and the company that the company shall sell and the Postmaster-General shall buy certain of the company's telegraphs hereinafter more particularly specified. During the preliminary negotiations for this agreement it was agreed that the purchase-money to be paid for such telegraphs should be the cost price thereof, as shown by the company's books, together with the further sum (in respect of cost of administration) of 10 per cent. of the amount of such cost price, such cost price to be settled by arbitration if the parties differed. As the company's books do not show in detail the cost price of such telegraphs, it has been further agreed between the Postmaster-General and the company that the purchase-money to be paid for such telegraphs shall be a sum equal to the estimated cost thereof to the company (including in such cost all reasonable incidental expenditure), together with such further sum as aforesaid of 10 per cent. of the amount of such cost, and that such estimated cost shall be ascertained by two experts in telegraphic engineering, one to be appointed by the Postmaster-General and the other to be appointed by the company, and that all differences between such experts shall be settled by arbitration in a summary manner upon the respective statements of such experts *viva voce* or in writing, or upon such other materials as the arbitrator may require, but without the aid of counsel."

Passing on from the definition of various words and expressions, the draft agreement continues: "On the first day of July, 1895, or on such earlier day as may be fixed by agreement between the Postmaster-General and the company (which day is hereinafter referred to as 'the appointed day'), the company shall deliver and hand over to the Postmaster-General: (i.) so much of any trunk line erected, or in course of erection by the company on the 11th of August, 1892, as is situate outside any exchange area; (ii.) with regard to those parts of trunk lines erected, or in course of erection, as aforesaid, which are situate inside exchange areas: (*a*) all trunk wires forming part of such trunk lines; (*b*) all posts, cables, tubes, or other works supporting or containing trunk wires alone; (*c*) where the posts, cables, tubes, or other works supporting or containing trunk wires, also support or contain other wires of the company, all such posts, cables, tubes, or other works as support or contain a larger number of trunk wires than of other

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wires of the company, unless the retention of any such work by the company is established to the satisfaction of an arbitrator to be essential to the conduct of the company's business after the appointed day.

"The several trunk lines, trunk wires, and other works hereinbefore specified, together with all estates, interests, rights, powers, and authorities possessed or enjoyed by the company in relation to the maintenance or erection of the same shall on and as from the appointed day become and be deemed to be the property of and vest in the Postmaster-General absolutely for all the estate and interest previously enjoyed there in by the company freed from any charge or incumbrance thereon created by the company, but subject to all wayleaves and other rentals, contracts, and burdens of every kind, subject to which the company hold the same, or which the company have to pay, observe, perform, or bear in connection therewith. Subject to certain provisions, the Postmaster-General shall indemnify and save harmless the company from all such wayleaves, rentals, and burdens as in this article mentioned, and the company will do all such acts as may be necessary to effect a complete delivery and transfer to the Postmaster-General of all such trunk lines, trunk wires, and works as are in this article mentioned, together with all such estates, interests, rights, powers, and authorities as aforesaid.

"Upon delivery of such trunk lines, trunk wires, and works in manner aforesaid the Postmaster-General shall pay to the company the said purchase-money of £——. From and after the appointed day the company shall, so long as it is required by the Postmaster-General so to do, maintain to the reasonable satisfaction of the Postmaster-General all trunk wires of the Postmaster-General which are supported by or contained in any post, cable, tube, or other work which is the property of the company; and the Postmaster-General shall, so long as he is required by the company so to do, maintain to the reasonable satisfaction of the company all wires of the company supported by or contained in any post, cable, tube, or other work which is the property of the Postmaster-General. The Postmaster-General shall pay to the company and the company shall pay to the Postmaster-General, in respect of all wires maintained as aforesaid, yearly sums accruing from day to day at the following rates, that is to say: (*a*) thirty shillings per annum for every mile of wire carried over the roofs of houses; and (*b*) one pound per annum for every mile of wire otherwise carried. Any fraction of a mile over and above a complete number of miles shall be treated as a mile, and the rates herein specified shall be subject to revision on six months' notice from either party at any time after the expiration of five years from the appointed day, and in like manner at any time after the expiration of any period of five years from the day on which any revised rates shall come into operation.

"The Postmaster-Gerneral may at any prescribed post office establish a call office or any exchange of the company, provided that the use of such call office for communications to subscribers to the company's exchange shall be subject to such charges as are for the time being made at other call offices of the company within the same exchange area. The company may on and after the appointed day at any time and from time to time without such request of the Postmaster-General as aforesaid establish call offices at other post offices on certain conditions. Where and so long as telephonic communication is established between an exchange and a prescribed post office the Postmaster-General will receive at such post office from any office on such exchange any telephonic messages for any of the following purposes—that is to say: (*a*) for transmis sion over the postal telegraphs and delivery as as a telegram, or (*b*) for delivery as an express letter, or (*c*) for conveyance and delivery as an ordinary letter, and the company and the Postmaster-General will respectively do all such acts and things as may be necessary to enable such telephonic messages to be received at such post office and to be so transmitted, conveyed, and delivered as aforesaid."

The memorandum also contains the draft agreement with the New Telephone Company, and a reference to the Stanhope Company also to pass into the hands of the Government.

COMPANIES' MEETINGS.

CROMPTON AND CO., LIMITED.

The sixth annual general meeting of this Company was held at Cannon-street Hotel on Monday afternoon, Viscount Emlyn occupying the chair.

The **Chairman**, in moving the adoption of the report of the directors and the accounts, which we printed in our last issue, said that there was a slight reduction in the gross profits as compared with the previous year's working, but there were certain other matters upon which the shareholders could be congratulated, for there was an increase of £22,000 in the turnover. They had also been able, by care, and economy, and watchfulness, to reduce the trading and office expenses by £3,000. The accounts apparently showed a reduction of £4,000 in the item, but that was due to the transfer of certain amounts from one account to another, the actual figure being as stated. The directors hoped that by further economies they would show a still more favourable result. The sum put down for depreciation of plant had increased by £900. This was partly due to an increase in the number of items, and partly to the desire of the directors to be overcautious rather than to err the opposite way. There was an apparent further increase in the item of subsidiary companies, owing mainly to the shares in the Chelmsford Electric Light Company having been transferred from trade debtors' to the investment account. It was also partly owing to the amount of the debentures which had been taken from the Australian Company. This latter item, however, was not permanently in the account, but a temporary investment. The trade debtors' item stood slightly higher; and the stock showed less, but part of this had been transferred to work in hand. With respect to the depreciation of assets, the chairman had explained in January last that for three or four years past no contracts had been made by the Company where they had to take shares or securities in place of cash for work done. During the past year, however, some of the securities previously taken had depreciated, and their directors thought it best that they should stand lower, and that something should be written off these items. Mr. R. E. Crompton and Mr. J. F. Albright, the managing directors, had agreed to relinquish their shares to the extent of the estimated depreciation, which had been written down severely to the amount of £20,000. A special meeting would be held directly to reduce the capital by this amount, another would be held in about a month, and then an application would be made to the Court of Chancery for sanction. The shareholders owed a debt of gratitude to Messrs. Crompton and Albright for their action in this matter. Their manager of works at Chelmsford had resigned, owing to receiving another appointment, and Mr. Brunton had been appointed manager in his place. Last year they thought that the Australian Company had good prospects and was improving, and they had now received orders from them to a considerable amount. According to advices received by the last mail, the contracts practically secured by the Australian Company amounted to about £40,000. They had been subjected to close competition in most departments, but they also had specialities. The arc lamp department had proved quite up to their expectation, and the cooking and heating appliances would probably prove a valuable property. The City Company had opened a showroom at which their stoves and other appliances were exhibited, and the St. Pancras Vestry had sent out circulars recommending the same. He would have been glad to have been able to tell the shareholders that they would have a full dividend. Recourse might have been had to the reserve fund, but the directors thought it best in the interests of the shareholders to pay only a moderate dividend. The Board were thus enabled to increase the sum set aside for contingencies by £1,000, and to carry forward over £1,000 to next year's account. With regard to the proposed issue of new debentures offers had been received for only about £32,000. It was necessary to raise the debentures to place the Company in a good position, as the want of money hampered them in buying in the cheapest markets and in getting reductions on the price of goods. He hoped the shareholders would put the Company on a firmer footing by taking up the debentures, the proposed issue being one of £100,000 4½ per cent. debentures.

Mr. R. E. Crompton seconded the motion, and in doing so confirmed the observations of the chairman as regarded the past and future of the Company. They now had to experience severe competition from new firms who tendered without full knowledge of what they were doing, and thus reduced prices. The period of low prices, based on erroneous estimates, would, however, result in a weeding-out process of the weaker firms, and then they might expect better prices and times. As regarded the change in the management of the works, Mr. Brunton was the best man he could have picked had he had all England to select from, and the manufacturing department was never in better order. He hoped the tendency of prices would be to increase, but if low prices continued the Company were in as good a position to manufacture cheaply as any other firm, and they could obtain a profit when some of their competitors would be unable to do so.

The motion having been adopted, **Mr. R. E. Crompton** moved, and **Mr. Albright** seconded, that a dividend of 3s. per share on the preference shares be paid, which was agreed to.

Mr. Crompton moved, and **Mr. Tufnell** seconded, the re-election of Viscount Emlyn as a director, and **Mr. Tufnell** moved, and **Colonel Gibson** seconded, the re-election of Messrs. J. H. Duncan and Co. as auditors. Both motions were carried.

A special meeting was then held, at which, on the motion of **Lord Emlyn**, seconded by **Mr. H. Osborne**, a resolution was passed that the capital of the Company be reduced from £300,000 to £280,000 by cancelling paid-up capital which has been lost or is unrepresented by available assets, to the extent of £20,000.

LIVERPOOL OVERHEAD RAILWAY.

The twelfth ordinary half-yearly meeting of this Company was held on Tuesday in Liverpool, Sir Wm. B. Forwood presiding.

The **Chairman**, in moving the adoption of the report and statement of accounts, said he was glad to think that the report which the shareholders had before them was of a very satisfactory and encouraging character. During the past half-year the traffic on their line had increased to an extent which ought to give them all great encouragement for the future. As in all new undertakings, it was difficult to get figures for the purposes of comparison. For instance, if they compared the traffic of the past half-year up to the end of June with that of the preceding half-year, they would be comparing the traffic of a summer half-year with the traffic of a winter period, and if they took the winter half-year they would be comparing it with a broken half-year, for the line was opened in the month of April last year. The figures showed that during the half-year ending June 30 they had carried 2,861,437 passengers, as against 2,475,639 in the half-year ending December, 1893, being an increase of 391,000. It was impossible to compare these figures with those of the previous half-year, because it was a

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broken period; but he had some figures which would give an indication of the increase of traffic at the present time. During the last half-year they carried 15,300 passengers, and during the corresponding period they carried 11,810 per day; and taking the traffic from April 30 to June 30 last year and comparing it with the same period this year, they found the receipts for the former period, nine weeks, to be £5,890, as compared with £8,045 for the corresponding nine weeks this year, showing an increase of £2,155. That was a very gratifying increase, and he was glad to say that since the close of the half-year with which they were dealing the increase in traffic had been kept up. During the six weeks that had elapsed since June 30 they had received £1,100, which he considered as very satisfactory. They opened the Seaforth Sands Station on April 30, and he was glad to say that their traffic from that station had been everything they expected it to be. It was a valuable feeder to the line. During the half-year they had opened two new stations—one at Nelson Dock and the other at Huskisson, the latter being a removal from the Sandon Graving Dock, and next day (Wednesday last) they proposed to open another new station at the Langton Dock, which experience had shown them to be necessary. With these three stations the line would be complete, and he might say that it would be an omnibus line, and that passengers would have no complaint to make on the ground of distance between the stations. It was an arrangement which would be advantageous to both, and to which he looked forward in the hope of a considerable increase in traffic. Turning to the revenue account, he found that they had received for the half-year £20 044. 7s. 6d., showing an increase of £1,696 on the previous half-year. That figure might be disappointing to them seeing the increase in the number of passengers, but the increase was due to the cheap workmen's tickets in the early morning. Coming to the expenditure, they had spent £14,947, being an increase on the corresponding half-year of last year of £1,215. That was made up of two or three items, including £425 on the ventilation of carriages and other alterations; and an additional sum of £878 on traffic expenses, which was largely made up of the cost of the new stations and the cost of running the 22,000 extra miles. They had also had an increase in the rates of £255, and the law charges were somewhat heavier than the previous half-year. On the other hand, they had effected a saving of £910 by taking over the generating station into their own hands. The total receipts were then £20,000, and the working expenses £14,947, leaving £5,097 to be dealt with. They had paid interest of debentures and calls in advance £2,639, leaving £2,457, which, by the addition of the balance from last year of £2,598, gave £5,056 available for dividend. The directors recommend the payment of 5 per cent. dividend on the preference, and 1 per cent. on the ordinary shares, leaving £1,010 to be carried forward. As regards the future, they were fully alive to the importance of the extension of the system, and they wished to see the present undertaking a little further developed. and they would not do anything without obtaining the sanction of the shareholders. He paid a tribute to the work and ability of the engineer, Mr. S. B. Cottrell, and referred to the interest taken in their work by the servants generally. Sir William then moved that the report be adopted, and that the dividends mentioned be declared.

Mr. Richard Hobson seconded, and the motion was agreed to.

Mr. Samuel Stitt moved a vote of thanks to the chairman and directors, which was seconded and carried.

BIRMINGHAM CENTRAL TRAMWAYS COMPANY, LIMITED.

The thirteenth annual meeting of the Birmingham Central Tramways Company, Limited, was held on Wednesday at the Queen's Hotel, Birmingham, Mr. J. Ebbsmith presiding.

The **Chairman**, in moving the adoption of the report, which was given in our last issue, referred to the recent decision of the House of Lords upon what was known as the purchasing clause of the Tramway Act, a decision which was adverse to the contention of the tramway companies affected and favourable to the local authorities. Dealing with the accounts, he said that the new engines referred to at the last meeting had been received and were working admirably. It was satisfactory to find that upon those engines a saving of close upon ¾d. per mile was effected in the consumption of fuel alone, and he was hopeful that the saving would be more marked during next year. They would have need of economy and improved traffic, for a cloud was looming over them in the Balsall Heath district. The horse department was what it had always been—a difficulty, and a blot upon their accounts. In the cable department there had been a most satisfactory increase of working profit. They could not have their profit at both ends, and he was glad to know that the profit on the cable department far outweighed any corresponding loss upon the horse department on the southern routes. The directors were satisfied that the cable line had established such a dominant position in the district that it was no longer fair or reasonable to expect them to maintain for the benefit of a few the system which up to that time had prevailed, and they had discontinued the horse omnibuses, which more or less were actually in competition with their own trams. He was glad to be able to say they might look with confidence to a probable decrease of expenses and increase of profit upon the working accounts during the next year. The electric department was one of mingled difficulty and hope. The shareholders were aware that the Corporation had not met the directors as they had a right to expect in the hope of establishing another and more economical form of traction, but the directors had turned their attention to two alterations of detail in the present system, which gave them distinct reason to believe that the electric department had seen its worst days, and that it would now show a steady if unsatisfactory improvement. He said "unsatisfactory," because he considered it was unsatisfactory that they should be compelled to work that form of traction which could be replaced by one of equal advantage to the public, and much more economical to the Company. He was quite sure if the Corporation had permitted the experiment of overhead lines to be tried in the Bristol-road, the inhabitants of that thoroughfare would in three months have warmly supported a continuance of the system, and the profit to the Company would practically have equalled the loss which they now sustained. The Public Works Committee laid down the conditions that the roads belonged to them, and they would maintain them, but the Company must pay the cost; and yet in the case of the Bristol-road they had actually entered into a contract with an outside commercial firm to maintain the roads at a price which was altogether in excess of the amount which could possibly be spent upon them. Mr. Carruthers Wain's agreement expired at the end of last year. He had done his work of organisation, and done it well.

The motion having been seconded, was, after some discussion, adopted.

On the motion of the **Chairman**, seconded by **Mr. Round**, a dividend of 2½ per cent. was declared on the ordinary shares of the Company.

WATERLOO AND CITY RAILWAY COMPANY.

The Waterloo and City Railway Company held its first half-yearly general meeting last week, under the presidency of Mr. W. S. Portal, in the Board-room at Waterloo Terminus.

The **Chairman**, after affixing the seal of the Company to the register of shareholders, who numbered 475, moved the adoption of the report and accounts. As this was, he said, the first general meeting, there was obviously very little for him to tell them. So far as the Company was concerned, everything was in a very promising way. The construction of the line had been tendered for, the borings were satisfactory, and the line would be completed, according to the evidence of the contractors, in about two years and a half. The agreement between them and the South-Western Railway Company, which was sanctioned by the shareholders in February last, had received the approval of the Railway Commissioners, and the Board of Trade had given the necessary certificate for the payment of interest on capital during the construction of the railway. The construction of the main portion of the line had been entrusted to Messrs. Mowlem, Burt, and Co., whose tender was less than the parliamentary estimate. All the necessary consents from the several public bodies concerned had been obtained, and up to the present time everything was making satisfactory progress Questions relating to the terminal stations in the City and at Waterloo were under consideration. These stations would, however, form the subject of separate contracts.

The motion was seconded by **Lieut.-Colonel Campbell**, and carried.

CONTRACTS FOR ELECTRICAL PLANT.

CONTRACTS OPEN.

Dundee.—Messrs. Urquhart and Small, of 17, Victoria-street, Westminster, S.W., have been authorised by the Dundee Gas Commissioners to invite tenders for contract No. 8, for a steam-engine and dynamo, in connection with the supply of electric light. Copies of the specification and form of tender can be obtained on payment of £1. 1s. (which will be returned to all *bonâ fide* tenderers) from the above-mentioned firm. Tenders will be received by that firm on or before the 30th inst.

Birmingham.—Tenders are invited for the electric lighting of the glasshouses, etc., at the Botanical Gardens, Edgbaston, Birmingham. A copy of the specification may be obtained from Messrs. Henry Lea and Thornbery, 38, Bennett's-hill, Birmingham, on payment of £1. 1s., which will be returned on receipt of a bona fide tender. Tenders must be sent in on or before September 1, 1894, addressed to Prof. Hillhouse, M.A., hon. sec., Birmingham Botanical and Horticultural Society, Botanical Gardens, Edgbaston, Birmingham.

RESULTS OF TENDERS.

Stowmarket (Suffolk).—The tender of Messrs. T. Prentice and Co., of Stowmarket, at £174, has been accepted by the Local Board for lighting the streets of Stowmarket up to May, 1895, and also for lighting the post office clock.

Walthamstow.—The Private Wire and Telephone Installation Company, of 110, Cannon-street, E.C., inform us that they have secured the contract for fitting up the fire alarms in connection with the houses of 13 firemen, for the Walthamstow Local Board. There are six standard street alarms, and the various offices will be connected by telephone.

Altrincham.—The Manchester Edison-Swan Company have received the contract for the supply of the electrical plant, including alternators and transformers, for the Altrincham Electric Supply Company, Limited. The order for the boilers has been placed with Messrs. Tinkers, Limited, of Hyde; that for the engines with Messrs. Browett, Lindley, and Co., Limited, of Patricroft; and that for the buildings with Mr. J. Hamilton, of Altrincham.

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BUSINESS NOTES.

Cowes.—The Marine Hotel has received an electric light installation.

Ashford (Kent).—The question of introducing the electric light is in abeyance.

Woodbridge.—The Local Board ask for tenders for lighting the town for 12 months.

Western and Brazilian Telegraph Company.—The receipts for the week ended August 10 were £2,219.

Fleetwood.—The Board of Trade has provisionally approved the electric lighting scheme for the district.

Worthing.—The Town Council have resolved to apply to the Board of Trade to license the Council to supply electricity.

Rugby.—A gas-engine of 120 h.p. is to be put down by the electric lighting company in place of that of 100 h.p. now at work.

Whitehaven.—New applications for electric current are being received by the surveyor to the Whitehaven Town and Harbour Trust.

Hawkshead.—The Highway District Board have agreed to an application by Mr. Fowkes to lay an electric cable between Smoothbecks and Sawrey.

Islington.—The Vestry have received a communication from the Board of Trade, enclosing provisional approval of the system oi electric lighting to be adopted in the parish.

City and Guilds of London Institute.—Particulars are given in our advertisement columns of the various examinations for the session 1894-95 in connection with this institute.

Ulverston.—The question of introducing the electric light into this district, to which we have previously had occasion to refer, has been considered by the Local Board in committee.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending 12th inst. amounted to £1,257, as compared with £1,138 in the corresponding week of last year.

Telephony.—The Cardiff Chamber of Commerce on Wednesday passed a resolution urging the establishment of direct telephonic connection by Government wires between Cardiff and London.

Brighton.—The manager of the electric light works has reported to the Town Council that the revenue for the half-year just ended amounts to £4,795, against £2,391 for the corresponding period of last year.

Submarine Telegraph Company, Limited.—The directors of this Company recommend a dividend on the ordinary shares at the rate of 8 per cent. per annum, tax free, for the half-year to June 30.

Cornholme.—Messrs. Joshua Smith, Limited, cotton manufacturers, have been altering and improving Frostholme Mill, which is to be lighted throughout by electricity. The work will be carried out by Messrs. J. H. Holmes and Co, of Newcastle.

Windermere.—The clerk to the Local Board has informed them that he has received a further notice from the electric light company, and that he was writing to the Board of Trade about the provisional order. The matter was left in the hands of the clerk.

Dewsbury.—The Town Council have passed an account for £275 in favour of Mark Scott, on account of his contract for the electric lighting station, and one for £1,000 in favour of Messrs. J. and J. Horsfield, on account of contract for boilers for the same place.

Church-Lighting.—An installation of the electric light has just been completed in the Church of St. Martin-on-the-Hill, Scarborough. About 100 lamps are used. The work has been carried out by Messrs. Walker and Hutton, electrical engineers, of Scarborough.

Newcastle.—Messrs. J. H. Holmes and Co. have in hand the contract to fit an electric lighting installation on the premises of Messrs. Galloway, wholesale confectioners, etc., Clayton-street, Newcastle. The installation will consist of 100 lights, supplied by a "Castle" dynamo.

St. Ives (Cornwall).—The St. Ives Town Council on Friday had before them a proposal to purchase the local gasworks, but after a short discussion it was decided to consider the matter more fully in committee. The Council would be better advised to leave the gasworks alone and introduce the electric light.

City and South London Railway.—The receipts of the Company for the week ended August 12 were £897, against £829 for the corresponding week of 1893, or an increase of £68. The total receipts for the current period of the present half-year amount to £5,203, as against £5,066 in the corresponding period of 1893.

Antwerp Telephone and Electrical Works.—Messrs. W. E. Dennis and Co, of 11, Billiter-street, E.C., inform us that they have been appointed sole agents in Great Britain and Ireland for the Antwerp Telephone and Electrical Works (Société Anonyme), Antwerp, manufacturers of telephones and other electrical appliances.

York.—Mr. Edward B. Pym, of Scarborough, has nearly completed an electric light installation throughout Messrs. Cox and Falconer's premises in High Ousegate. The plant consists of a nine-kilowatt machine, driven by a gas-engine, and the number of lights will be 150. This is the first firm to adopt the electric light in York.

Cooking by Electricity.—The landlord of the Imperial Restaurant, Sise and Pancras Lanes, and 38A, Queen Victoria-street, has discarded coal and gas in favour of electrical energy for cooking purposes. The result is in every way satisfactory. Mr. Percival, the lessee, will show his kitchen to those who may wish to see how electricity can be thus utilised.

Interim Dividend Announcement.—The directors of the Charing Cross and Strand Electricity Supply Corporation, Limited, have declared an interim dividend for the half-year ending June 30 at the rate of £4 per cent. per annum on the ordinary share capital of the Corporation (£150,000), and carried forward £1,335, after payment of £5 per cent. per annum on debentures.

Electrical Exhibition at Ealing.—As will be seen by our advertisement columns, the Ealing Local Board will hold an exhibition of electrical appliances in the Victoria Hall, Ealing, commencing on October 3rd, and continuing to the 13th. Manufacturers and others desirous of exhibiting can obtain information respecting same upon application to Mr. C. Jones, C.E, Public Buildings, Ealing, W.

Taunton.—The electrical engineer (Mr. H. W. Cowzens) reported to the Town Council on Tuesday that during the past quarter improvements and alterations at the electric light works, suggested by Dr. Fleming, had been completed. The Electric Lighting Committee reported that they had insured the electric lighting station, machinery, and plant in the Atlas Insurance Office for £6,000 at 4s. per cent.

Leeds Tramways.—The town clerk of Leeds has received notification that the action commenced by the tramways company against the Corporation to recover £61,000, being the difference between the value of the tramways on the structural basis and their value on the rental basis, will not be further proceeded with. This course, it is stated, has been taken in consequence of a recent judgment of the House of Lords.

Ship-Lighting.—The s.s. "Knight Bachelor" has made her trial trip on the Firth of Clyde. For expeditious working of cargo she has seven hatches and seven of Messrs. Clarke, Chapman, and Co.'s steam winches; and when it may be necessary to work at night the vessel is supplied with a cluster of electric lamps to illuminate the decks. The vessel has a complete installation of the electric light carried out by Messrs. J. H. Holmes and Co., of Newcastle.

Bristol.—The Electrical Committee of the Town Council reminded the Council on Tuesday that at their meeting on December 12 they authorised the committee to arrange for the borrowing of the further sum of £24,000 for electric lighting. The sanction of the Local Government Board has now been obtained, and the committee have arranged to borrow the money from the Bank of England. The Council adopted the report of the committee on Tuesday.

Chester.—The Town Council have received a letter from the clerk to the County Council, Mr. Reginald Potts, giving the Corporation the opportunity of buying a portion of the old county gaol site. It appeared that the County Council proposed to lease the land to the War Office, with the exception of the portion offered to the Town Council. The matter, after some discussion, was referred to the Improvement Committee, it being suggested that the site might be a desirable one for the electric light works and the baths.

Stirling.—It was stated at a meeting of the Police Commission on Monday that the Caledonian Electric Supply Company and the House-to House Electric Supply Company had notified to the clerk their intention of applying for a provisional order to light the burgh. It was agreed, on the recommendation of the Electric Light Committee, to meet on the 17th prox. to make arrangements to acquire the order for the town. The area of supply was fixed as the burgh, and the compulsory area as King-street, Murray-place, and Port-street.

Edmondson Electricity Meter Syndicate, Limited.—This Company has been registered with a capital of £2,000 in £1 shares, to take over the patents and patent rights for the manufacture of electricity meters, invented by Mr. Joseph Edmondson, of Bradford, electrical engineer, either alone or in conjunction with Mr. Joseph Oulton, of Bradford, and to manufacture and deal in electricity meters and all apparatus, etc., connected with the measuring of electricity and to carry on the general business of electrical and mechanical engineers.

Blackpool.—The minutes of the Electrical Committee, adopted by the Town Council last week, included particulars of a claim on behalf of Mrs Wild for an alleged accident in Market street, the Corporation disclaiming liability in the matter. The tender of Mr. W. Moister, for the excavating and concreting required for the foundation for the new chimney at the electricity works, was accepted. The recommendation of Mr. R. Hammond, the consulting electrical engineer, that a further sum of £500 be expended in the provision and laying of street mains was adopted.

Monmouth.—With regard to the preliminary expenses in connection with the drainage and electric lighting, Mr. Tippins asked, at a meeting of the Town Council last week, what arrangements had been made for the preliminary expenses before they got their drainage loan. Mr. Mayor replied that the treasurer and himself had waited upon Lloyd's, and had learned that they were willing to grant whatever the Corporation might want before they were in a position to negotiate their loan. He did not think they would want to go over £2,500, including the present overdraft.

Hotel-Lighting.—The ordinary general meeting of the Inns of Court Family Hotel, Holborn, was held last week at the hotel, under the presidency of Sir Edwin Galsworthy, J P., who said that they had extended and would still further extend, the electric

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lighting installation. Messrs. Rashleigh Phipps and Co., of 102, Oxford-street, have received instructions for the electric lighting of Limmer's Hotel, Conduit-street and George-street, Regent-street. The firm also obtained the contract for the lighting of the Howard Hotel, Norfolk-street, Strand, with 450 lights of 16 c.p.

Bromsgrove.—The Local Board have considered a resolution proposing that the application of Messrs. Hemming and Co., electrical engineers, Birmingham, for the consent of the Board to their laying down plant for electric lighting in the district be granted. Mr. Leadbetter seconded the proposition. Mr. Hall moved an amendment that the question be referred to the committee to consider and report before deciding upon the matter Mr. Weaver proposed that a town's meeting be called to consult the ratepayers. Mr. Hall seconded the amendment, which was carried.

Hoisting Machinery.—Messrs. Pickerings, Limited, of Stockton-on-Tees, inform us that they have appointed Messrs. Bolton, Fane, and Co., of 96 and 98, Leadenhall-street, E C., as their agents in London and district for the sale of their lifts, hoisting, and other machinery. Messrs. Bolton, Fane, and Co. have acquired the old-established business of iron, tinplate, and metal merchants formerly carried on by Messrs. Ben Gibson and Co., and latterly by Messrs. Harry Williams and Co., and in the management of this branch of their business they will be assisted by Mr. Harry Williams.

Newport.—The work of laying the pipes for carrying the electric cables for the central station, which is about to be erected by the Corporation, was commenced on Monday in a section in Dock-street, Newport, between Cross-street and the electric station in Friars'-field. Messrs. Fowler and Co., of Leeds, are the contractors. The Town Council have decided to pay the contractor for the electric light (street work) installation £500 on account of his contract, without keeping him for the proper period of one month longer. This payment, it was provided, should not form a precedent.

Appointments Vacant.—The Corporation of Blackburn invite applications by the 25th inst. for the post of engine and dynamo attendant. Applicants must have had experience of central-valve high-speed engines and dynamos as applied to a three-wire system. Applications, stating age, previous experience, and wages required, with not more than three recent testimonials, are to be addressed to Mr. Robert E. Fox, town clerk, Town Hall, Blackburn. The Corporation also invite applications for the post of central-station wireman; in this case also applications are to be forwarded not later than the 25th inst.

Woking.—The Sanitary and Lighting Committee of the Local Board have reported that the contract for electric lighting had been settled with Mr. New, and was recommended for sealing. It provided for 48 single and 13 double lamps, the price to be reduced if possible, and with iron open shades instead of globes. In reply to Mr. Dalziel, who asked a question as to the distribution of the lamps, Mr. Storey said the distribution was practically the same, except that they had decided to light all the back streets, which were not lighted when the Board took them over. This would mean 13 more lamps. The report was agreed to.

Factory-Lighting.—Messrs. Mardon, Son, and Hall are having the electric light installed in their new factory at Temple Gate, Bristol. The offices and works are being fitted throughout with 500 16 c.p. lamps. Arrangements have been made so as to allow of an addition of another 120 16-c p. lamps if necessary. The current is supplied from an Edison-Hopkinson dynamo, manufactured by Messrs. Mather and Platt, Limited, and has an output of 350 amperes at 105 volts. The whole of the arrangements is being carried out by Mr. E. J. Tongue, consulting engineer, and is under his personal supervision. The contract for the work has been secured by Messrs. F. W. Ball and Co., of Unity-street, College Green.

Radcliffe.—The Electric Lighting Committee of the Local Board decided some time ago that Messrs. R. Walker and S. Walker interview the Earl of Wilton's agent with reference to the purchase of a plot of land in Mount Sion road, the plot having been offered to the Board for a period of 999 years at 1½d. per yard It has now been resolved that Mr. Bennett be requested to inform the committee upon what terms he will provide the plans and estimates for the electric lighting station, plant, and the necessary means and appliances, and give all engineering assistance required up to and inclusive of the obtaining of a provisional order, and to also state his terms for the carrying out of the work from the obtaining of the order to the completion of the work.

New Issue.—W. T. Henley's Telegraph Works Company, Limited, announce that the increase of the company's ordinary business (as distinct from laying submarine cables) and the prospect of extending it in new directions render it advisable to increase the capital. For this purpose it has been resolved to pay off the existing mortgage of £10,000 at 4½ per cent., the £15,000 A debentures at 5 per cent., and the £12,000 B debentures at 6 per cent., and to raise a further sum of £13,000 by the issue of £50,000 debenture stock. This stock will bear interest at 4½ per cent. payable half-yearly, and will be secured by a trust deed constituting a first charge upon the company's property and undertaking, and will be redeemable by the operation of a sinking fund.

Stockton.—At the May meeting of the Stockton Corporation the town clerk was instructed to write to the Board of Trade requesting that the Electric Lighting Order, 1890, might be further extended for a term. He has now received a reply stating that the Board of Trade are not disposed to allow it to remain in force any longer unless the Corporation are prepared to give an undertaking that they will give effect to its provisions within a year from the present time. At a Town Council meeting it was agreed that the Board of Trade should be informed, in reply, that the Corporation will give effect to the provisions of this order within two years from this date. Alderman Hind stated that Alderman Richardson, M.P., had called at the Board of Trade and obtained an intimation that two years would be allowed.

Meeting of Creditors.—The first meeting of the creditors of Mr. M. L. Ross, an electrical engineer, who formerly had offices at 90, Queen street, Cheapside, was held before Mr. Cooper, deputy receiver, at the City Bankruptcy Court last week. The debtor failed about 12 years ago, when carrying on business at Boston, U.S.A. He closed the office at 90, Queen-street in 1892, having lost about £6,000 in the business. Since then he has been engaged in the development and sale of various patents, and he attributes his failure to delay in the completion of certain contracts. He denies that he is insolvent, but does not estimate the value of his assets in his statement of affairs; his debts he returns at £1,954. 10s. The meeting stood over to August 29, at noon, for a scheme of arrangement to be submitted to the creditors and reported upon by the official receiver.

Leicester.—A committee has reported to the Leicester County Council that by the month of October it was expected the Corporation of Leicester would be in a position to supply the electric light at the Assembly Rooms. The committee considered it desirable, if the Council decided to have an installation of electric light, that the wiring of the rooms and the fittings should be attended to before the repairs were carried out. It was estimated that the sum of £250 would be sufficient to meet the cost of wiring and providing suitable fittings for lighting the large room, drawing, dining, and smoking rooms, and the entrance-hall, and the committee recommended the Council to carry out the work. Mr. Bowles, in moving the adoption of the report, expressed the opinion that the committee were following a wise course in recommending the Council to use the electric light in that building. The cost would, he believed, be well within the sum of £250 which was mentioned.

Hertford.—The Lighting Committee of the Town Council have reported that the returns so far received with regard to the adoption of the electric light were encouraging. A full report on the subject was promised as soon as the committee was in possession of the complete returns. In proposing the adoption of the report, Alderman Shelly remarked that it referred to the circular which was sent round to the householders—a method not very well adapted for obtaining precise statistical results, but which was calculated to give some idea of what was the general feeling of the town. He was sorry the complete returns could not be brought before the Council, and he hoped definite information would be ready very soon, because there were indications that if the matter was to be taken up it should be taken up shortly. The returns obtained up to the present were very encouraging, the number of applications being more than treble those received on the former occasion.

Poole.—The Poole and Bournemouth Tramways Company, referring to their application to the Board of Trade to extend the time for the commencement and completion of the Poole and Bournemouth electric tramways, have written to the Dorset County Council that they hoped long ere this to have commenced the works, and would have done so had the times been more propitious. They had, however, now secured the co-operation of some capitalists, who would make an issue of the capital of the company at the earliest possible date, and, in addition, had made arrangements with a large company for laying down the electrical plant, and were negotiating with a firm of contractors to construct the permanent way and erect the necessary buildings. They had had an interview with the Secretary to the Board of Trade, who informed them that before they considered the application they should furnish them with a resolution of the Council consenting to the extension of time being granted. The Council have decided not to grant further time.

Dalkey.—The Dalkey Commissioners have determined on taking proceedings against the tramway company to compel them to put their line in order. A local paper says: "Leaving aside the condition of the tramroad, let us ask what has become of the gigantic scheme to provide an electric tramway from Dublin to Dalkey? The company that is now to be proceeded against promised last year that they would form the electric line. They pointed out the advantages of such a system to the Boards of Commissioners, and asked, if we remember rightly, their countenance to the scheme. We then heard how the townships might be beautifully illuminated by electricity, and we stared in amazement when we had pictured for us rushing trams, cosily appointed and lighted, and driven by the electric current. The change was to have been made last March, but we have as yet heard nothing further about the matter. How is this? Did the directors really intend to form the electric service, or was the promise only a sop thrown out to keep the dogs from howling against the condition of the roads?"

Traction at Bristol.—The ordinary general meeting of the shareholders of the Bristol Tramways and Carriage Company was held at the Grand Hotel, Broad-street, last week, when Mr. W. Butler, J.P., chairman, presided. In the course of his remarks the chairman said: "I am pleased to say that after an inspection of the system of overhead electricity as applied in South Staffordshire, the Corporation and its officials were much impressed with the advantages of the system, and at once admitted that the principle could be satisfactorily applied in Bristol. There were, however, as you may well imagine, a very large number of con-

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ditions which had to be thoroughly discussed, and upon which we ultimately came to complete agreement. The specifications and drawings for the new electrical tramway are nearly ready, but we have not wholly waited for these, as we some time since ordered the necessary copper wire to lay down a short piece on the old St. George's line, which we shall get the Board of Trade inspector to pass immediately it is completed, so that we may be on safe ground in carrying through the bulk of the construction of the electrical lines."

Brechin.—Dean of Guild Ferguson, convener of the Lighting Committee, at Monday's meeting of Police Commission reported that, in accordance with instructions, the clerk had written to the Northern Electric Lighting Company and the House-to-House Electric Lighting Company asking on what terms they would be prepared to supply electric light to the town. No very definite reply had been got, but some member of the Commission had had an interview with Mr. M'Leod, of the House-to-House Company, who had answered a number of questions, and as he was to be in Brechin again next week the committee proposed meeting him and going over the whole matter. The Clerk, in answer to a question, stated that Mr. M'Leod had written to the effect that his company would supply the electric light at 6d. per Board of Trade unit. A long discussion took place. The Dean of Guild moved that a special meeting of Commission should be called to meet Mr. M'Leod. Mr. Jamieson seconded. Mr. Murray moved, and Mr. Knowles seconded, that Mr. M'Leod be not asked to come to Brechin. Ultimately the finding of the meeting seemed to be that they should not meet Mr. M'Leod as a Board, but that every member who desired should do so.

Southport—The Gas and Electricity Committee of the Town Council have reported that with reference to the electric lighting scheme the Local Government Board have given their consent after holding an enquiry for the land before named being used for electric light purposes, and have also sanctioned the borrowing of £28,000, the same to be repaid within 25 years from the date of borrowing. The laying of the two cables named in the scheduled area, and a little beyond, has been completed, the engines, boilers, and dynamos are all about ready for delivery, and the buildings are approaching completion It is expected that electric current will be ready for consumers before the end of the current year, for which the price has been fixed at the rate of 7d. per Board of Trade unit, the current to be supplied by meter. A number of tables were appended to the report, the consideration of which was deferred. The expenditure on capital account for the financial year 1893-4 includes £1,590. 7s. 10d. for electric light Councillor Travis sai l that the machinery put down was equal to the supply of 4,000 8-c.p. lamps; and quite apart from anything which the Corporation might require for the municipal buildings, they had already received applications for something like 1,800 8-c.p. lamps. The report has been adopted by the Town Council.

Hampstead.—On the motion of Mr. James Thwaites, chairman of the Electric Lighting Committee of the Hampstead Vestry, it was decided that the Electric Lighting Committee be empowered to engage such staff as they may consider necessary for working and attending to the plant at the central electric supply station, and the mains connected therewith. Mr. Thwaites said that Mr. R A. Chattock, the recently appointed chief engineer, would commence his duties on September 3, and it would be necessary that the machinery and mains should be thoroughly tested before October 1. the date fixed for the beginning of the supply. A letter was received from Mr. R. A. Chattock, confirming his acceptance of the appointment of chief electrical engineer to the Vestry, and tendering his thanks to the Vestry for the same. A cheque for £500 was down in payment of the eleventh instalment to Messrs. Yerbury and Sons under the contract for the erection of the central supply station. The third instalment under Messrs. Siemens Bros. and Co.'s contract for supplying and fixing plant amounted to £3,811. 4s, for which a cheque was drawn. The account included the following items: boilers and accessories, £1,499. 12s.; pipes, £400; dynamos and accessories, £1,392; switchboards, etc, £148; arc lamps and posts, etc., £155. 9s.; transformers, £166. 8s. A cheque was also drawn for £75 in payment of commission due to Mr. Preece, C.B, the consulting engineer.

Stowmarket.—A number of gentlemen assembled in the Institute Hall on Wednesday to consider the desirability of introducing the electric light in the town. Mr. C. G. Hayward presided. Many tradesmen of the town and many private residents have expressed a wish to adopt this illuminant. Mr. Charles R. Dewhirst convened the meeting, and Mr. Napier Prentice gave some statistics as regards the cost and maintenance of the light. Figures were given which showed that there was not much difference in cost between electricity and gas. Then came the question of supply. Three methods could be adopted. The first would be to get the gas company, who could do it cheaper than anyone else, to put down a gas-engine and run a dynamo. The second would be to form a company and provide means for generating electricity. The third plan would be to call in an outside company, who would sell the electricity after having obtained a provisional order. Several gentlemen took part in the discussion, Mr. Gostling stating that although a shareholder in three gas companies he was in favour of the electric light. In reply to a question, Mr. Prentice said the cost of fixing incandescent lamps of 16 c.p. would be about 20s. each. Mr. Gower thought that the gas company could doubtless supply the light better than anyone else. On the proposition of Mr. Gostling, seconded by Mr. Gower, the meeting unanimously appointed Mr. Prentice and Mr. C. R. Dewhirst as a committee to approach Messrs. Thos. Prentice, the lessors of the gas company, with a view of inducing them to supply the town with the electric light.

Winchester.—The question of introducing a municipal supply of electricity, to which we referred in our last issue, has again been considered by the Town Council. A report of the Joint Committee of the General Purposes and Electric Lighting Committee, embodying proposals of the gas company and the Brush Electric Lighting Company respectively, was submitted, and it was on this that the discussion took place. The committee recommended that the Council should take steps to obtain a provisional order for the public and private lighting of the city according to the system suggested by the Brush Company. The Mayor (Alderman Stopher) pointed out that the report was incomplete, and he furnished the figures—155 lamps of 16 c.p. for side streets, 142 lamps of 32 c.p. for main streets, and 14 lamps of 50 c.p., with 133 oil lamps as at present costing £2. 5s. each, making a total of £1,020. The ex-Mayor, in moving the adoption of the report, entered at length into the question, pointing out what he considered were the advantages of electricity over gas, and the benefits accruing by the obtaining of a provisional order at a cost of about £250. Other members having expressed their views, Alderman Warren pointed out that all they were asking for was the cost of the provisional order; so as to protect themselves and get the powers in their own hands. It was stated that the cost of procuring the order would amount to £250; and that to carry out the electric lighting scheme it would be necessary to obtain borrowing powers for £25,000. Eventually it was decided to proceed with the application for a provisional order.

Gas and Electricity in London.—A deputation, consisting of representatives of all the North London Vestries, the Holborn District Board of Works, and the Gas Consumers' Protection League, waited on Thursday last week upon Mr. Bryce, President of the Board of Trade, to ask for an enquiry into the metropolitan gas supply. In the course of his reply to the deputation, Mr. Bryce said in regard to the gas companies that he thought Parliament did make a bad bargain, and that it was to be regretted that the hands of Parliament and of London were tied in the way in which they were tied by existing statutes. He was happy to say that the Board of Trade had learned by experience in this matter; and he could also say that the Board would have made a better bargain for the people of London in previous years than had been made for them by Parliamentary Committees. The researches which had been made for him into the archives of what had passed then, showed that the Board of Trade would gladly have done more for the people of London in those days than Parliament permitted it to do. When the question of electric lighting came up—as was no doubt known to the deputation—provisions were inserted in the Electric Lighting Provisional Order Bills, under which the interests of the people of London in the future were protected and provision made for them. It was quite true that great steps forward had been taken since 1876. They had, he thought, much larger views of what was due to the interests of the people than they had in 1876. He was also sure that, if they were entering upon this matter again, they would have the same regard to the interests of the people as was had when the Electric Lighting Bills were passed; and that they would endeavour to profit by the experience which had been obtained since then by those great towns in which the gas supply was in the hands of the municipality.

Profit Sharing.—A report on profit-sharing, undertaken by Mr. D. F. Schloss on behalf of the Labour Department of the Board of Trade, was issued on Monday. In indicating the scope of enquiry, Mr. Schloss states that profit-sharing, as the word is used by him, comprehends a variety of forms of industrial remuneration, all covered by the definition given in the first of the resolutions passed at the International Congress on Profit-Sharing held at Paris in 1889, a meeting which was attended by a large number of the leading exponents of the method. Profit-sharing is there declared to be "a voluntary agreement by virtue of which an employé receives a share, fixed beforehand, in the profits" of an undertaking. The report first deals exhaustively with the share system and with industrial co-operation, and then gives a history of profit-sharing in Great Britain. From the detailed description of the different cases in which profit-sharing has been adopted, it is noted that in hardly two cases is the system adopted identical in all particulars, and the task of classifying the various methods is far from easy. In a certain number of cases (of which Sir Joseph Whitworth and Co., Limited, "A. B.," Willans and Robinson, Limited, William Thomson and Sons, Limited, and Brownfield's Guild-Pottery Society, Limited, may serve as good examples), the right to share in profits accorded to the employés is a strict legal right, the employers being under an express obligation to pay the bonus. But in many cases the bonus is declared to be given "gratuitously." In the cases of Messrs. Willans and Robinson, Limited, and Messrs. Crompton and Co., Limited, the employés holding debentures received a fixed interest of 5 per cent., with the right to a higher rate if the profits exceed 5 per cent. Among cases in which the bonus is a proportion of the entire profits without any reservation of a minimum interest or dividend or reserved limit in favour of the employers, we find 10 per cent. of the amount available for division as profits allotted to the bonus fund by the New Welsh Slate Quarry Company, Limited, and by the Brush Electrical Engineering Company, Limited.

Portsmouth.—The Electric Light Committee of the Town Council recommended that they should be authorised to extend the supply of electricity through Unicorn-road to the Connaught Drill Hall, at an estimated cost of £265, and that application be made to the Local Government Board for their sanction to the

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borrowing of that sum. The committee also recommended that they be authorised to extend the supply of electricity through Clifton-road, and also along the Clarence-parade as far as the corner of South-parade, at an estimated cost of £1,000, and that application be made to the Local Government Board for their sanction to the borrowing of that sum. In moving the first of these clauses, Alderman Ellis stated that he had had a report prepared, which showed that, exclusive of the public installation, on June 16 last 2,094 16-c.p. lamps were in use in private houses, while the number on August 1 had increased to 3,517 lamps of 16 c.p. He congratulated the Council on this increase. It was a very important matter, since on the day they arrived at 6,000 or 7,000 they would be able to run the installation of the town and pay all expenses without coming on the rates for a farthing. This could only be done by extending their lines and getting people to take up the new illuminant. The number of shops that had taken up the electric light in Russell-street was double the number he had prophesied, and he ventured to say that the amount realised at the end of the year for that district would be nearer £600 than £300. Councillor F. G. Foster said that it should be known that if in any district the support promised would guarantee a return of 6 per cent., the committee would extend their lines in that direction. If, however, it was proposed that the arc lighting at Southsea should be increased, without a proportionate extension of the light to the northern side of the borough, he should strongly oppose it. Alderman Ellis pointed out that the fire brigade station, the police station, and the Corporation stables, and the baths were still lighted by gas. If the various committees would only support the Electric Lighting Committee, it would be much better for that committee and also for the ratepayers. The recommendations were adopted.

The Waterloo and City Railway.—The huge pile of staging in the Thames on the south side of Blackfriars Bridge is the first outward and visible sign of the existence of the Waterloo and City Railway Company. The object is to construct a line from Waterloo to the Mansion House. Messrs. John Mowlem and Co. are the contractors, and the engineers are Messrs. Galbraith and Church. A representative of the *City Press* has gathered some details of the construction of the line, from which it appears that there is a peculiarity in this respect at least, that the above-named staging in the river is the basis of the whole of the operations, and the advantage of this is that there will be no openings on land, and therefore no property to acquire in the streets for carrying on the works, and no interruption to traffic. Within the space enclosed by the timber piles huge cylinders, 16ft. in diameter, will be sunk well into the London clay, but not down to the level of the tunnels—the up and the down—which will be of cast iron, 12ft. in diameter, where the line is straight and on easy curves, but 9in. wider on sharp curves, so as to allow the running round of the bogey carriages to be employed without fouling the sides. Below the cutting-edge of the cylinders brickwork in cement will be used. At the tunnels' levels, shields—two in each cylinder—forced by hydraulic pressure, will be used for boring through the clay, the *débris* being raised to the surface of the river, taken away in barges, and used for levelling, or what not, far away from the scene of operations, for the railway. The precise form of the carriages does not appear to have been decided upon yet. It is anticipated that the journey from end to end will occupy four minutes. The contract was placed on June 1, and the contractors have undertaken to construct the tunnels from Cross-street, Waterloo-road, to the Mansion House in 2½ years. The station works will be separately contracted for. Operations were commenced on June 18, and the sinking of the first cylinder at Blackfriars will be begun in the course of a few days. The resident engineer for the railway is Mr. H. Dalrymple Hay, and for the contractors Mr. W. Rowell. The line will be worked by the London and South-Western Railway Company.

Wolverhampton. — The Wolverhampton Town Council on Monday discussed various points in connection with the electric lighting of the town. In reply to Mr. Weaver, it was stated by Mr. Craddock that the contractor who is laying down the electric light cables in the streets was not liable to replace the foot pavement in the state in which he found it. An allowance was made in his contract for this work which would amply recoup the ratepayers. Replying to Mr. Stevenson, Alderman W. H. Jones stated that Mr. A. P. Brevitt, the architect, was acting as clerk of the works at the electric light works. Mr. Cousins asked when the improvement in Lichfield-street would be completed. Alderman Owen said the committee were waiting for a faculty to be granted before the work could be proceeded with. A discussion was raised by Mr. Stevenson, who drew attention to a letter from Mr. Walton, the secretary to the Wolverhampton Trades and Labour Council, alleging a violation of the fair wages clause contained in the contract relating to the execution of certain work at the electric light station. Mr. Johnson said the matter had been enquired into by the committee, who had come to a conclusion by a large majority that there had been no violation such as was alleged to have taken place. With that decision, however, he disagreed. Mr. Rhodes thought it was a piece of gross impertinence on the part of any section of society to dictate to the Council. Mr. Johnson said the Council had passed a resolution that no portion of a contract should be sub-let, yet work at the electric lighting station had been sub-let without the written consent of the Council. Mr. P. Lewis did not think it right that a resolution of the Council should be allowed to be violated, nor did he think it impertinence for a representative of the working-men to call attention to any violation of a resolution. The report of the committee on the subject was read, and it was stated that it would be impossible to carry on work if they were to quarrel with contractors over trifling matters. Alderman Dickenson said the whole question arose with regard to some work being executed on piecework instead of daywork, and as far as he gathered the wages received were as high as would be paid for daywork. He contended that there had been no sub-letting at all. It was a question whether the work should be executed on piecework or daywork. Mr. Craddock said there was no suggestion that there had been any sweating, or that anyone had suffered through a technical violation of the clause having taken place. On a vote being taken the report was adopted.

Halifax.—Good progress is being made with the Corporation electric light works, and there is every probability, if all continues to go well, that the opening of the works will take place early in November. Three Lancashire boilers, each of 350 h.p., with which a commencement is to be made, have already been fixed, and beds for three dynamos are in course of preparation. Ample provision is being made for extensions in both these departments as the demand for the electric light increases, space having been left for an additional six boilers and for two extra dynamos. For any further extensions some adjacent land near will have to be brought into use. The engines for the driving of the dynamos are being supplied by Messrs. Pollit and Wigzell, of Sowerby Bridge, and they are now almost completed. These, however, will not be delivered, or the dynamos fixed, until the building has been roofed in, a work which is now in hand. The large chimney is being built, and a start has now been made with the reservoir required for condensing purposes. The laying of the cable along the streets was commenced this week, a work that will occupy about three weeks. It is believed that when the plant has been got into complete working order there will be a great demand for the electric light. Already orders for the light have been received from about 70 customers, who will take 2,000 of the 5,000 lights which will be available for private customers from the plant now being put down. Certain banks, large shops, and one or two places of worship will use the electric light. The committee of management of Trinity-road Baptist Chapel have decided to light the chapel throughout with electricity, and have finally adopted the plans and specifications submitted by Messrs. Walter Emmott and Co., who have been entrusted with the work. The body of the chapel will be illuminated by about 109 incandescent lamps suspended from the ceiling and from the under parts of the galleries. The chapel is being repainted and decorated throughout, and it is expected that this, together with the electrical installation, will be completed by October 6. The Halifax Club are also having their premises fitted throughout for about 140 incandescent lamps, and the wiring for this work is just about completed. This has also been entrusted to Messrs. Walter Emmott and Co. The Town Council appointed a sub-committee to consider the desirability or otherwise of lighting the Town Hall electrically. The committee have advised the Council to sanction an expenditure of £500 in furnishing the building throughout with the fittings necessary for an electric light installation. The proposal has, however, been negatived.

Reading.—The Highways Committee of the Town Council have lately reported having received applications from Mr. F. W. Albury, on behalf of the Reading Electric Supply Company, for permission to construct a level railway crossing in Vastern-road, and a transformer sub-station under the cabmen's shelter in the Market-place. The committee recommended that the approval of the application in regard to the transformer station be agreed to subject to the company paying a rent of £20 per annum, but recommended that the other application be rejected. The Town Clerk submitted a draft which had been sent to him by Messrs. A and C. Collins, the solicitors to the Reading Electric Supply Company at the request of Mr. Kite, of a proposed license by the Corporation to the Laing, Wharton, and Down Syndicate, Limited, to assign to the said company all the rights or privileges conferred upon Messrs. Wharton and others by the agreement between them and the Corporation dated March 6, 1889, relating to the fixing of posts, poles, and wires in or over the street in this borough for purposes of the supply of electricity. The committee resolved to recommend to the Council to grant the license applied for, but subject to the provisions of the Reading Electric Supply Order granted by the Board of Trade to the company in respect of this borough and confirmed by the Electric Lighting Confirmation (No. 5) Act, 1893, and upon the understanding that the license shall not be construed as sanctioning the supply of electricity by means of overhead wires except as authorised by the order, or as authorising any particular system of supply, and that the town clerk do settle the draft license accordingly. It was further resolved that the town clerk do forward for approval by the Reading Electric Supply Company, Limited, an agreement between them and the Corporation for providing security to the extent of £1,000 for due payment of any expenses incurred from time to time by the Corporation in executing works which they are empowered or may be required to execute under the provisional order. At a subsequent meeting, Messrs. Collins forwarded a statement of the nominal, issued, and subscribed capital of the company, and urged that as that statement showed that the company could meet any claims the proposed deposit was unnecessary. The committee decided to recommend that the proposed security be £500 instead of £1,000. Mr. Walters moved a resolution to the effect that the application of the Reading Electric Light Supply Company to lay a railway crossing in Vastern-road be granted. He argued that the company was a public one, established for the convenience of the inhabitants, and, further, that it would save the roads if a railway crossing were made. Any future application of a similar nature, he said, could be treated on its merits. Mr. Wellman seconded the motion, which was lost by a large majority.

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Telephone Wires at Cardiff.—The Public Works Committee of Cardiff considered on Thursday of last week the subject of the institution of a system of underground wires in connection with the National Telephone Company, Limited. A letter was read from Mr. W. E. L. Gaine, of the company's head office, on the matter, and the copy of agreement was forwarded on behalf of the company. The Borough Engineer (Mr. W. Harpur) pointed out that the company, in the agreement they submitted, sought really perpetual powers. There was no question of the termination of the agreement, nor payment for the privilege. The agreement as drafted by the company was practically equal to an Act of Parliament, giving them the right to put down pipes in any and every street in the borough. He could not recommend the committee to accept it. The Post Office people had not such powers. They made application for every pipe put down, though they had the right of appeal to quarter sessions in the case of refusal. The committee instructed the town clerk (Mr. J. L. Wheatley) and the borough engineer to prepare a draft agreement. Mr. Gaine attended before the committee and explained that the company found the work at their two exchanges in Cardiff could not be so efficiently fulfilled as they would desire, and had, therefore recently acquired premises at the corner of New-street by the Custom House Bridge. The company intended to concentrate their Cardiff exchanges in one central exchange. It being necessary to take down a considerable amount of overhead plant, the company deemed it advantageous to ascertain the views of the Municipality on the subject. If the desire was to put the wires underground it would involve greater initial expenditure, though in connection with maintenance he did not know whether underground or overhead wires was the cheaper system. Some discussion took place on the subject of wayleave, and £5 per mile per annum was proposed. Mr. Gaine said the company were quite willing to pay nominal rent, but beyond that he would not go, and he was not prepared to assent to either £5 or £2 per mile of pipes per annum. Unless the rent applied only to the length of streets used this would not be a nominal rent. He would prefer to put down underground pipes, but if they had to pay more than nominal rent he should, in view of the additional cost, not do so. It would cost from £4,000 to £5,000 for overhead wires, and to put the wires underground it would cost £20,000. They had to pay £75,000 to the Post Office to compete, and in Cardiff they fulfilled a great service to the public. Councillor Johnston observed that the company took the profits whereas the Post Office devoted the profits to the nation. Mr. Gaine retired, and the committee appointed the chairman, Mr. Beavan, and Mr. Johnston to confer with the town clerk and borough engineer and arrange an agreement with the company. The committee decided that a rent of £1 per mile per pipe of 3in. diameter should be charged.

PROVISIONAL PATENTS, 1894.

AUGUST 7.

15034. **Improvements in instruments for measuring electric currents.** William Thomson (Baron Kelvin), 154, St. Vincent-street, Glasgow.

15051. **An improved grip to be employed in laying electric cables.** Robert Middlemass, Peasholme House, Scarborough.

15065. **Apparatus for making electrical contact by passage of a railway train.** Edward Tyer, 28, Southampton-buildings, Chancery-lane, London.

15070. **Improvements in overhead conductors for electric railways and tramways.** William John Brewer, 9, Gracechurch-street, London.

15082. **Improvements in magneto-electric machines for cycles or other vehicles and driving gear for the same.** Ernest Tilmann and Charles King Lexow, 22, Southampton-buildings, Chancery-lane, London. (Complete specification.)

AUGUST 8.

15170. **Improvements connected with arc lamps.** John James Rathbone and Arthur Chester, 166, Fleet-street, London.

15174. **An electrical rolling contact making and breaking device.** Karl Ast, 34, Southampton-buildings, Chancery-lane, London. (Complete specification.)

AUGUST 9.

15219. **Improvements in the method of and means for preventing undue reciprocal influences between telephonic lines, or between telephonic and telegraphic or other electrical lines.** Emil Müller, 6, Lord-street, Liverpool. (Complete specification.)

AUGUST 10.

15258. **An improved material for the manufacture of lamp, gas, electric light shades, and other fancy articles.** Harrington O'Reilly, 8, Berners-street, London.

15276. **Improvements in or connected with diaphragms for electrolytic purposes.** Martin Kiliani, Walter Rathenau, Carl Suter, and Elektrochemische Werke Gesellschaft mit beschränkter Haftung, 47, Lincoln's-inn-fields, London. (Complete specification.)

15282. **Improvements in or connected with ploughing by electricity.** Friedrich Brutschke and Hugo Schimpff, 4, South-street, Finsbury, London.

AUGUST 11.

15321. **Improvements in and relating to flexible telephone cords.** Otto Schrimpff and Ruppert Riffelmacher, 70, Market-street, Manchester. (Complete specification.)

15353. **Improvements relating to electric motors.** William Routledge, 4, South-street, Finsbury, London.

15356. **Improved means for opening or closing valves, taps, electric switches, and the like.** Daniel Thomas Bostel, 32, Southampton-buildings, Chancery-lane, London.

15360. **Improvements in arc lamps.** James William Rogers, 24, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1892.

20598*. **Electric accumulators.** Theyryc and Oblasser. (Amended specification.)

1893.

14130. **Electrolysis of iodides, bromides, etc.** Hargreaves and Bird.

14131. **Electrolysis of chlorides, iodides, etc.** Hargreaves and Bird.

15485. **Glow lamps and holders.** Mann and Hopwood.

17197. **Dynamo-electric machinery.** Crompton and Brunton.

17341. **Alternate-current dynamos.** Kapp.

17348 **Electrical transformer street surface boxes.** Bowden and Boby.

17645. **Distribution and regulation of electric current.** Grenfell and March.

17866. **Electric accumulators.** L. W. and G. E. W. Schöffer.

17972. **Electric bells, fire and burglar alarms, etc.** Mills.

1894.

433. **Electric switch.** Elieson.

5572. **Elastic ear-cushion for telephone receivers.** Fearnley.

8218 **Electric signalling.** Jones and Collier.

8585. **Electric conductors.** Conner.

10386. **Clocks for operating electrical alarms.** Fritz.

10851. **Electric railway signals.** Lake. (Beattie.)

11100. **Electric dental motor apparatus.** Denison.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	5	5¼-5⅜
Bournemouth Electric Company	—	—
Brighton and Hove Company Original	100	210-215
—— "A" Ordinary	—	162-166
Brush Company, Ordinary	3	2⅞-3
—— Nom. Cum., 6 per cent. Pref.	2	2⅛-2¼
—— 4½ Debenture Stock	100	110-113
Charing Cross and Strand	5	4⅛-5⅛
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	12¼-13½
—— 6 per cent. Cumulative Pref.	10	14-14½
—— 5 per cent. Debenture Stock	115	128-131
City and South London Railway, Consolidated Ordinary	100	36-38
—— Debenture Stock	100	121-123
—— 5 per cent. Pref. Shares	10	12½-13
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2⅛
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	95-100
Electric Construction, Limited	2	⅛-¼
—— 6 per cent. Debentures	—	87-92
—— 7 per cent. Cumulative Pref.	2	1⅛-1⅜
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1-1⅛
Elmore's French Company	2	⅛-¼
Elmore's Wire Company	2	¾-1
Fowler-Waring Cables	5	⅛-1⅛
W. T. Henley's Telegraph Works, Ordinary	10	7-8
House-to-House Company, Ordinary	5	1-1⅛
—— 7 per cent. Preference	5	5⅛-5⅜
India Rubber and Gutta Percha Works	10	23-24
—— 4½ per cent. Debentures	100	103-105
International Okonite, Ordinary	—	—
Kensington and Knightsbridge	5	4⅞-5⅛
—— 6 per cent. Pref.	—	6⅛-6⅜
Liverpool Electric Supply, Ordinary	5	6⅛-6⅜
—— Pref.	—	—
Liverpool Overhead Railway	10	8⅛-8 3/16
—— Pref.	10	13-13½
—— 4 per cent. Mortgage Debentures of £100	100	111-113
London Electric	5	¾-1⅛
Metropolitan Electric Supply	10	8¼-8⅜
—— 5 per cent. Reg. Debentures, 1-10,000 in Bonds of £10, £20, and £40	—	—
National Telephone, Ordinary	5	4⅞-5⅛
—— 6 per cent. Cum. First Pref.	10	14-15
—— 6 per cent. Cum. Second Pref.	10	13⅛-14½
—— 5 per cent. Nom. Cum. Third Pref.	5	5⅛ 5⅜
—— 4½ per cent. Deb. Stock	—	109-112
Notting Hill Company	10	4⅛-5⅛
Oriental and Electric Company, £1 shares	1	1-1⅛
—— £5 Shares	—	6⅛-6⅜
—— £4½ shares	—	5⅛-5⅜
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	6¾-7⅛
—— 7 per cent. Pref.	5	8⅛-8⅜
Swan United	—	—
Telegraph Construction and Maintenance	12	40-42
—— 5 per cent. Bonds	100	102-105
Westminster Electric Supply, Ordinary	5	6-6⅛
Yorkshire House-to-House	4½	4⅛-4⅜

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NOTES.

Junior Engineering Society.—The members of this society are visiting Cardiff and neighbourhood during the present week.

Dredger-Lighting.—The large dredger "Percy Sanderson," which has just been launched on the Clyde, is lighted throughout by electricity.

Anarchists and Electricity.—It is announced from Chicago that electrical explosive machines have been discovered in the possession of local Anarchists.

Central Station at Culm.—Good progress is being made with this station, which is being carried out by the Allgemeine Elektricitäts-Gesellschaft of Berlin.

Park-Lighting.—A correspondent of a daily paper suggests that arc lamps should be introduced for the illumination in the evening of the avenues in the public parks.

Electric Traction in France.—As mentioned in a previous issue, the electric tramway at Havre was partly set in operation in July, and this month all the lines have been opened to traffic.

Electric Traction in France.—It is proposed to construct an electric tramway to connect Gérardmer with Retournemer. The electric tramway system at Saint-Adresse has just been opened.

Electric Heating.—It appears that in winter time the electric cars on the Mont Salève electric railway in Switzerland are heated by electricity from resistance coils carried in metallic cases under the seats of the cars.

Electric Tramways for Plymouth.—A local paper urges that horse traction should be abolished at Plymouth, that steam is not to be thought of, that cable traction is expensive, and that electric traction is what is required.

Electric Traction at Baden-Baden.—A special municipal commission is studying the question of building an electric tramway from Lichtenthal to the Rhine. It is estimated that the cost of the line, together with the central station, will amount to about £82,500.

Paris Exhibition of 1900.—In our issue of June 15 we gave the heads of the various sections of this exhibition as far as related to electrical matters. The sub-divisions of the various electrical sections are given at length in the *Bulletin International de l'Electricité* of 20th inst.

Tunnel-Lighting.—The Ivanhoe Tunnel, which is on the point of being completed, is cut through the backbone of the Rocky Mountains from Busk to Ivanhoe. The tunnel is 9,400ft. long. During construction the tunnel was lighted by electricity, an arc light being placed at intervals of 80ft.

Patents, Trade Marks, and Designs.—We have to acknowledge receipt of a copy of "A Practical Treatise on Patents, Trade Marks, and Designs," by Mr. David Fulton, A.M.I.C.E., Fellow of the Chartered Institute of Patent Agents. It is published, at 15s., by Messrs. Jordan and Sons, of 120, Chancery-lane, E.C.

Electrically-Lighted Hansom.—The Gloucester Railway Carriage and Wagon Company have built a hansom cab for Mr. Oscar Farmer, Montpellier-mews, Gloucester, which is lighted electrically. A battery is placed underneath the seat of the driver. The interior light is of 2½ c.p. and the two side lamps outside of 4 c.p.

The Hermite System in India.—Experiments are to be carried out to ascertain whether the Hermite system can be adopted in Bombay. Before going to any expense, *Indian Engineering* advises the Commissioners to communicate with the Singapore Municipality, as Mr. Newton, the assistant municipal engineer, has personally watched this process for disinfecting sewage on behalf of that municipality.

Electro-Chemistry in Austria.—There has been formed in Vienna, under the title of Konsortium für Elektrochemische Industrie, a company having for its object the electrolytic preparation of soda, etc., on the patents of Mr. Kellner, of Hallein, near Salzburg. It is proposed to erect a works at Golling, near Hallein, where water power to the extent of 2,500 h.p. is available, and where raw material can be procured cheaply.

Underground Railways in Paris.—The French Minister of Public Works, M. Louis Barthou, has this week visited London and Liverpool, where he studied the system of metropolitan and tubular railways, with a view to suggesting, on his return, the construction of similar lines in Paris. He was accompanied by several directors of railways and the deputy for the Vosges, who is the reporter before the Chamber on the Berlier project for a tubular electric railway in Paris.

Ageing Brandy Electrically.—According to the annual report of the directors of the Brandy Distillers' Company, Limited, great progress has been made by their technical manager in the ageing of brandy by electricity, which, it is said, will enable the directors to dispose of their brandy at advantageous prices within 18 months after distillation. The process consists of the application of ozonised compressed air to the spirit while it is under the influence of an electric current.

Electrical Communication with Lighthouses.—The Royal Commission on Electrical Communications with Lighthouses and Light-vessels intend to visit Liverpool next week. The following are the members of the Commission: The Earl of Mount-Edgcumbe, the Hon. H. L. Mulholland, M.P., Admiral Sir Leopold M'Clintock, K.C.B., Vice-Admiral Sir George Nares, K.C.B., W. H. Preece, C.B., Sir Edward Birkbeck, J. C. Lamb, and J. A. Kempe. The secretary is Mr. Ernest G. Moggridge.

Gas v. Electricity at Hanley.—A further result of the introduction of a municipal supply of electric light at Hanley is shown by the fact that the British Gaslight Company have decided to reduce the price of gas to private consumers in the Potteries district from 2s. 9d. to 2s. 6d. per thousand. There will also be a reduction in the price charged for public lighting of 5s. per lamp per annum, making the charges £2. 15s. per lamp. This is the second reduction due to the adoption of the electric light.

Telephony in Italy.—The project for the erection of telephone lines between the chief Italian cities is ready. The lines will be: Rome—Naples; Rome—Genoa, Turin; Rome—Florence, Milan; Turin—Milan; Turin—Genoa; Rome—Florence—Venice. It is subsequently intended to construct lines in connection with Paris, Berne, Berlin, Vienna, and Trieste. The Italian Minister of Posts and Telegraphs has decided to send an inspector to Germany to study and report upon the organisation of the telephone service in that country.

Postal Telegraphs.—The annual report of the Postmaster-General, which has just been issued, states that the work of connecting by telegraph the coastguard stations on exposed parts of the coast for the saving of life is now proceeding steadily, some 74 stations having been brought into connection this year. Further, in pursuance of the recommendations of the Royal Commission telegraphs have been extended to 18 of the principal shore lighthouses. Lundy Island, the Goodwin Sands lightship, the Kentish

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Knock lightship, and the Gunfleet pile lighthouse are now in communication.

Durham College of Science.—This college, the professor of which is Mr. R. L. Weighton, M.A., M.I.N.A., provides complete courses of instruction in mechanical, marine, and electrical engineering, and naval architecture. New buildings for the accommodation of the department have been erected, and the laboratories are equipped with quadruple-expansion engines and boiler for experimental purposes, a 100-ton testing machine, turbo-electric generator, dynamo, horizontal compound engines, etc. The session commences on September 24. Prospectuses can be obtained on application to Mr. H. F. Stockdale, secretary of the college, Newcastle-on-Tyne.

The Trans-African Telegraph.—Sir James Sivewright, who was formerly general manager of telegraphs in the Cape Colony, speaking in the Cape House of Assembly, of which he is a member, on the subject of the Trans-African telegraph line, said there is little to prevent the completion of the telegraph from Capetown to Cairo, but, in his opinion, it could never be a competing line with the cables. Unless some improvement not now foreseen is made in telegraphy, they would never be able to send a message direct the whole distance. The two places are not in the same latitude: they would be going from mid-summer to mid-winter; and the elements would effectually prevent the attainment of their object.

Wellington (New Zealand).—A leading article in a Wellington paper, referring to the lighting of the city, says: "In some parts the lamps make the darkness visible, but they certainly do very little more. This should not be. The present average cost of street-lighting is over £2,000 a year, and the city should get better value for the money than it is now receiving in the dispersion of nightly darkness. If the money is not enough to secure better lighting, then more should be spent in order to save outlay from being largely useless and a waste. With Dr. Lemon to advise it, the Electric Light Committee of the Council should be able to see thoroughly into the whole matter. As things are at present, the lighting of the city is certainly extremely deficient."

Light Railways.—"Progress" has written to a Cork paper as follows: "I have been reading attentively the reports of Irish railways and other companies, and I have come to the following conclusions—1. That the railways ought to be worked and owned by the Government. 2. That corporations ought to take over the lighting of the cities with electric or other form of light. 3. That tramways should be run by the body corporate. 4. That the people should meet and discuss these matters before the general election. I hope that the Mayor will convene a public meeting of the citizens to consider the questions raised. The prosperity of the country is at stake, and the people of the United Kingdom are crying out for cheap railways, cheap light, and cheap tramways."

Electric Mail Cars.—The Atlantic Avenue Railway Company has completed an electric postal car designed by the company's officials, assisted by the postal authorities of Brooklyn, patterned after the standard type of postal car used on steam lines. Only half the car will be used for postal purposes, the other half being a smoking compartment. There are pigeon-holes for distributing the mails, and hooks for holding the mail pouches upon. Drop-letter boxes are provided at each corner of this compartment. The exterior of the car presents a very handsome appearance. It is painted white, like the United States mail cars which are run on steam routes, the smoking compartment being lettered "Smoking Car." The windows are covered with wire screens. Two of these cars have been put into service.

Telephony in Glasgow.—The Telephone Committee of the Town Council last week discussed the Postmaster-General's copy of memorandum with reference to the proposed agreements with the National Telephone Company and the New Telephone Company, and of which we gave an abstract in our last issue. It was pointed out that the Postmaster-General was left absolutely free to grant a license to the Corporation of Glasgow or any other licensee. In reference to communication with towns outside the municipal area, the committee were satisfied that it was absolutely secured that in the event of Corporation telephones being established messages would be taken and delivered in the same way as by the present company.

Dalziel on Telephony and Telegraphy.—We always admire Dalziel's telegrams, and that is the reason for our reproducing the following items published on Wednesday. From Brussels the Dalzielite says: "It has been decided by the Belgian Government to open negotiations with the British Government for the construction of direct telephone communication from London to Brussels *vid* Ostend, it being understood that should the negotiations be successful the authorities at Berlin have signified their willingness to consent to a connecting telephone line from Brussels to Berlin. It is thus highly probable that before long London will be in direct telephone communication with Berlin." From Paris the correspondent states: "It is rumoured here that negotiations are pending between the French Atlantic Cable Company and one of the largest of the English telegraph and cable systems for an amalgamation."

Leipsic Tramways.—Mr. Bayley Hawkins mentioned at a meeting of the Leipsic Tramways Company on Tuesday that it was expected that certain street electric tramways in Leipsic would be worked by a German company, with the sanction of the Municipality, but in the opinion of the company's representatives, and having regard to the experience gained in other towns, no serious competition, he stated, need be apprehended. At the present time the directors had no actual knowledge that concessions had been signed and properly registered, but they believed that there was a determination to have some of these electric lines, and the wisest course to be adopted by the English company in the circumstances was to strengthen their resources in every way they possibly could. That had been done in the present year to a greater extent than it had ever been done before. The information with respect to the concession, which Mr. Hawkins was unable to give, appears in our note on "Electric Traction in Germany" in another column.

The Odessa Central Station.—The extensions of the electricity works at Odessa, which were commenced by Messrs. Ganz and Co. in 1887, have been completed, and the undertaking has now passed into the possession of the Municipality. It appears that the contract was handed over first from one firm to another, resulting eventually in the General Electric Company of New York agreeing to equip the station. The first plant laid down comprises three Thomson-Houston alternators, giving 60 amperes at from 2,080 volts to 2,300 volts, the exciters yielding 30 amperes at 110 volts when driven at 1,450 revolutions a minute. The generators are operated by three compound vertical condensing engines made by Messrs. F. Tosi and Co., and supplied with steam from two boilers made according to the Collet system by the Compagnie Générale des Chaudières Inexplosibles of Paris. Although the works are now owned by the town, as above mentioned, the working of the station has been leased to Messrs. Margulis and Co., of Odessa, who have entrusted the technical management to Mr. Novinsky.

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Turning Lathes.—A fourth edition has been issued by the Britannia Company, of Colchester, of the handbook edited by Mr. James Lukin, B.A., entitled "Turning Lathes: A Manual for Technical Schools and Apprentices. A Guide to Turning, Screw-Cutting, Metal-Spinning, Ornamental Turning, etc." The book commences with the elements of turning by describing what a lathe is; and we then have chapters on tools, hardwood turning, metal-turning with hand-tools, slide-rest work in metal, the self-acting lathe, chuckmaking, turning articles of square section, screw-cutting by self-acting lathe, the overhead driving apparatus, choosing a lathe, grinding and setting tools, metal-spinning, Beddow's appliances, and ornamental drill and eccentric cutter. Then follow 68 pages of new matter, with 67 new engravings on the eccentric, the oval, and the dome chuck, the goniostat, the eccentric and the horizontal cutting frame, and a chapter on handy receipts and wrinkles. The work is one which is of much utility to those engaged in turning.

"Electric Transmission of Power."—Before leaving England, Mr. Kapp handed the final proofs of the fourth edition of his work on the "Electric Transmission of Power" to Messrs. Whittaker. The work has been brought up to date, both as regards theory and practice. Examples of the most recent installations of power transmission by continuous current, including the series arrangement of a number of machines for working at extra high pressure, have been added to or substituted for the examples in the third edition. The theory of continuous-current generators and motors has been further developed in accordance with latest investigations, and several new chapters have been added dealing with the transmission of power by simple and multiphase alternating current. The theory and construction of alternators, transformers, and alternating-current motors, has been added, as well as examples of large alternating-current plant successfully at work on the Continent. The book contains many illustrations and full particulars of dynamo-electric machinery made by the best English and foreign engineers.

Portable Accumulators.—A revised price-list of their manufactures has been issued by Messrs. Peto and Radford, of 57B, Hatton-garden, E.C. A noteworthy feature in the list is the variety of portable accumulators for different purposes. Among these may be cited the two-volt pocket accumulators which are suitable for cases where a compact and light battery is required for testing work, driving small motors, induction coils, etc. For stage purposes, the four-volt accumulators are used. These batteries can readily be carried in a belt placed round the waist, and which will accommodate four or five cells. This arrangement allows of a light being obtained for special use by employés engaged on work in magazines, gasometers, and the holds of vessels where a naked light would be dangerous. The portable accumulators are made in four standard sizes, having capacities ranging from six to twelve ampere-hours. A variety of portable lamps and carriage batteries next engages attention. Each set gives 12 hours' light, the increased number of volts giving a greater amount of light. Passing on from the table lamps, we note a low-resistance primary battery recommended for charging the accumulators, and a selection of electric jewellery for use with the pocket cells. Among other manufactures illustrated in the list may be mentioned protective dust and damp proof fittings for use in mills, factories, and chemical works; ammeters and voltmeters of the gravity and marine types, battery-cell testers, arc lamps and carbons, switchboards and switches, etc.

Electric Lighting in Germany.—The Saxon villages of Potschappel and Deuben have decided to construct a central station, the cost being divided equally between them. Since the Cologne Municipality have decided upon the electric lighting of the Hohestrasse, two arc lamps have been experimentally put up at two different places, which show a marked difference as compared with the gas lighting. The work has been carried out by Mr. Louis Welter, of Cologne. The Wilsdruff Municipality have decided to light the streets by means of 16 900-c.p. to 1,000-c.p. and four 400-c.p. arc lamps. Current will be obtained from the local private central station of Mr. Gustav Fischer. The Munich Gasworks have protested against the further extension of the electricity works. A site has been selected at Friederichroda for a central station. The project to connect Friederichroda with Gotha has fallen through. That the erection of a central electric light station in Dresden was much required is obvious from the large number of applications which are being made to the Municipality for light. Notification has been made that 15,000 lamps will be required for the Royal Palace and Court Theatre. The machinery for the installation will be supplied by the Helios Company, of Cologne. Three 800-h.p. steam dynamos will be put up at once. The system of mains will be carried out jointly by Messrs. Schuckert and Messrs. Kummer. The local authorities at Crefeld have decided to erect a municipal central electric station. As, however, the gas company has a monopoly for lighting until 1900, the current produced will until then only be used for working the trams and for electric motors for industrial purposes.

The Brockie-Pell Arc Lamp.—The Brockie-Pell arc lamp occupies a position which stamps it as one of the best lamps in existence, and the fact that over 7,000 are already in use demonstrates the great success that has attended it since its introduction some years ago. In this connection Messrs. Johnson and Phillips, of London and Charlton, who are the sole makers of the Brockie-Pell arc lamp, have just issued a revised price-list of arc lamps and accessories. This type of lamp is specially adapted for the illumination of streets. It has been largely adopted for this purpose—notably by the St. Pancras Vestry—by many corporations, including amongst the most recent those of Nottingham and Tunbridge Wells, and by the Ealing Local Board. Apart from this, the Brockie-Pell lamp is used by the English and Colonial Governments, and by those of Germany, Russia, Italy, and Japan. It has also been introduced in connection with the lighting of numerous public buildings, colleges, theatres, exhibitions, hotels, railways, docks, shipbuilding yards, etc. The double lamp will burn for 32 to 40 hours, and the cost of maintenance, owing to the simplicity of construction, is extremely low. It will work either with alternating or direct currents on 50-volt circuits, or two in series on 100-volt direct-current circuits, or three in series on 100-volt alternating-current circuits. The lamp is made in various sizes: for examining and photographing the interior of cannon a horizontal arc lamp is provided; whilst for optical lanterns the firm supply a small projector. Lamps for the illumination of mills and factories are also illustrated in the list, which concludes with reference to arc lamp accessories and views of the arc lamp carriers adopted by the Corporations of Wolverhampton and Blackpool. A leaflet enclosed in the list deals with a new short-series arc lamp of from three to fifteen amperes, and specially designed for use on low-potential circuits.

Electric Traction in Germany.—The municipal authorities of Leipsic have granted a 40 years' concession

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for electric tramways in the town to the Allgemeine Elektricitäts-Gesellschaft, of Berlin. It is proposed to construct at first lines to the extent of about 15 miles, to which about 6½ miles will be subsequently added. The new lines will run alongside of the existing horse tramways, but will only use the latter's tracks at certain points. There will be 75 motor cars, each to carry 34 passengers, and about 50 trailers of the same capacity. The total estimated cost is £258,400. After considerable delays, at last it appears that the local authorities of Düsseldorf have come to an arrangement with Mr. von Tippelskirch for the construction of an electric tramway to Grafenberg. A scheme has been drawn up for an electric tramway between Hagen and Eckesey, accumulator traction being employed. This will be the first accumulator line in Germany. It is proposed subsequently to extend the line to Herdecke. On completion the Hagen street tramways will be turned into electric lines. The Allgemeine Elektricitäts-Gesellschaft propose to turn the horse and steam tramway, in which they hold a number of shares, and which runs between Daerlach, Carlsruhe, and Mühlburg, into an electric line. Good progress is being made in connection with the electric plant for the so-called "blue" circular tramway in Hamburg. The posts have been erected and the conductors are now being fixed. A number of the motor cars has already been completed by the works at the Falkenried railway station. It is expected that the line will be in operation by October. Negotiations are in progress between the Municipality of Eibenstock and Messrs. O. L. Kummer and Co., of Dresden-Niedersedlitz, for the construction of an electric tramway to the railway station. The electric tramway at Gmunden has been completed, and trial runs for the purpose of instructing the employés have taken place. The overhead trolley system is employed.

Cost of Producing Electrical Energy.—A paper on this subject was read recently by Mr. B. J. Arnold before the North-Western Electrical Association, St. Paul, Minn. After enumerating statistics dealing with continental and American practice, the author concluded as follows: I will briefly call attention to the approximate results we are now getting from the different portions of power stations, and what we ought to expect from future stations. First—boilers: a large number of stations running now are using boilers with plain furnaces, from which they secure an evaporation of 5lb. of water per pound of coal. By the introduction of water-tube or internally fired boilers or tubular boilers set in improved furnaces, we will secure an evaporation of 8lb. of water per pound of the same fuel. Second—engine and generators: while we now get an average commercial efficiency of 60 to 70 per cent. in direct-belted plants, and 50 to 60 per cent. in those using shafting, we can increase these efficiencies to 70 and 75 per cent. respectively by the adoption of fewer and larger direct-coupled units. This will not only reduce the cost of fuel and labour, but will decrease the amount of real estate required and make the total investment less. Third—while Europeans have recognised the advantage of the use of accumulators with batteries as auxiliaries in central-station work, we have been slow to see this advantage, but the tendency now among American engineers and central station men is to look with favour upon this adjunct, and as there are many cases wherein a battery plant as an auxiliary can be made to pay well, the probability is that we shall see in the next five years many such plants installed. With a properly-designed direct-connected plant we may reasonably expect to deliver a kilowatt-hour to the consumer in stations having a capacity of not over 1,500 kilowatts for five cents per kilowatt-hour, which includes total cost of production and depreciation on the plant, but excludes interest on the investment and profit, assuming that a good quality of bituminous coal can be had for 2dol. 50 cents per ton. In larger stations with cheaper fuel the cost can be brought to 3½ cents.

Testing of Insulated Wires.—Though the full report of the World's Fair judges on insulated electric wires is not yet in the hands of the Awards Commission, the awards have been made public. The judges in this department were Profs. D. C. Jackson, B. F. Thomas, R. B. Owens, and M. O'Dea, and the tests ordered by the Awards Commission were, according to the *Electrical World*, as follows: First, a breakdown test under high pressure to the point of rupture of the insulation, using a 2,000-volt Westinghouse alternating current. Second, a soak test extending over a period of sufficient length to exhaust all but the best wire, which proved to be 100 days, the test ending to April 1, 1894. There were five solutions used, as follows: (*a*) 10 per cent. sulphuric acid solution; (*b*) 10 per cent. ammonia solution; (*c*) a saturated lime-water solution with heavy sediment of lime; (*d*) a solution of subway refuse or scrapings from Chicago subways suspended in Chicago river water; (*e*) Chicago hydrant water. The wire used was No. 14 B. & S., with $\frac{3}{32}$in. insulation. There were 10 varieties of commercial wire subjected to this test; two samples 100ft. long of each were used and tested at least once a week for resistance and the figures kept for computing the final results. To these tests Prof. Jackson added a third, with the consent of the committee, which consisted of a combination breakdown and soak test. Five solutions made up as those in the second set of tests were used, the wires being connected up in short lengths to a 6,000-volt current and kept in circuit until the insulation was ruptured. Prof. Jackson and the other members of the committee are now preparing an exhaustive report on their work, but the results have been given out in advance along with awards to the successful competitors. The first award is to Mr. W. R. Brixey for "highest excellence in insulating qualities, durability of insulation under conditions found in commercial service, and uniform high excellence in mechanical qualities of insulation." Other awards were to the Okonite Company, New York Insulated Wire Company, Simplex Electric Company, Standard Underground Cable Company, and Norwich Insulated Wire Company. J. A. Roebling's Sons' Company received awards for bare copper and trolley wire, and the Washburn and Moen Company for bare copper wire.

The Government and Telephony.—Consequent upon the publication of the memorandum relating to the draft telephone agreements, which were abstracted in our last issue, questions on the subject were put in the House of Commons last week. Mr. A. C. Morton asked whether, having regard to the statement in the Treasury minute of May 23, 1892, upon the proposal for the development of the telephone system in the United Kingdom, that the intention was to meet, as far as possible, the views of the municipal authorities, and having regard to the fact that the proposals were embodied in certain draft agreements which had only just been circulated, the Postmaster-General would postpone until next session the completion of the agreements, so as to give the municipal authorities who had now adjourned an opportunity, which they would not otherwise have, of considering and expressing their views on the draft agreements. Sir A. Rollitt desired to know whether the public interest would not be likely to suffer from any further delay. Mr. Henniker Heaton asked the Postmaster-General whether he would consider the propriety of referring the Treasury minute to a committee of business men chosen from members of the House. In

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reply, Mr. A. Morley stated that the committee which sat in 1892 recommended that the details of the arrangement should be carried out by the Department. He might perhaps be allowed to answer questions 43 and 47 at the same time. He had pointed out in reply to previous questions that the agreement did not require the confirmation of Parliament. He might again point out that it merely carried out the policy which had already received parliamentary sanction, and in connection with which large sums had already been expended out of the amount authorised to be raised by the Telegraph Act of 1892 in the erection of main trunk lines. As he had before stated, the telegraph estimates would afford an opportunity for any discussion that it might be desired to raise, and, in view of the inconvenience and prejudice of the public interests which the further delay desired by the members would involve, he was not prepared to assent to the postponement of the matter until next session. Not being content with this reply, Mr. A. C. Morton asked whether this agreement would not prevent the granting of any licenses to municipal authorities for a period of 18 years. Mr. A. Morley answered in the negative, and said that his discretion in the matter remained absolutely unfettered.

Driving Looms by Electric Motors.—The employment of electricity for lighting and power purposes has rapidly developed in the industrial district of Saint-Etienne, in the neighbourhood of which are not only large metallurgical establishments but also textile works, the products of which, especially in the case of ribbons, are known throughout the world. A noteworthy instance in connection with the latter industry is afforded by the factory of MM. Forest and Co., where 500 persons are employed. This building was reconstructed in 1891, and after having given the matter full consideration, MM. Forest and Co. came to the conclusion that electric power was preferable to the use of purely mechanical means for the operation of the looms and other machines in the works. Accordingly, MM. Vallot and Pauze, a local electrical firm, were entrusted with the work of installing the electrical plant. An illustrated description, from which the following particulars are abstracted, is given of the installation in *L'Electricien* of August 18. The plant comprises two MacNicol tubular boilers constructed by MM. Broyet, of Saint-Etienne, and which supply steam to a general heating system for the various rooms and for the operation of the steam-engine; and a horizontal condensing engine of 120 h.p. made by M. Piquet, of Lyons. This engine drives by belting two Sautter-Harlé dynamos giving 42,000 watts, the pressure being 70 volts at 600 revolutions. These machines are used partly for lighting and partly for power purposes. When the generators are at rest the offices and warehouses are lighted from a battery of 36 Tudor cells, supplied by M. Martin, of Saint-Etienne, and having a capacity of 200 ampere-hours. The battery is charged by one of the dynamos during the day. The illumination of the warehouses is effected by 50 six-ampere arc lamps, whilst the offices, etc., are lighted by means of 350 incandescent lamps. After having made some experiments, the Olivet-Dessaul type of electric motor was adopted for actuating the looms. There are 40 motors, which are arranged on the top of the looms, which drive them by means of belts and pulleys. When the loom is momentarily stopped, a loose pulley is brought into play which allows of the motor running free. The normal speed of the motors is between 800 and 900 revolutions, and when running without load it rises to 1,000 revolutions. The ribbon and velvet looms are operated by 60 motors, taking from 2·5 to 4 amperes at from 1,400 to 1,500 revolutions. In addition to these, there are seven motors installed of from 1 h.p. to 3 h.p., these being used for a variety of purposes. Simple switching arrangements are provided for cutting out the various motors when necessary.

Photographing the Effects of Telephone Vibrations. — A correspondent of the *Manchester Guardian* has written to that paper: "The problem has been attacked in a new way by Mr. G. J. Burch, who has succeeded in making an instrument by means of which the E.M.F. of the currents generated by speaking into a telephone can be recorded photographically. These currents are too rapid to affect an ordinary galvanometer individually, and inasmuch as they flow alternately in opposite directions their combined effect is nil. But it seems that the capillary electrometer, invented some years ago by Lippmann, has been brought to such perfection in Oxford that electrical changes occurring hundreds, and even thousands, of times in a second can be recorded by its means. The instrument consists of two glass tubes, one drawn out to a fine point, and the other bent into the shape of the letter V. The latter is about half filled with mercury, and contains in one limb a few drops of dilute sulphuric acid. Mercury is poured into the other tube, and is forced, partly by its weight, and partly by compressed air, into the narrow part of it, where it hangs balanced, as it were, by the force of capillarity. This tube is fixed so that its point dips into the acid in the V-tube. Platinum wires dipping into the mercury in either tube serve to connect the instrument with the circuit of the telephone. The smallest change in the electrical condition of the circuit instantly disturbs the balance of the capillary forces, and the end of the mercury column is driven up or down, according as the pressure of the current is towards it or away from it. These movements occur with a rapidity that the eye is unable to follow, and the instrument is perfectly dead-beat in its action—*i.e.*, there is nothing at all resembling the oscillations of the needle, which render observations with a sensitive galvanometer so serious. In order to record these movements recourse is had to photography. The magnified image of the capillary tube is projected on to a screen in which is a narrow slit. Behind the slit a sensitised plate is made to pass with a perfectly regular motion, any rise or fall of the mercury column being recorded as a projection or a notch on the edge of its shadow. This method was introduced by Prof. Burdon Sanderson. The apparatus now employed was invented by Mr. Burch. The first photograph shown was taken seven years ago. The electrometer was connected with a telephone, near which a whistle was blown. The currents generated were so intense as to cause electrolysis, and it was evident that the movements of the electrometer had been too rapid to be properly recorded on the photograph. This led to the construction of the present apparatus, in which the plate can be made to travel at any desired rate from 6in. to 6ft. per second. The next illustration was obtained by singing a falsetto note near the telephone, the electrometer having responded to the currents generated by each vibration to the number of 650 per second. From this result it was evident that the apparatus might be used for studying the sounds of the human voice in speech. The syllables 'pop-pop-pop-pop' and 'dod-od-od-od,' spoken during the passage of a plate, produced results easily distinguishable from each other and evidently characteristic of these consonants. The vowels 'a' and 'e' formed the subject of the next two photographs, and the last represented the buzzing sound of 'Z-z-z-z.' This gave a very irregular curve, and Mr. Burch stated that with the lens fine serrations could be distinguished which corresponded to from 2,500 to 3,000 double vibrations per second."

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THE ELECTRIC LIGHT INSTALLATION AT ARUNDEL CASTLE.

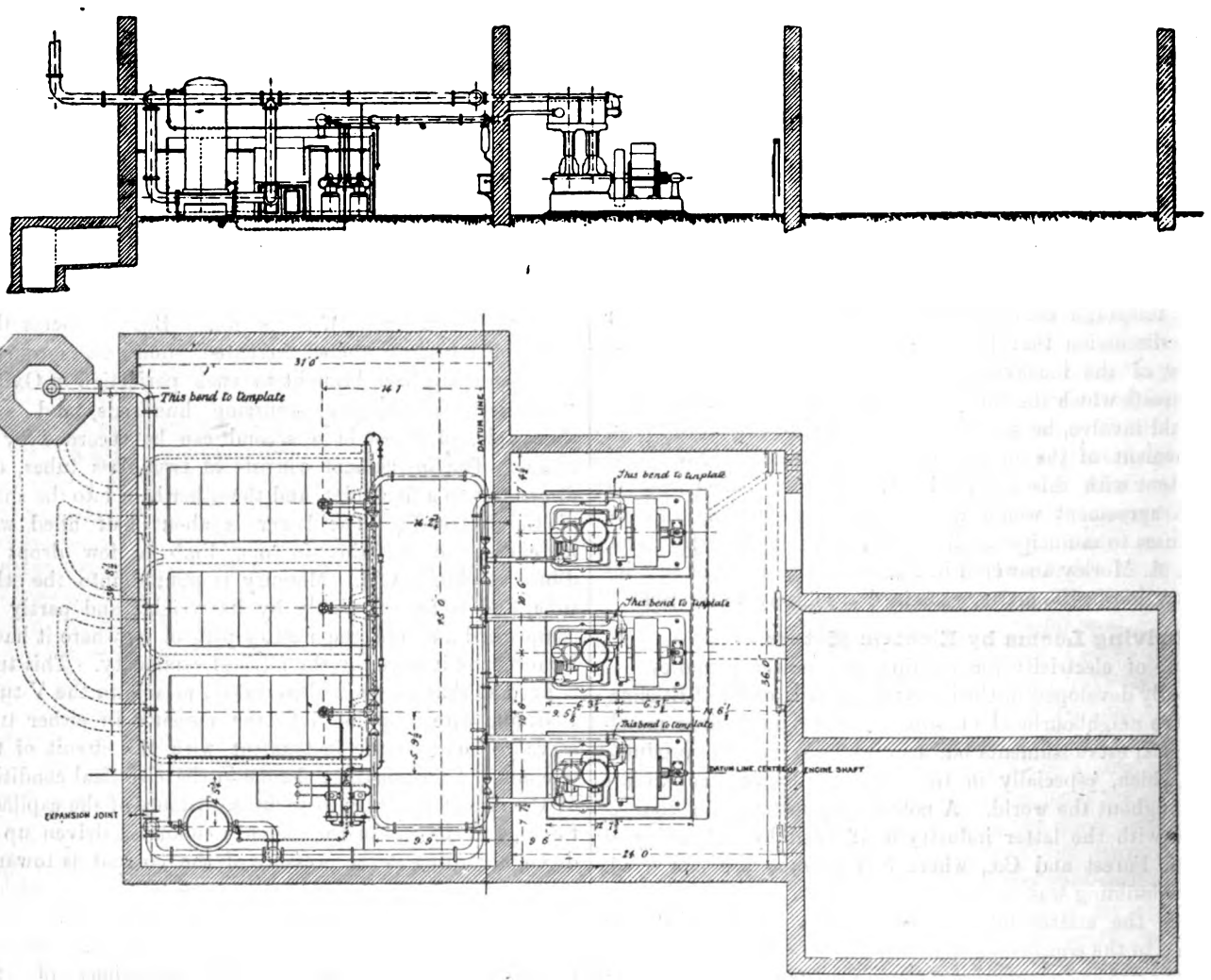

FIG. 1.—Arundel Castle Electric Light Installation—Plan and Section Showing the General Arrangement of Boilers, Engines, and Dynamos.

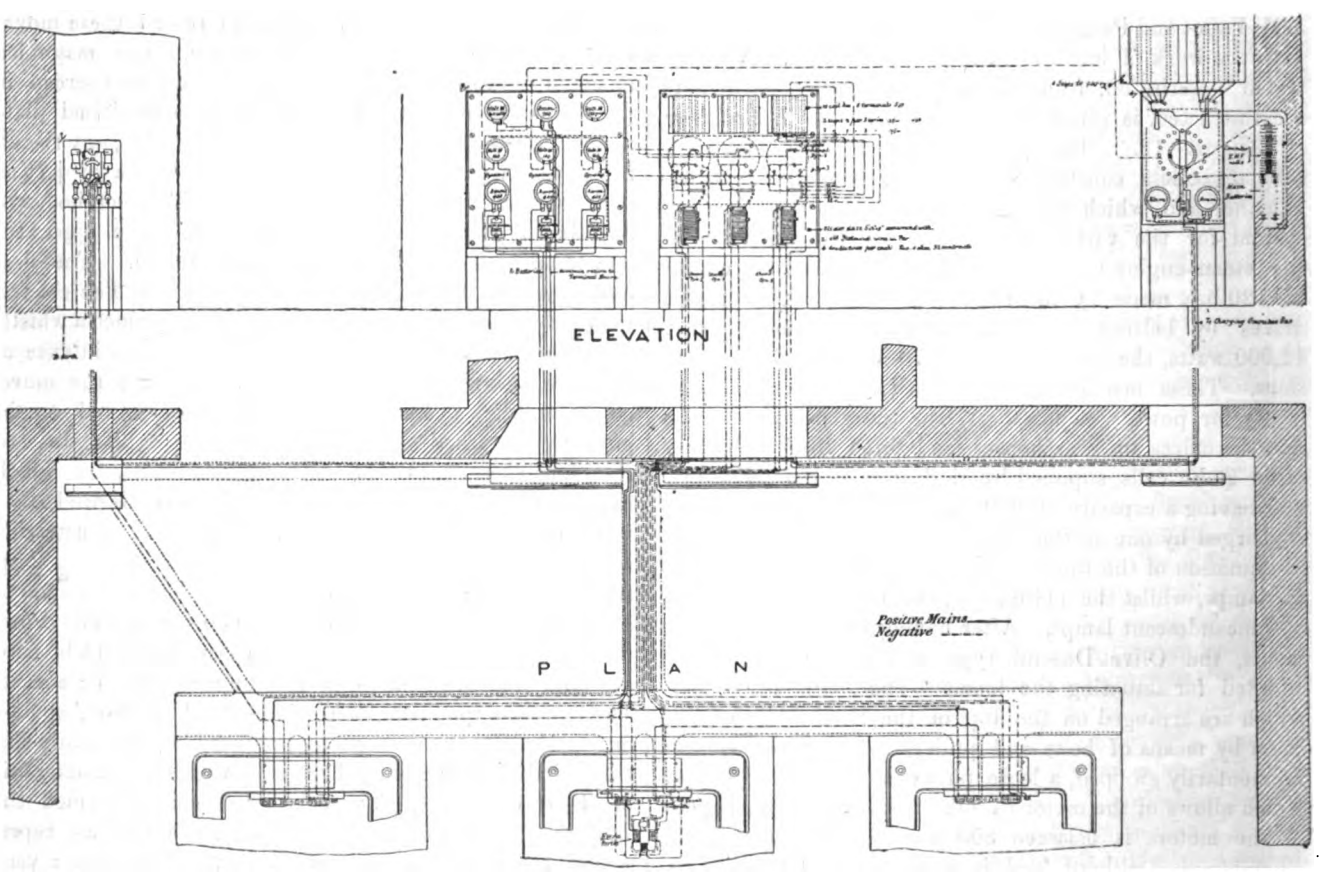

FIG. 2.—Arundel Castle Electric Light Installation—Arrangement of Switchboard Connections.

In our last issue we published plans and elevations of the buildings forming the generating station from which Arundel Castle and the grounds are electrically lighted. We now proceed to refer to the electrical features of the

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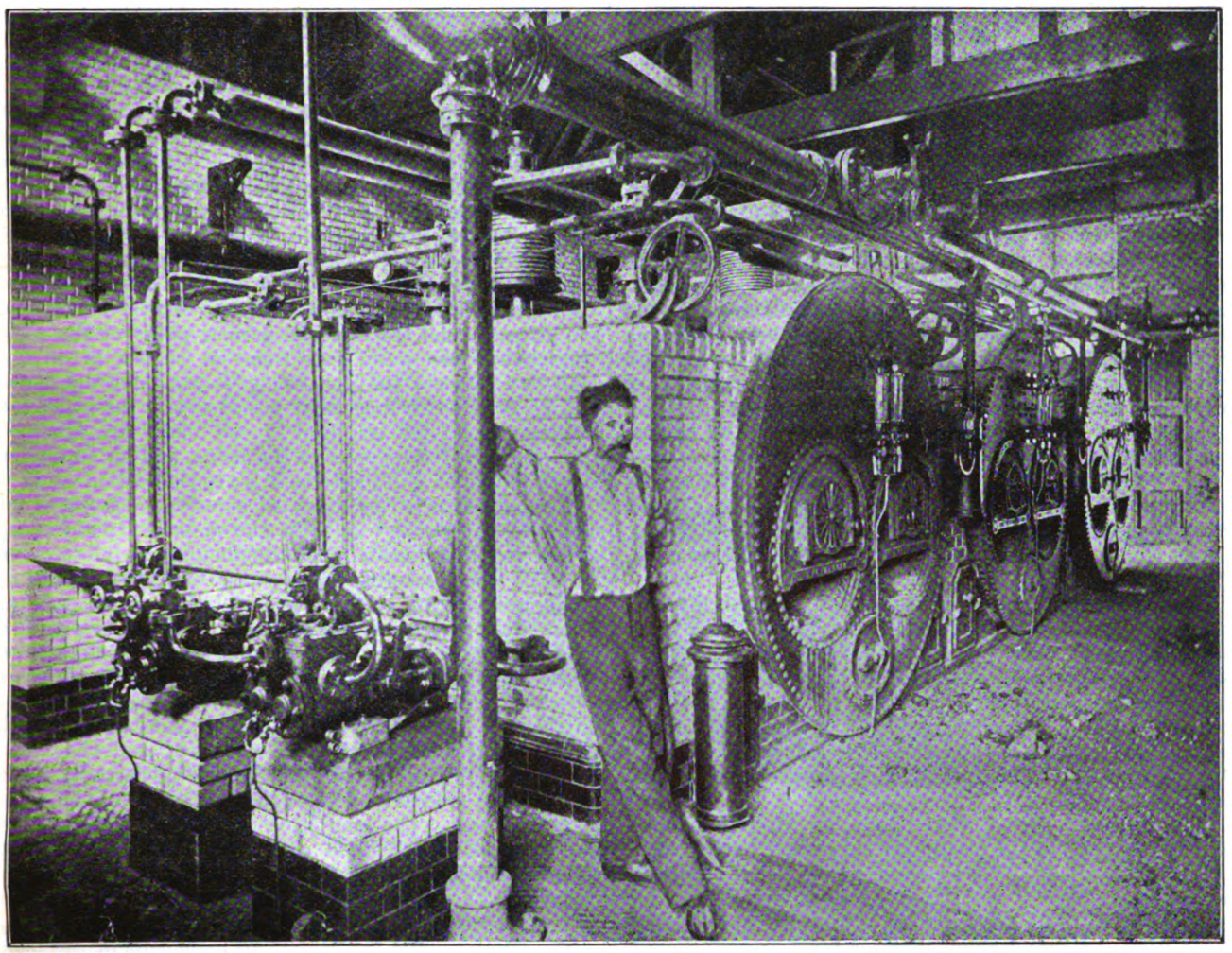

FIG. 3.—Arundel Castle Electric Light Installation—Internal View of Boiler-House.

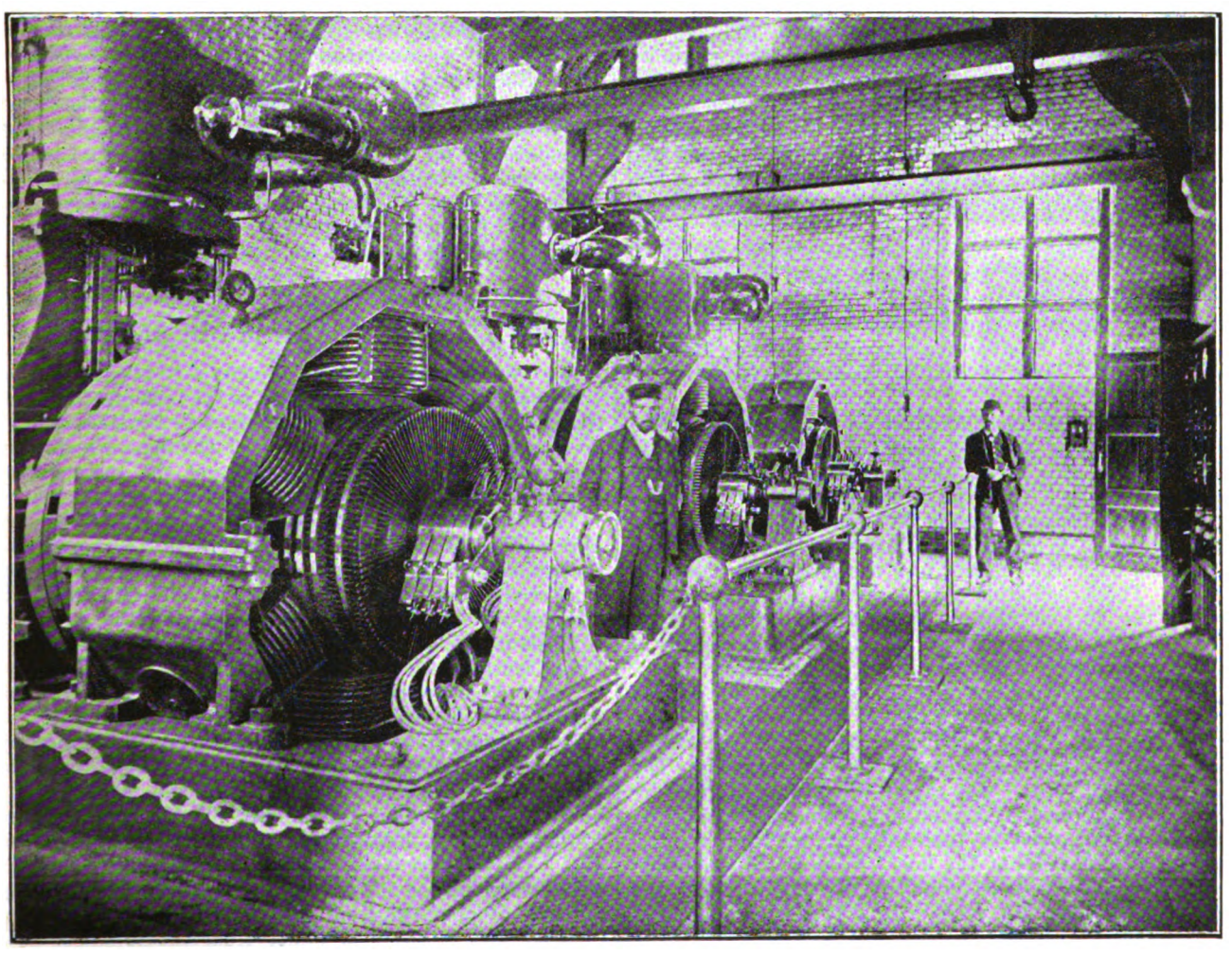

FIG. 4.—Arundel Castle Electric Light Installation—Internal View of Engine and Dynamo Room.

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installation, illustrations of which are annexed. Fig. 1 is a plan showing the general arrangement of the plant; Fig. 2 is an elevation and plan showing the connections of the switchboards; Fig. 3 gives an internal view of the boiler-house, and Fig. 4 a similar view of the engine and dynamo room.

As mentioned in our last issue, the generating station has been erected in the new road at the top of Poorhouse-hill, near the entrance to the gardens. The building, which was commenced in 1893, is hidden from the road for much of its height by a wall. It has a total frontage of 92ft., with a depth of 48ft. and 36ft., and is divided into boiler-house, engine and dynamo room, accumulator-room, and fitting-shop. The boiler-house contains three Galloway boilers, 18ft. long by 6ft. 6in. diameter, and having two flues. Each boiler is capable of evaporating 3,300lb. of water per hour. There are two steam feed pumps, either of which is capable of supplying any two of the boilers, and one of Atkinson's feed-water heaters. The steam main is of wrought iron, and is arranged in a ring with valves, so that any boiler can work either engine. The exhaust main from the engines to the heater, and thence to chimney, passes round the boiler-house, and, as well as all other pipes, is neatly lagged.

The engine-room contains three 90-h.p. vertical inverted compound steam-engines of the Brush type, which are fitted with Raworth's expansion governor, adjustable by hand, whilst running at from 120 to 140 revolutions a minute. The engines are capable of indicating 140 h.p. To each engine is coupled direct a dynamo capable of working up to 400 amperes at from 128 to 160 volts. The engines and dynamos are mounted on a strong bed-plate on massive stone foundations.

The dynamos, which were made by Messrs. Johnson and Phillips, are of the multipolar type, each having eight poles. The armatures are drum wound, and are fitted with Kapp segmental connectors. Each machine is capable of working up to 64 kilowatts at a pressure of 160 volts when used as a simple shunt machine for charging accumulators at a speed of 155 revolutions per minute, and up to 51·2 kilowatts at 128 volts when used as a compound dynamo supplying lamps direct at the same speed. The compounding has been specially designed to give the required pressure at the castle voltmeter board within an error of two volts up or down between no load and full load. Each machine is mounted on an extension of the engine bed-plate, and is direct coupled to its own engine, running at the speed mentioned. The current is collected from the commutator by two sets of three brushes, 2in. wide, each having independent adjustment and hold-off catches.

The arrangement of the switchboards is shown in Fig. 2. As already mentioned, the dynamos have, in addition to the ordinary compounding, an extra compound winding in series with the main circuits, thus compensating for the loss in the mains, whether one machine is running alone or two in parallel. The method of connection is shown in the diagram.

The accumulator-room contains two sets of the H size D.P. accumulators, made by Messrs. Johnson and Phillips. There are 124 cells in all, and these in two parallels are capable of giving a discharge of 240 amperes for 3½ hours, and a normal discharge rate of 142 amperes for 10 hours. The regulation is effected by inserting a more or less number of back E.M.F. cells into the circuit, as shown in Fig. 2. These regulating cells consist of plain lead grids, and as the current always passes through them in one direction only, they are always well formed and capable of giving an opposing E.M.F. on the line when required.

The feeders passing out of the generating station are led to the distributing-room, which is situated in the old dungeon tower. They comprise two pairs of cables, each having a sectional area of ·80 square inch. The distance is 440 yards. The cables, which were supplied by Callender's Bitumen, Telegraph, and Waterproof Company, Limited, are arranged so that they can be readily interchanged at either end of the line. From this distributing-room a ring main is laid round the castle courtyard, the length being about 270 yards. It is connected at each of its extremities with the switchboards in the distributing room. This ring consists of a pair of cables having a section of ·80 square inch. The ring is tapped at four points, from which branches are run into the service switchboards placed in the corridors within the castle. A pilot wire is built up inside the main cable, and, in addition to this, a separate cable for indicating pressure, or for signalling, having three conductors each $^{7}/_{22}$, is laid from the generating station to the distributing-room, and connected thence to each of the castle switchboards. The main cable is formed of 60 wires each, No. 10 S.W.G., and is insulated by bitumenised fibre. This is sheathed by a heavy tube of lead, which is protected by thick servings of yarn dressed with preservative compound. The cables are laid direct in the ground under the turf and garden paths of the park, where they are quite free from all chance of injury. Half-way between the generating station and the distributing-room, boxes have been placed so that the mains can be disconnected for testing. Branch mains are also laid from the distributing-room to the lodge, and for supplying the lamps which will light the drive to the castle.

The current is led by insulated wires in the castle to the lamps in the usual way, with the necessary distributing switch and fuse boards. The conductors are all covered in neat wood casings, the positive and negative being distinguished from each other in black and red colours. There are separate switches to each room, and the principal rooms are arranged so that the whole, the half, or one-third of the lights may be used. A telephone connects the main switchboards at the generating station and the castle. The number of lamps at present arranged for the castle is 1,200. Only the east wing is completed and the lamps fixed. The wiring of the south wing is partially done, and is being proceeded with as the restoration of the castle is carried out. The courtyard and the drive from the lodge will both be lighted with incandescent lamps, from an independent main, by means of which the whole of the lights can be switched on or off, whilst a switch will also be provided for each lamp.

The buildings and the general arrangements of the plant have been carried out according to the designs of Mr. A. F. Phillips, C.E., of 31, Great George-street, Westminster, Mr. Gisbert Kapp acting as consulting electrical engineer. Mr. A. Bard, C.E., has acted as the resident engineer. The contractors for the buildings were Messrs. Reed, Blight, and Co. The whole of the machinery and electrical plant has been supplied and fixed by the Brush Electrical Engineering Company, Limited, under the superintendence of Mr. W. Geipel, M.I.E.E., who also laid the cables and carried out the wiring of the castle. Mr. J. E. Sayers has been in charge of the electrical section, and Mr. J. W. Donnet in charge of the mechanical department at the generating station.

THE ELECTRIC TRAMWAYS IN BRUSSELS.

A short time ago we referred to the opening to public traffic of two lines of electric tramways in Brussels, and we are now able to give a description of the lines, which were inspected last week by the members of the Incorporated Association of Municipal and County Engineers.

The whole of the work has been carried out by the Union Elektricitäts-Gesellschaft, of Berlin, who own the concessions for the Thomson-Houston patents. The lines worked electrically are those from the Nord to the Midi through the high circular boulevards, and the line from Brussels to Uccle.

The central station, which is situated in the Rue Broquier, at present comprises the following plant: three Babcock and Wilcox boilers, each having 235 square metres of heating surface; five compound tandem steam-engines by McIntosh and Seymour—diameter of high-pressure cylinder 13in., of low-pressure cylinder 19in., and stroke 15in.; number of revolutions per minute 235, working pressure 120lb., indicated horse-power 180, effective horse-power 150. The exhaust takes place in the atmosphere through a feed water heater. The feed water, which is previously purified, is obtained from a cistern of 90 cubic metres capacity, and is supplied either from the town mains or

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from an artesian well. The steam-piping is in duplicate, so as to avoid any stoppage.

The five dynamos, which are driven direct by belt, are of the Brown tetrapolar type, with drum armature. These dynamos are each of 100 kilowatts (500 volts and 200 amperes normal output. The armature is toothed (Paccinotti type). The excitation is hyper-compound, regulated so as to allow for a loss of 10 per cent. pressure on the line. The switchboard has as many panels as there are dynamos. Each panel carries, in addition to the switches, an ampere-meter, a voltmeter, an exciting rheostat, a current indicator in the balancing wire, and an automatic cut-out, which isolates the dynamo when the current reaches a dangerous point.

The supply to the cars on the line is effected by two trolley wires of 8mm. diameter. This trolley wire is fed at intervals of about 500 metres by means of an underground feeder cable which is placed along the line. The section of this cable varies from 316mm. to 55mm. It is a Siemens cable having a copper core with two lead coverings and doubly steel armoured. It is placed in the ground on a bed of sand without any protection other than flat bricks, not mortared together, intended to indicate the position of the cable when the street is broken up. The trolley wire is divided into isolated sections, each of about 500 metres in length. Each section is connected at its two extremities with the feeder cable by means of cables inside the posts, the connecting cables carrying switches which allow of a section being put out of circuit in case of necessity. On the whole of the way along the boulevards the trolley wire is supported by iron arms fixed on hollow steel posts. In the streets the trolley wire is supported by cross wires of steel attached to the fronts of the houses. The wire is doubly insulated throughout.

The rolling-stock comprises 23 closed cars having 16 sitting places and 20 standing places. Each car has two motors of the W.P. type, each of 15 i.h.p. This power is sufficient to allow of hauling an open car carrying 36 passengers. The cars weigh 5½ tons empty and eight tons full. A motor car with trailing car weigh, loaded, about 13 tons. The average speed is 12 kilometres per hour, but owing to numerous stoppages the rate actually reaches at certain points 20 kilometres per hour. The cars are furnished with a series Carslett controller made by the General Electric Company, United States of America. This apparatus allows of the motors being at will put in series or in parallel, and of varying the intensity of the magnetic field so as to realise four degrees of normal speeds. The return is formed by the rails. For this purpose the rails, which weigh 30 kilogrammes per metre, are connected at each joint by two pieces of galvanised copper wire of 8mm. diameter. These wire are fixed to the rails by means of soft steel rivets. In addition, the four sets of rails are connected with each other at distances of about 90 metres. An experimental measurement of the resistance of the return gave a figure sensibly less than the estimated value of this resistance, although the earth connections are of little importance. This arises from the fact that other tramway lines connect the electric lines to the works, and all these lines tend to improve the conditions of the return.

The positive pole of the dynamos is connected with the trolley wires, the negative pole with the rails, and at the same time with two pits situated in the works. The telephonic protection consists of creosoted wooden arrangement placed above the wire. Protection against lightning is obtained by Thomson lightning arresters with magnetic blower. There are, of these arresters, one on each car, one on each section of the trolley wire, and one on each dynamo at the works. The following are the general particulars of the lines served: Boulevard line—length, 4,650 metres of double line being worked; maximum gradient, 6·2 per cent.; minimum curve, 20 metres. Uccle line—length, 3,925 metres; maximum gradient, 4·8 in 1,500 metres.

The switching apparatus on the car consists mainly of two drum commutators, which allow of any desired combination being effected. One of the drums serves simply to reverse the direction of the current in the two armatures for reversing the car. The second allows of the following combinations being obtained.

1. The two motors in series with all the resistance.
2. „ „ „ with a part of the resistance.
3. „ „ „ without resistance.
4. „ „ „ „ „ with a fraction of the field.
5. The same as the second.
6. One motor only with a part of the resistance.
7. The two motors in parallel with a part of the resistance.
8. „ „ „ without resistance.
9. „ „ „ „ „ with a part of the magnetic field only.

The driver is obliged to follow the above order in the various combinations. The combinations 3, 4, 8, and 9 are the only ones used in the course of running. The others are only transition combinations. An accessory apparatus allows of one or other motor at will being thrown out of circuit. A special appliance then prevents any combination beyond the fourth being made.

FACTS AND FIGURES CONCERNING SOME CONTINENTAL ELECTRIC TRAMWAYS.

(Concluded from page 145.)

With regard to the **Hamburg** electric lines, there arises no little interest from the fact that the entire tramway system in that city—amounting in all to nearly 156 kilometres (or 96·7 miles)—will be operated by electric traction within the next three years, in accordance with an agreement between the city authorities and tramway interests. At present, 126 kilometres (78·12 miles) are worked by horses, and seven kilometres (4·34 miles) by steam locomotives. There are 42 electric motor cars employed now, each with a carrying capacity of 30 persons. Of course, this number will be enormously increased when the whole of the lines are converted for electric traction. The average total daily distance run by the motor cars is 5,200 kilometres (3,224 miles). Their maximum speed is 16 kilometres (10 miles) per hour. The cost of current per car kilometre averages, as near as can be ascertained, 6 pfennig, equal to, say, 1·16d. per car mile. In the case of the steam locomotives, the *total* costs work out to 32·6 pfennig per car kilometre, or 6·3d. per car mile. These motors, however, also draw each a trail car, the total capacity of the two cars being 100 passengers. The horse cars will carry 24 persons, and are pulled each by a single horse; the total cost of traction being given as reaching 13 pfennig per car kilo metre, or 2·5d. per car mile.

Various technical descriptions have from time to time been published concerning the tramway at **Dresden**, and we do not therefore enter upon these features so much as its financial aspect and working conditions.

The following brief summary will serve to recall the chief constructional particulars: An overhead system is employed, with feeders; the current returns by the rails, return wires connected with the rails being also employed. Each motor car has two 8-h.p. motors, which drive the car axles through single-reduction gear. The switch lever for making and breaking circuit through the motors forms part of the brake handle, so that the two actions of starting the car and releasing the brakes—or *vice versâ*—are effected together. The line is four kilometres (2½ miles) long, and is almost entirely on the level, there being but one grade of 3⅓ per cent. The sharpest curve has a radius of 12 metres (say, 40ft., or two-thirds of a chain). In the central station are two sets of steam-engines, indicating 175 h.p. each; these drive a couple of Siemens dynamos, and are furnished with steam from water-tube boilers. The entire station is owned by the firm of engine-builders, Messrs. O. L. Kummer and Co., who supplied the steam plant, and undertake to provide the current required for the tramway at so much per unit or kilowatt-hour. There are nine motor cars, of which eight have longitudinal seats for 14 persons, with standing room for 14 more; the ninth car has transverse seats for 24 passengers, and accommodates 17 standing. With regard to minor points, as a result of working on this line, it is considered that the ordinary tramcars may be used for electric traction, if the underframes, and especially the end platforms, are suffi-

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ciently strengthened by iron angle plates or other means. Iron underframes are, however, thought the best for motor cars, more particularly when the trucks are not of special design. Double-decked cars are approved of, so long as there is a roof or cover provided; in any such case, however, the overhead wire must be placed at least 18ft. above the street-level.

The capital outlay upon this line is as follows:

	Marks.		
Overhead wire system—four kilometres (2½ miles)	58,000	...	£2,900
Feeders, outgoing and return, two kilometres (1¼ miles)	17,000	...	850
Permanent way, etc., telephone connections, and sundries	152,000	...	7,600
Total	229,000	...	£11,450

	Marks.		
Cost per kilometre of line, with sidings	44,700	or per mile	£3,605
Cost of rails, paving, etc.	148,000		
or per metre of single line	31·49	or per yard	14s.
Cost of motor-car body, frame, etc.	3,000	.....	£150
Cost of electric equipment for motor car	5,900	.....	295
Total	8,900	.....	£445

The working results on this line are not considered to be very favourable, as it runs for the most part outside the chief lines of traffic in the city and surrounding districts. The annual traffic is at present only 250,000 car kilometres (say 155,000 car miles). The ordinary service is conducted at a pressure of 420 volts, with a current of 25 to 75 amperes, the maximum being 230 amperes at 500 volts. The average speed maintained is about 15 kilometres per hour (say 9·3 miles). A service varying from 7½ minutes to 15 minutes is given through the day; on Sundays, a number of trail cars are added. The mean daily travel is about 100 motor car kilometres (say 62 car miles). The maximum number of motor cars on the line which can be kept at work is 10, each drawing a trail car, and making 140 car kilometres (say 87 car miles) per day.

The annual cost of operating, based on results of one month (March), is as follows:

	Marks.		
Production of current in central station	23,214	or	£1,160
Wages, salaries, repairs, and materials	16,200	,,	810
Sinking fund	8,240	,,	412
	47,654		£2,382

This works out to ·188 mark per car kilometre, or, say, 4d. per car mile. Few accidents have occurred, and none of any importance. The following is the list: one suspension wire broken by derailment of trolley; a short-circuit between the outgoing and return feeders; and breakage of a stay wire owing to violent snowstorm.

Comparatively few details are available with respect to the line at **Essen**: this was equipped by the Allgemeine Elektricitäts-Gesellschaft of Berlin, and has a length of some 18 kilometres (11·16 miles). The steepest grade is 6¼ per cent., and the sharpest curve has a radius of 65ft., or, as near as may be, one chain. At one point of the system a curve of this radius coincides with a grade of 3·3 per cent. The central station has a total capacity of 400 h.p., half of which is sufficient to operate a service of 20 cars. The latter each have seating accommodation for 16 passengers, whilst 14 more can stand on the platforms. The trail cars are of similar size and capacity, and may be converted into motor cars if necessary, with slight alterations. As at Aix-la-Chapelle, the use of double-decked cars does not seem to be approved of. The cost of each motor car is stated to be 12,000 marks—say, £600.

The working pressure is 500 volts, and a current of 16 to 18 amperes is required per car in service. A speed of 12 kilometres (7½ miles) per hour is maintained; an average number of 16 cars is maintained on the road, travelling in all some 2,000 kilometres (1,240 miles) per day, or 77·5 miles per car per day.

At **Milan** a similar system is used, the line having been built and equipped by the Thomson-Houston Company. Its length is slightly over three kilometres—say, 1·8 miles—and wholly on the level; the sharpest curve on the line has a radius of not more than 48ft., or about two-thirds of a chain, though at the car-shed entrance there is one of 37ft. radius—say, half a chain. In the central station there are two dynamos of 100 kilowatts capacity, generating current at 500 volts. A compound condensing engine of 200 h.p. drives each machine; one set is usually kept in reserve, since the ordinary load is not more than 10 cars on the line, and six more might be operated. There are at present 13 cars in use or under construction; these each have sitting accommodation for 13 passengers, whilst 16 can stand on the two end platforms. The weight of each car complete with motor is about 5½ tons. With regard to the use of ordinary tramcars for electrical work, the management of the Milan line conclude that this is quite feasible so long as the trucks are properly altered. Double-decked cars are advantageous under certain conditions, but it seems better, as a general rule, to use the ordinary type with trail cars. The total cost of the line has been 446,674 lire, or, say, £17,867; of this the fixed plant is represented by 309,416 lire (£12,376), which is equivalent to 51,360 lire per kilometre (£3,313 per mile) of track, and 30,941 lire (£1,237) per motor car. The permanent way consists of Phœnix rails weighing 95lb. per yard. The rolling-stock has cost 137,257 lire (£5,490), or per car 13,725 lire (£549).

The working costs cannot fairly be ascertained or stated as yet, owing to the short period during which the line has been at work. The average number of cars on the line is 10, and the consumption of energy—based on the record of a wattmeter at the supply station—is about 5·7 e.h.p. per hour per car. The mean speed of the cars—including stops, both fixed and miscellaneous—is about 9 kilometres (5½ miles) an hour; their daily service averages 160 kilometres (say 100 miles) per car. So far the cost of traction has averaged ·276 lire per car kilometre (equal to 2¾d.), or, say, 4½d. per car mile, including cost of producing motive power, repairs to fixed plant and rolling-stock, wages and salaries.

At **Gera** there is an electric tramway line of metre gauge, having a total length of 11¾ kilometres, or 7¼ miles. The electric supply station serves not only to provide energy for this line, but also operates an electric lighting system in the town. The same plant and staff is used alternately as required for the tramway service, the charging of storage accumulators, and lighting direct. It is in consequence extremely difficult to separate out or properly apportion the expenses amongst the services thus rendered; and this can only be done with exactness after a few years have passed and enabled averages to be struck. So far as can now be ascertained, the cost of traction may be taken as 12·18 pfennig per car kilometre, each car having a capacity of 36 passengers. This is equivalent to nearly 2½d. per car mile, not including any allowance for sinking fund.

There are several lines now being operated in **Brussels**; the most important of them is perhaps that which connects the suburb of La Petite Espinette with La Place Rouppe in the city itself. This line has been erected on the Thomson-Houston overhead or trolley wire system by the Union Elektricitäts-Gesellschaft of Berlin. It has a length of nearly 13 kilometres (eight miles) in all, counted as single track, the actual distance traversed being 10½ kilometres, or 6½ miles. The shortest radius of curves may be taken at about 120ft., or, say, two chains: the greater part of the line, so far as gradients are concerned, lies on slight inclines up to 2·5 per cent., although for nearly one quarter of its length the grade reaches as much as 5 per cent. A curve of 1½ chain radius occurs at one point in conjunction with a grade of 5·3 per cent. At the central supply station are two condensing steam-engines each of 132 i.h.p., of which one serves to work the traffic, the other being in reserve. There are 12 motor cars on the line, each with a couple of 15-h.p. motors, and the same number of trail cars. The former have each seating accommodation for 24 passengers, and accommodate 11 persons on the end platforms. The trail cars are slightly longer, seating 20 only, but with standing capacity for 24. Double-decked cars are not used,

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or thought advisable; they are looked upon as too draughty and cold, besides which it is considered that the getting on and off of passengers takes up too much time.

The capital outlay has so far been as follows:

Supply station buildings, chimney stack, water supply, etc.	£2,400
Electric generating plant, fixed	14,560
Motor and trail cars, 24 in number	12,960
	£29,920

or, in round figures, £30,000. This works out at £3,750 per mile of single track, or £1,250 per car. The cost of the latter has been £880 for each motor car, and £200 per trail car.

A second electric system at Brussels is operated by the Brussels Tramway Company, two lines—the Boulevards Circulaires Nord-Midi, and the Place Stéphanie to Uccle—being at present equipped. The former has a length of 4½ kilometres (say, 2·88 miles), and the latter nearly 4 kilometres (2·43 miles). The system employed is the Thomson-Houston overhead trolley wire method, with underground feeders. The greater proportion—at least two-thirds—of these two lines are built on grades ranging up to 2·5 per cent., but on the first line there is a length of nearly 300 yards on a 6·2 per cent. grade. The second line also runs for about half a mile on a 5 per cent. grade. The sharpest curves have radii of 80ft. to 100ft. In the supply station there is sufficient capacity for giving an output of 750 i.h.p. The rolling-stock comprises 23 motor cars each with seats for 16 passengers, and standing accommodation for 16 more. The average speed maintained on the first line is about 11 kilometres (6·8 miles) an hour, and 12 kilometres (7½ miles) on the second, including all stops.

THE BRITISH ASSOCIATION.

The following paper and abstracts conclude our *resumé* of the papers read before the British Association:

A Direct-Reading Form of Platinum Thermometer.

BY G. M. CLARK.

During the last few years much progress has been made in the subject of thermometry. This is more especially the case in instruments whose action is based on a change in electrical properties—such as the E.M.F. of a thermal junction, or the changes in resistance of a wire. It is to this latter class that the platinum thermometer belongs.

Whatever method of measuring temperature is adopted, the assumption may be made that the change measured is proportional to the changes in temperature. This assumption will give a scale of temperatures, depending, however, on the thermometric substance used, and which will not be the same when the thermometric substance is changed. In order to bring all such thermometric scales to a common basis, they have to be compared with the indications of the normal air thermometer.

In the case of a platinum thermometer we make the assumption that the change in resistance is proportional to temperature, and call the temperature so deduced the platinum temperature. Thus if R and R_o are the resistance in steam at 760mm. pressure and ice, $R - R_o / 100$ is the change in resistance per degree; and if R is the resistance at any other temperature the platinum temperature, $p\,t = (R - R_o) \div R - R_o / 100$.

The relation between the platinum temperature and the air thermometer scale has been experimentally shown to be expressed by the formula

$$a = t - p\,t - \left(\frac{t}{(100)^2} - \frac{t}{100}\right)$$

where t is the air thermometer temperature, and p is a coefficient whose value is approximately 1·50. This value of p varies slightly from 1·47 to 1·63 with different samples of wire, but its value can always be determined by observations at three different temperatures. Hence it is always possible to reduce the temperature as given by any specimen of wire either to the air scale or to that which would be given by some standard wire. This latter is the scale which one is almost forced to adopt when dealing with extremes of temperature. For, in the case of very low temperatures—*e.g.*, where air liquefies—the air thermometer is obviously no longer serviceable, and at very high temperatures, above 700deg. C., reliable experiments with the air thermometer have yet to be carried out.

The departure of the platinum scale from the air scale is not greater than the departure of the mercury scale from the air, so that those who are accustomed to accept mercury thermometer readings without hesitation will not have the order of accuracy of the observations reduced by accepting the platinum scale. In the construction of a direct-reading instrument it is obviously advantageous to have a scale divided into equal parts. The platinum scale has therefore been adopted in the direct-reading thermometer of Callendar and Griffiths. This instrument is most easily described in two parts—(1) the thermometer itself, (2) the indicator.

In the thermometers, the platinum wire of ·008 in diameter is wound non-inductively on a wire formed about 2in. in length and ⅜in. in diameter. In order to eliminate changes in resistance in the connecting leads, the stem of the thermometer contains four leads insulated by means of washers. Two of these are connected to the ends of the coil; the other pair, called compensators, are joined to fetters just above the coil. The lower 12in. of these leads are of thick platinum wire; these and the coil are protected by a glazed porcelain tube. The choice of a suitable material on which to wind the coil and the complete protection of the wire from furnace gases, are both points of considerable importance. Neglect of these precautions in the earlier forms of hygrometers fully accounts for the changes which they used to undergo. The upper portion of the leads are of copper, fixed to the platinum, and insulated by being threaded through pipe stem. They are protected externally by a steel tube, which may be extended to protect the porcelain tube in cases where the thermometer is liable to rough usage. The upper ends of the copper leads terminate in four binding screws, to which the leads connecting thermometer to the indicator are attached. These connecting leads may be of any length, so long as their resistance is not much greater than ·5 ohm. The indications of the thermometer can then be read at a distance from the place under observation.

The resistance of the platinum coil is adjusted so that the change in resistance for 100deg. C., from ice to steam, is one ohm, or, in other words, each degree is equivalent to an increase in resistance of ·01 ohm. The platinum coil has therefore a resistance of ·258 ohms at 0deg. C.

The measurements of resistance or temperature are made in the eudicator, which consists essentially of a Wheatstone's bridge of a specially-arranged galvanometer.

The two ratio arms of the bridge are made equal, and have a resistance of about 20 ohms. In the third arm of the bridge are 15 resistance coils, each of one ohm, and the thermometer is introduced in series with these. The fourth arm is made up of the compensating leads and a coil whose resistance is such that the whole bridge is balanced when the thermometer is at 0deg. C. The battery used consists of dry cells giving about two volts at the terminals of the bridge, so that the current through the bridge is about one-tenth of an ampere.

In the galvanometer the moving portion consists of a combination of steel magnets pivoted on a needle point, and to these a light aluminium needle is attached swinging in a horizontal plane. The movement of the system is controlled by two sets of coils. These are arranged so that one pair is parallel to the pointer at the zero position of the scale, the other pair at right angles. The former pair are the equivalent of the ordinary galvanometer coils, the latter are in the direct battery circuit. Since the resistance of each arm of the bridge remains practically constant, the current which passes through the galvanometer coils will always be the same proportion to the current in the battery circuit whatever the E.M.F. of the battery may be. The deflections of the galvanometer are, therefore, independent of the strength of the battery. The adjustment of the strength of the two sets of coils is made by means of a low resistance across the field coils in the battery circuit. This is adjusted until the galvanometer swings across the scale for an increase of one ohm in the thermometer arm. The scale is divided into 50 parts, each representing $\frac{1}{50}$ of an ohm, or 2deg. As each of these divisions are about $\frac{1}{25}$ of an inch the scale can easily be read to 1deg. For greater convenience the scale is repeated on the other side of the zero, so that the whole range of the scale without altering the resistance coils is 200deg.

The resistance coils are all made of manganised wire, annealed and protected from air. There is thus no connection to be introduced for changes in temperature of the air. The instrument is also unaffected by changes in temperature of the leads to the platinum coil, for since these are in duplicate and are placed in opposite arms of the bridge, any temperature change in one pair will be balanced by the same change in the other pair. The balance of the bridge is thus only affected by the temperature changes in the coil itself. When the platinum coil has been heated through 100deg. it will have increased in resistance by one ohm, and the galvanometer pointer will be deflected across the scale. The resistance of this arm of the bridge can now be made the same as before by plugging in the one-ohm coil, and the galvanometer returns to zero. The scale is then repeated every 100deg., and thus a wide range of temperature and an open scale are obtained at the same time. The temperature is then directly read off—the hundreds of degrees by the coils plugged in, and the remainder on the scale.

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A further advantage of this arrangement is that any error in the original adjustment of the swing, or want of permanence in the system, does not produce any cumulative error. A truly graduated scale would not be one of equal parts, though it is not, as might appear at first sight, a tangent scale. The error introduced by the equal scale, however, is small, and the above remark about its non-cumulative effect applies to it also.

A very common objection to this form of hygrometer is the statement that its fixed points change after exposure to high temperatures. The only answer I can give to his objection is that in the experiences of those who have experimented with this form of hygrometer, its most distinguishing feature is the permanence of its fixed points. The objection is only urged by those who have no experience of the instrument, but is based on the report to the British Association in 1874 appointed to examine one particular form of instrument only. As an illustration of the permanence of the fixed points I may give the following: One of these instruments was immersed in melted silver, the source of heat being an oxyhydrogen flame playing on the bottom of the crucible. This crucible by some means became broken, the silver poured out, and the oxyhydrogen flame was left playing directly on the lower end of the porcelain tube for some time before the accident was discovered. As a consequence the lower end of the tube became fused. On subsequent examination it was found that the wire coil and leads had become embedded in the porcelain, and it was impossible to remove the interior of the instrument. On trial in ice, however, the freezing point was found unaltered.

The porcelain tube may thus be considered as completely satisfactory in protecting the platinum coil. The difficulty of the protection of the stem is one which has not as yet been fully overcome. The difficulty is not insurmountable, as it might be met by extending the porcelain tube the whole length of the stem. Such tubes are, however, difficult to obtain, and if broken would be expensive to replace.

The second objection is the adoption of a new scale of temperature. As bearing on this point I may quote from Callendar's paper on "The Practical Measurement of Temperature in 1886": "We at present require a practical standard to which all measurements may be directly referred; the question of its exact relation to the absolute thermodynamic scale may be matter for subsequent investigation, and can best be solved when we have arrived a more accurate and extended knowledge of the phenomena of heat, of the dependencies of radiations, conductions, etc., on temperature measured in a scale, which may be to some extent arbitrary, but which will have the incalculable advantage of uniformity so that the results of different experimentalists will be accurately comparable."

It must be borne in mind that if circumstances render it advisable to express the temperature on the air scale, the relation as given by the D formula has been established up to 700deg. C., and that there are indications that it holds over a far more extended range. One fact will, I think, show the accuracy of the above formula, which was determined by Callendar in his exhaustive comparison with the air thermometer in 1885. In 1890 Griffiths came to the conclusion that the relation apparently established by Callendar was in error at temperatures above 450deg. C. In assuming Regnault's value for boiling point of sulphur, 448·3, the difference between this and air temperature from the platinum temperature, as deduced by Callendar's formula, was found to be about 5deg. It was evident that either Callendar's or Regnault's conclusions were incorrect. A redetermination of this boiling point of sulphur by direct measurement with the air thermometer was made in 1891, when it was found that the true boiling point of sulphur under a press of 700 m.m. was 444·5—a result in almost exact accordance with the temperature obtained by using platinum thermometers and the assumption of Callendar's formula. It is difficult to imagine a more conclusive proof.

Evidence that this relation between the platinum and air scales also holds at very low temperature are not wanting. In a communication to the *Philosophical Magazine* by Griffiths and myself in 1892, we pointed out that if we assume that R becomes 0, and also assume that the D formula holds over such a range, the result in temperature is in the immediate neighbourhood of −270deg. C. According to the experiments of Profs. Dewar and Fleming, it is at this temperature that the resistance of pure platinum should vanish.

Although there is so much evidence that the D formula is correct throughout the whole range of the platinum thermometer, still it is never safe to extrapolate beyond the range of actual experiment. I would, therefore, suggest that all measurement of temperature be referred to a standard platinum thermometer in which $p = 1{\cdot}50$. There is no necessity that such a thermometer should actually exist, as it is only a matter of calculation to reduce the observed platinum temperature to the standard.

Address to the Geological Section.

The president, L. Fletcher, M.A., F.R.S., F.G.S., in the course of his presidential address, which dealt mainly with crystallographical questions, after referring to systems of crystallisation, crystallographic notation, and similar questions, touched upon electrical properties in connection with crystals in the following paragraphs:

Piezo-electricity.—The most remarkable addition to our knowledge of the relation of minerals and electricity has been the recent discovery of the electrification produced by strain (piezo-electricity). It has been shown by J. and P. Curie that if a quartz plate, with faces cut parallel to the axis and silvered to make them conductive, be strained in a certain direction, the two faces either become oppositely electrified or show no signs of electrification at all, according as the faces of the plate are cut to be perpendicular to the prism faces, or to pass through the prism edges. Lord Kelvin says that this result is explicable by electric eolotropy of the molecule and by nothing else, a character which he had suggested for the molecule 34 years ago: experiments confirmatory of this hypothesis of the permanent electrification of the molecule were made some time ago by Riecke.

Pyro-electricity.—The development of opposite electricities at different parts of a crystal during changing temperature (pyro-electricity) has long been known in the case of tourmaline. We owe to Hankel a long series of investigations of this kind relative to boracite, topaz, and various other minerals, but it seems to be now established that most of the electrifications observed by means of his method are really piezo-electric, and are due to strains caused by inequality of temperature in different parts of the cooling crystal. A model has been lately made by Lord Kelvin which gives a perfect mechanical representation of the elasticity, the piezo-electricity, and also the pyro-electricity of a crystal.

Electrical Methods.—A delightfully simple method of investigating the difference of electrical condition of the parts of a cooling crystal and of making the distribution of electricity visible to the eye has been invented by Kundt. Mixed particles of (red) minium and (yellow) sulphur are oppositely electrified by their passage through the meshes of a small sieve; falling on the cooling crystal, each particle adheres to the oppositely electrified region, and the electrical condition of the latter is thus immediately indicated by the colour of the adherent powder. Mr. Miers remarks that this method is practically useful as a means of discrimination even when the crystals are extremely minute.

Hertzian Waves.

BY PROF. OLIVER LODGE.

The author described some experiments to illustrate Clerk Maxwell's theory of light. He began by saying that his experiments referred to the waves generally known as Hertzian waves, though Maxwellian waves would be a more correct term. Various detectors of electric radiations were now known, but the most sensitive was one which depended on the breaking down of the resistance of a bad electrical contact when electric surgings passed across it. Such a bad contact could be made by a row of iron borings in a tube, or by a steel spring with its end resting on a metal plate. These instruments he called "coherers," from the fact that when exposed to electrical waves their resistance was diminished, the particles cohering together, as it were, so that when connected with a battery and galvanometer the latter showed an increased current. The original resistance could be restored on tapping. Using for radiator a sphere charged from an induction coil, he exhibited the phenomena of reflection, refraction, and polarisation of electric waves of about 9in. in length. The coherer could detect the surgings in a sphere 5ft. away when charged by an electrophorus, or the oscillations in an electric gas-lighter; in Liverpool a sphere nearly 70 yards distant had affected the instrument. Polarisation was shown by gratings of parallel wires which stopped vibrations along the length of the wires and allowed those perpendicular to the length of the wires to pass undisturbed. One interesting experiment consisted in resolving a polarised beam into two beams polarised at right angles (elliptic polarisation) by one of these gratings. Reflection from gilt paper and from a block of wood at the polarising angle were also exhibited. It was also shown that glass was transparent to these waves. The phenomenon of refraction was seen by the bending of a wave out of its course by means of a large prism of paraffin wax, but a lens intended to concentrate the rays to a focus was not so successful, although Dr. Lodge said the experiment had often succeeded in his own laboratory, and its failure was due only to the disadvantageous conditions under which he had to work. He subsequently showed that the coherer would not respond to long waves like those produced by the discharge of a Leyden jar, and that the change in its resistance was effected whether a current was passing through it at the time or not. Prof. Lodge then described an electrical theory of vision. He said the rod and cones of the eye were of such a diameter that light falling on them would excite transverse vibrations in them. It had occurred to him that such

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vibrations might increase the resistance of some part of the eye—perhaps the pigment cells—and thus the light stimulus would be recorded. Another stimulus would be necessary to correspond to the process of tapping which restores the coherer to its original state; this would be the sensation of darkness, and would be an actual positive sensation, not a mere absence of light. Between the stimulus of light and that of darkness there would be persistence of vision. Dr. Lodge showed an experiment to illustrate this, the coherer being restored by periodic tapping applied by a clockwork arrangement. For a continuous radiation the coherer showed continuous indications, which died away when the radiation ceased.

Discharge of High-Pressure Electricity through Gases.

Prof. J. J. Thomson, F.R.S., Cambridge, showed experiments illustrating the phenomena that accompany discharges of high-tension electricity through gases, and the conditions by which the discharges are influenced. In moist gases discharge as a rule starts easily and immediately, but when the gases are dry the discharge takes place either with great difficulty or not at all. If, however, a brush discharge is caused to pass through the gas the ordinary discharge begins and continues. It is in the starting of the discharge that the presence of moisture has the greatest influence. If the tension of the electricity is sufficiently high, the discharge will take place in gases as dry as it is now possible to get them. It seems probable, however, that if the gases could be made perfectly dry, no discharge would take place with any tension, however high. In some cases, and notably with oxygen and cyanogen, after the discharge has been cut off the gas remains luminous for a considerable time. This phosphorescence is due to the gas itself, and not to the vessel which contains it, and it is not observed when the oxygen and cyanogen are quite dry. With air, however, the phosphorescence is not observed when moisture is present, but appears if the gas is dry. The potential difference required to separate the atoms of gases from one another is extremely high, and it would seem that this separation requires the preliminary formation of aggregates of molecules that afterwards help by their relative instability to pull one another asunder. It is well known that in an electric field water vapour tends to collect in small drops, and these drops may form nuclei round which these aggregates can form. It is probable that the high specific inductive capacity of water may be an important factor. Temperature affects the electric discharge through gases in much the same way as it affects chemical changes. The facts that electric discharges through gases and chemical changes are affected in much the same way by the presence or absence of moisture, by temperature, and other conditions, seem to show that there is an intimate connection between electric discharges and chemical changes, the latter being conditioned by the electrical charges of the reacting atoms and facility with which these charges can neutralise one another.

NOTES ON ELECTRIC POWER, WITH SPECIAL REFERENCE TO WORKS DRIVEN BY ELECTRICITY IN BELGIUM.*

BY D. SELBY-BIGGE.

Last May the author of these few notes had the honour of submitting to the Iron and Steel Institute a paper on "Electricity as a Motive Power in the Iron and Steel Industries,"† in which he treated the subject somewhat closely, and at considerable length. The author has often thought that in countries where no very large water powers exist, such as the powers available in our counties of Lancashire and Yorkshire, turbine dynamos might be laid down at the different falls, and the power distributed to one collective centre, where the greatest demand for current would arise; in this way, many falls which, though formerly employed in the driving of factories, have been abandoned owing to their distance from main lines and high railway dues, would again be brought into use. There are, however, many, if not the majority of countries, in which water powers are few and far between, and the next best means for the economical driving of works has to be considered. The author has already pointed out and laid great stress upon the utilisation of waste furnace gases for producing steam in the boilers connected with the electric generating plant; in those cases where such a course is feasible, the cost of production per unit of electrical energy must necessarily be very low, and in order to arrive at a figure, it would be necessary to put a fixed value upon the quantity of waste gases used for firing the boilers, providing steam for running the electric generators at a fixed load, and for a given time. The cost of wages, oil, waste, upkeep, and incidentals could be arrived at in the ordinary manner.

The question of cost of production of electricity to be employed in driving engineering works, steelworks, shipyards, and factories of any description, must necessarily be of the first importance when considering an application of electric power; and in order to convey an accurate idea of the probable cost, the author will refer to some of the Board of Trade returns of electric lighting stations in England for 1893, showing what has been the cost of production to different companies.

Name of company.	Total h.p. capacity of engines.	Cost of production and distribution per unit delivered to consumers.				
		Coal.	Oil, waste, water, engine-room stores, and carbons.	Salaries of engineers and wages.	Repairs and maintenance.	Total.
			Low tension			
		d.	d.	d.	d.	d.
Liverpool	3,800	0·93	0·16	0·38	0·64	2·11
Westminster.....	4,530	0·78	0·19	0·95	0·35	2·27
			High tension			
Newcastle District.	1,200	0·83	0 28	0·85	0·14	2·10
Newcastle Supply.	1,200	0 63	0·18	0·77	0·53	2·11

It is hardly correct to compare an electric power station with an electric lighting station, but it may be taken that in power work where it is possible to use larger generators than is usually advisable in electric lighting stations, the cost of production should be rather less than more, and when waste furnace gases are available the cost of production should certainly not exceed one penny per unit of 1,000 watt-hours. The author's experience would lead him to suggest that for large-sized power generating dynamos of 300 h.p., 500 h.p., 800 h.p., and 1,000 h.p., an efficiency of between 90 per cent. and 92 per cent. may be expected.

In the case of motors, the following:

For	3	h.p.	motors an efficiency of	78	per cent.
,,	5	,,	,,	80	,,
,,	8	,,	,,	84	,,
,,	11	,,	,,	86	,,
,,	16	,,	,,	87	,,
,,	20	,,	,,	87	,,
,,	40	,,	,,	89	,,

As to the loss in transmission through heating of cables, leakage, etc., this should not exceed 3 per cent. in cases where the motors are situated at distances from the generating source of not more than 300 yards, and 5 or 6 per cent. in cases where the distance does not exceed 500 yards; this, however, cannot be taken as a hard-and-fast rule for every case, but it will be found to apply in the case of most works, and the expenditure of copper in the mains will not be found to be prohibitive.

The contention of the author in advocating electricity as the right and proper agent for operating new works, and as a means whereby old works can be remodelled, may be summarised by the one word "economy." In no country, perhaps, have engineers looked more thoroughly and closely into the economics of electricity as applied to power work than in Belgium, and the author trusts that reference by him to works driven by electricity in this country may not be out of place at the present meeting. In the first instance he would refer to an installation which has now been at work for some considerable time—viz., that of the National Arms Factory, at Herstal, near Liège.

Mr. Leon Castermans, in a communication which was published in the *Revue Universelle des Mines*, stated that towards the end of 1886 the principal arms manufacturers at Liège formed a syndicate with the intention of laying down works to carry out in a rapid manner important orders for guns. A company was eventually formed, under the title of the Fabrique Nationale d'Armes de Guerre, and an order was given to this company for 150,000 to 200,000 rifles. In order to carry out this work, the society determined to lay down works provided with all the latest improvements, and up to date in every respect. The Compagnie Internationale d'Électricité went most closely into the matter, with the result that they were able to offer to the syndicate absolute guarantees for successful working which have since been fully realised. When these works were started, the Compagnie Internationale d'Electricité laid down:

Nine motors of	16	h.p.	=	144 h.p.
Two ,,	21	,,	=	42 ,,
Two ,,	37	,,	=	74 ,,
Total.....				260

For each motor the Compagnie Internationale d'Electricité guaranteed: for the 16 h.p., a commercial efficiency of 87 per cent.; for the 21 h.p., a commercial efficiency of 87 per cent.;

* Abstract of paper presented to the Brussels meeting of the Iron and Steel Institute.

† *Vide Electrical Engineer*, May 11, 1894.

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for the 37 h.p., a commercial efficiency of 89 per cent.; so that the available power would be produced by an initial power of—

$$\frac{144}{0{\cdot}87} = 165{\cdot}5$$

$$\frac{42}{0{\cdot}87} = 8{\cdot}34$$

$$\frac{74}{0{\cdot}89} = 83{\cdot}1$$

Total ..... 296·9 h.p.

As the loss by canalisation would not be greater than 2 per cent. :

$$\frac{296{\cdot}9}{0{\cdot}98} = 303 \text{ h.p.}$$

at the dynamo terminals.

In addition to the above there was a large amount of lighting to be considered, and the power eventually adopted was an engine and dynamo combined of 500 h.p. This dynamo is of the shunt-wound type, and suitable for a tension of 125 volts ; there are 20 pole-pieces formed in the form of a circle round the armature, and allowing a play of 6mm. to the latter. The armature, on account of its large dimensions, some 17ft., had to be built up *in situ*. The current is taken from two commutators, one on either side of the armature, by 80 metallic brushes ; the current is taken away to the main distributing switchboard by four underground cables. The commercial efficiency—that is to say, the ratio between the electric energy available and the energy transmitted to the shaft by the engine—was guaranteed to be 90 per cent. The carcase, which is in steel, of the dynamo weighs 10 tons ; the armature alone weighs 10 tons ; the copper in the magnets weighs two tons ; and the armature coils 600 kilos. The particular characteristic of this dynamo is that not only it is driven direct by the steam-engine, but that the armature itself forms the flywheel of the engine.

The motors about the works drive different line shafts. The efficiency of transmission—that is to say, the ratio between the power available and the effective horse-power developed by the steam-engine—is given by the product of the three efficiencies:

98 per cent. guaranteed for the dynamo ;
98 per cent. guaranteed for the conductors ;
87 per cent. guaranteed for the motors ;
=76·6 per cent.

The installation at Herstal has now been running continuously for three years, and until recently the entire works depended solely on the running of this single dynamo, both for light and power. About 2,000 hands are employed at the works. Up to the present, the large dynamo has never been the cause of the cessation from work for a single minute. The installation has of late been considerably extended, and an additional 300-h.p. plant has been laid down. The speed of the large engine and dynamo is only 66 revolutions per minute. The engine employed, being of the Corliss compound condensing type, was built by Messrs. Van de Kerkchove, while the dynamo was constructed by the Compagnie Internationale d'Electricité, under the direction of Mr. H. Pieper. The 300-h.p. plant consists of a combined Willans engine and Pieper dynamo, running at about 350 revolutions per minute, and it is interesting to compare the results obtained with these two engines. The efficiency of the Corliss combined plant—that is to say, the efficiency of the engine and dynamo taken together under full load, is about 77 per cent.

The dry steam consumption of the engine per indicated horse-power per hour=14·34lb.

The dry steam consumption of the engine per electrical horse-power per hour=18·75.

On the other hand, we get the highest efficiency from the quick-running plant. The efficiency of the Willans engine and dynamo combined at full load is about 85 per cent.

Dry steam consumption per indicated horse-power per hour=15·4lb.

Dry steam consumption per electrical horse-power per hour=18·19lb.

At the zincworks of the Vieille Montagne Company, near Jemeppe, a large electric power installation has recently been laid down. The works were formerly driven by a large number of steam-engines, which took from 60lb. to 88lb. of steam per indicated horse-power per hour to drive them, and required a number of enginemen to attend to them. The station is placed alongside the railway, so that coal may be brought right up to the boiler-house by truck. Three Babcock and Wilcox boilers have been laid down—one acting as spare, while the other two provide steam for a 600-h.p. compound condensing engine, on the Friekart system, built by the Société Cockerill, at Seraing, which drives direct a Pieper flywheel dynamo of 600 h.p., at a speed of 80 revolutions per minute. The dynamo is wound for a pressure of 500 volts. Every provision is made in the engine-house for a second section of 600 h.p., of a similar character to the first.

The water from the Meuse, situated at a distance of 2,700 metres from the generating station, is pumped to the works by a 45-h.p. motor, and the current is further utilised in operating two electric wharf cranes for loading and unloading the boats. The motors laid down at present are of the following sizes : five motors of 1 h.p., seven of 2 h.p., six of 3½ h.p., six of 5 h.p., four of 7 h.p., two of 10½ h.p., four of 14 h.p., two of 45 h.p., and one of 64 h.p. It is now proposed to add the following motors : one motor of 80 h.p., one of 14 h.p., five of 1 h.p., and one of 10 h.p. The current is taken from the main generator to the main power switchboard, and is carried through 18 circuits to distributing boards in the works. In addition to the power, there are 75 arc lamps and 500 incandescent lamps in the works. As a tension of 500 volts is too high for the latter, a continuous-current transformer is used which reduces the pressure to 100 volts. During the daytime this transformer charges a battery of accumulators.

The motors drive, amongst other things, joiners' shops, forges, fans, machine tools, saws, pumps, lifts, washing machines, crushing machines, brickmaking machines, etc.

Efficiency of the Installation.

The efficiency of the steam-engine is	90	per cent.
,, ,, generating dynamo	90	,,
,, ,, circuits at full load	98	,,
,, ,, motors	86	,,

which gives a total efficiency of 0·685.

Such are briefly the outlines of the Vieille Montagne installation. Electric power installations have also been laid down, and are working most successfully, at the Royal Arms Factory, at Liège, where the coal consumption has been much reduced ; at the works of Messrs. Dietrich and Co., at Luneville, and at the celebrated glassworks of the Val St. Lambert. At this last place there are six motors, 86 arc lamps, and 1,100 incandescent lights. The author thinks that it has now been shown that electricity has passed out of its experimental stage as far as regards its suitability for driving the various classes of works ; and, in conclusion, trusts that these few very unpretentious notes may have proved a source of interest to the members of the Iron and Steel Institute.

THE DOUBLE-TROLLEY SYSTEM.

Shall we come to the double trolley at last? This is the question which Mr. Nelson W. Perry discusses in the *Street Railway Gazette* of July 28, with special reference to the use of the single trolley with rails and earth return, and the damage done to underground conduits by electrolytic corrosion. In the course of the article the author says :

The remedies that have been suggested from time to time, though they seem to have worked well in some cases, have signally failed in others, and even when a success has been claimed it has not infrequently happened that the claimant was mistaken and that a failure was recorded instead of a success. Much faith is pinned to the welded rail as a panacea for the evil of electrolysis, but it has not been proved that the welded rail is practicable. There are strong hopes that it will prove so, but in the only extensive experiments thus far tried—viz., those in Johnstown and Boston—the rails have failed to withstand the contractions due to the rigours of winter. The only alternative left seems to be to keep the current away from the rails entirely—to use the double trolley.

The double trolley is scarcely known outside of Cincinnati. With something like 200 miles of road electrically equipped there is but one road, consisting of about four miles of double track, that uses the single-trolley system.

During a lawsuit brought by the telephone company against the single-trolley road to compel it to cease interfering with its service, the single-trolley road attempted to prove that it could not operate with the double trolley. The double-trolley road was called in to prove that it was really the better system. A comparison showed that the double trolley was operated at less expense than the single trolley, the reason being, as we know now, that the former had at all times as good a return circuit as the outgoing, while with the single trolley the ground return was a very uncertain quantity.

The greatest objection to the double trolley lies in the complications in the switches and cross-overs. This trouble is both mechanical and electrical. When two roads cross each other there is difficulty in insulating the positive from the negative, since in this system they must necessarily

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cross each other, whereas in the single trolley the two crossing wires are both positive and presumably at the same potential. In the double trolley, too, at a crossing there are four intersections, whereas in the single trolley there is but one. It is also evidently more difficult to insulate the positive and negative sides of the circuit when they are but 12in. or 13in. apart, as in the double trolley, than when they are so far separated, as in the single trolley; but as an offset to this the cars on the double trolley are entirely independent of the condition of the track, since it forms no part of the circuit. As a result of all this, the double trolley in suburban districts where it does not intersect other wires has proved itself superior to the single trolley, but in centres where many lines cross and radiate it is at a great disadvantage, both on account of the mechanical and of the electrical difficulties attendant upon the many intersections. These difficulties are not insuperable, however, as in Cincinnati there is one centre—the intersection of two streets—Fifth and Broadway, where two lines run east and west, two run north and south, and there are four curves connecting these four lines together, and on Fountain-square the situation is even still more complicated, yet these are the busiest car centres in the city. The complication of wires—trolley wires, span wires, and pull-off wires—at these points is most unsightly, and greatly to be deplored. A perfect stream of cars, however, is continually passing these points, and doing it apparently without trouble. But the water and gas mains are safe, and I believe this is the only way to make them so. There may be other partial remedies which will postpone the day of reckoning, but this seems to be the only radical cure.

THE PACIFIC CABLE QUESTION.

In previous issues, references were made to the Intercolonial Conference at Ottawa, and to the resolutions passed at the various meetings. In this connection, the following article which is reproduced from yesterday's *Times* will be of interest:

The large proportion of time spent by the conference in discussing the question of the Pacific cable furnishes probably a just measure of the interest felt in the scheme. With one exception, to be referred to later, there was practical unanimity of opinion, in spite of all that Sir John Pender has written, as to the need which exists for the cable. The debates brought out the relation of the various colonies to the question. Canada's direct interest in the cable is perhaps less than any of the other communities concerned. Both for strategic and for commercial purposes her present telegraphic connection with the centre of the Empire is cheap and sufficient. But, in pointing this out, the Minister of Finance added: "The unity of the Empire, the security of all its parts, the interdependence of those parts are articles which have worked themselves into the creed of every Canadian." For this reason alone Canada would support the cable energetically. Besides, it is now an accepted axiom that trade follows the cable as well as the flag, and, though the Pacific trade of the Dominion is still chiefly prospective, confident hopes are entertained about its development. The actual interest taken in the line by Canadians is therefore great, and justifies the action of the delegates from the other colonies in giving to the Dominion, as they did at the close of the conference, a practical leadership in pushing forward the work.

Australia's concern in the cable is more direct, and is based on both commercial and defensive considerations. She already spends immense sums in keeping up telegraphic communication with Europe, and the expenditure steadily increases. The people have, therefore, a deep commercial interest in the cheaper cable rates which it is believed the new line will give. Besides this, Australia dreads isolation in time of war, and isolation seems not only possible but probable so far as existing lines are concerned. To no part of the Empire does a remark made during the conference by Sir Charles Mills apply more closely than to Australia. Someone had said that even a Pacific cable, though remote and laid in deep water, might be cut in war as well as the lines which cross Europe and Asia. The Agent-General for the Cape replied that if the line remained intact only long enough to convey the declaration of war it would amply repay the expense of building it.

Once more, if there is to be a cable across the Pacific, Australia wishes it to be British. More than one delegate pointed out that the beginning made by the French in laying a line 800 miles long to New Caledonia, and by the United States in surveying the route from San Francisco to Hawaii, opens up prospects which Australians do not like to contemplate. It was remarked during the conference that, even if Canada and Australia abandoned the project, the cable would still probably be built, and so it might easily turn out that, while the Empire would lose much, the Eastern Extension Company would gain nothing, should its present opposition to the cable prove successful.

The only distinct note of Australian opposition therefore came from Mr. Playford, who was naturally bound to present in the strongest light he could the great sacrifices which South Australia had made to complete connection with Europe by building the trans-continental line, and the risk she runs of losing more heavily in the future than in the past if a rival route be established. Everybody admitted the weight of his argument in these particulars, and the feeling was general that the position of South Australia should, in any new scheme, receive careful consideration.

Mr. Playford went further than merely to state the South Australian view of the situation, and he marshalled with much skill the various criticisms which have been made upon the scheme—the uncertainty about expense; the difficulties which are likely to be met with in unknown seas, and in working the cable over long ocean spaces; the fact that the hydrographer to the Admiralty has apparently taken up an attitude of hostility to the plan for a cable, while no military man of acknowledged authority has yet given a decisive official opinion upon its strategic valve. All this, he said, was pointed out in order that the conference might rightly measure the task it was undertaking, and the cost. But he added that, if it were proved that the cable is required for Imperial and public purposes, then he was instructed by his Government to say that South Australia would not oppose it, but would only ask that the risks which the colony might incur would be as far as possible minimised. The significance of this qualification to Mr. Playford's opposition is manifest.

South Africa is not so directly interested in the cable as Canada and Australia. Sir Charles Mills and Sir Henry de Villiers, however, expressed their belief in the national importance of the line. They also suggested a resolution, which was adopted, looking to the ultimate addition to the cable equipment of the Empire of a line from Australia to the Cape.

Mr. Hoffmeyr was not present during the debate on the cable. He afterwards mentioned to me a view marked with his usual originality and boldness of thought. He claimed that for an Empire such as ours the question of cable construction should be lifted above the range of merely commercial considerations. A Royal Commission should be appointed to report on what lines are required to make the national position strategically complete. This might involve connection, not merely across the Pacific or Indian Oceans, but with remote points like St. Helena, Ascension, and West Indian or East Indian Islands, in order to give effectiveness to naval operations and combinations. The necessities of national defence being settled on definite principles, the lines required should then be constructed at the common expense. Had Mr. Hoffmeyr been present at the cable debate he would have urged upon the conference this view, which it seems well to put on record here.

The relation of the United Kingdom to the question necessarily came up for consideration. Mr. Foster expressed what seems to have been the general opinion of the conference when he claimed that, in view of the interests concerned, it was not unfair nor unreasonable to ask for the support of the Imperial Government. Sir Henry Wrixon pointed out that the outward communication by post or telegraph from a great centre like Britain was known to be greater than the inward, and so the United Kingdom had the greater interest in cheap cable rates, to say nothing of the utility of the alternative route for defensive purposes.

After the criticisms of Sir John Pender had been carefully analysed by Mr. Fleming, Mr. Bowell, and others, the views of the conference finally became crystallised into three resolutions, the first of which affirmed the desirability of constructing a Pacific cable free from foreign control; the second asking the Imperial Government to undertake the survey of the route on the understanding that the expense should be equally divided between Canada, Australasia, and the United Kingdom; and the third requesting the Canadian Government to use its efforts to push forward the scheme and carry out the wishes of the conference.

Everybody agreed that the survey is a necessary preliminary to final and decisive action. As the conference was closing, Mr. Siemens, who had hurried to Ottawa after laying the last Atlantic cable, placed before the delegates his opinion that, with the new apparatus now brought to perfection, it is possible to lay a cable in unknown and varying depths, and that the work is quite feasible with the knowledge of the route already existing. But it is doubtful if this opinion, even if placed before the conference earlier, would have influenced the final decision.

There can be no doubt that the agreement of the colonies to share in the expense of survey and the determination expressed to push forward the scheme, advance the question of the cable much beyond the position in which it was left by the conference of 1887. A fair degree of energy on the part of the colonies, and reasonable co-operation by the mother land, should soon bring the matter to a final issue.

What has been said would be incomplete without reference to a discussion upon the method of construction brought up by Mr. Thynne in a resolution which proposed that the cable should be undertaken as a joint national and public work. The delegates of New South Wales and of New Zealand were strongly opposed to the work being done otherwise than by means of a private company. Mr. Playford as warmly supported the resolution, which had the endorsement, I think, of a majority in the conference, though two or three of the members looked upon the question with an open mind. The resolution was finally withdrawn as being premature, but the discussion and difference of opinion which it evoked have interest, inasmuch as the question is one which must be settled at an early stage of the enterprise.

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STREET-LIGHTING WITH INCANDESCENT LAMPS.

There is hardly any need at the present day to deal with and explain the greater cost of arc lamps for the purpose of street-lighting as compared with the ordinary expenditure upon gas lights to an extent hitherto considered sufficient. Perhaps in a few country towns there may yet be local authorities and officials who require convincing upon the subject, and who when asked to authorise the payment of £25 or £26 per annum for each and every arc lamp installed in the streets, instead of an eighth of that amount per gas lamp, previously used, cannot understand without much and lengthy argument that the extra light given in the first instance (say, fifty times as much) is well worth the greater expenditure. Speaking generally, however, it may be said that not only municipal authorities and officials, but even the outside public have begun to realise these facts, and assess them at their proper value.

There is, nevertheless, a great deal to be said upon the subject from an economical standpoint, and all those who have to decide the question of improved street-lighting will do well to bear constantly in mind the great difference that exists between the amount and quality of illumination required for the various thoroughfares of a single town or city. Arc lamps must without doubt have extensive employment in the main streets; their additional expense is more than counterbalanced by the greater light afforded, but when the side streets and less important thoroughfares are considered, the lighting authorities may well feel somewhat perplexed as to their most advisable action.

Efforts, of course, are made to overcome the difficulty by fixing the arc lamps on main streets at or near the corners of side streets, so that their more powerful light may at least shine as far as possible down the latter; but this can only be done to a limited extent, and not at all in streets at a distance from the electric light mains. What is to be done with these cases? Several suggestions have been made from time to time, but the real solution of the problem seems to turn upon the introduction of a satisfactory method of lighting incandescent lamps in series, just as in the case of the arc lamps now employed.

Obviously it would not altogether be safe or advisable to work incandescent lamps for street-lighting from the ordinary low-pressure mains that serve for house-lighting, etc.; the expense of running separate low-pressure wires—with the lamps in parallel—and the difficulty of maintaining full pressure over a scattered area, both seem to point out a series system as being the more likely to give satisfaction with economy. We should not be surprised at any time to hear of a favourable plan being thus devised; indeed, whisperings have already reached us that experiments will very soon pass into experience, and that we may see a system of this type at work in connection with the largest street-lighting plant now in operation.

In this connection, then, it is peculiarly interesting to note that a special committee of the Islington Vestry has reported to that body upon the entire

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question of street-lighting throughout its district, coming to the conclusion that a system of arc lamps along the main roads will cost but little, if any, more than gas, whilst the illumination of the streets will be greatly increased, and consequently also the thoroughfares made more attractive and trade generally developed in the neighbourhood. We congratulate the committee on coming to such a conclusion, obvious as it may be to the well informed; and whether the cost of arc lighting as thus proposed be much the same as or greater than that of gas, we are quite sure that after once installing such a system there will afterwards be no question of ever doing without it.

The committee appears to be quite awake to the extra cost involved, and propose to reduce it slightly by switching off, say, half the street lamps during the long hours of the night, or by replacing the arcs with incandescents. Whether this latter proposal would effect any great saving whatever is not too clear to our minds, though obviously the horse-power expended would be less. That, however, is not the only item involved.

To find a local authority in readiness to consider the use of incandescent lamps for street-lighting at all, is decidedly an important sign of the times. If such a method is of service in main streets, it must be still more so in the secondary thoroughfares: and we shall expect to see great progress made soon in deciding the question. After all, it only means the devising of a reliable and efficient cut-out for incandescent lamps—automatic in action, cheap, and simple to construct.

HORSES FOR SALE.

There has been quite enough of mere "talk" concerning the better development of electric traction in this country for some years past, and we plead guilty ourselves to some of it, although the purpose behind any such expressions has been wholly the consideration of electrical interests. Less than a week ago, however, the Imperial Tramways Company held its usual half-yearly meeting, and the chairman introduced some very important statements into his speech.

It will be remembered that this company owns a number of separate enterprises in different districts, amongst these being the Dublin Southern District Tramways, which reach from Dalkey, through Kingstown, to Dublin. Privy Council and parliamentary powers for the use of electric traction on the lines, with an extension of the system and assimilation of gauge, were obtained some time ago (after no little opposition from the Dublin, Wicklow, and Wexford Railway, who obviously feared the effects of wholesome competition), and since that time the directors have been completing the necessary financial and other arrangements for the heavy work thus taken in hand.

A further cause of delay has been the discussion and settlement before the Board of Trade of standard rules for the erection and working of electric lines: for obviously it was unwise to take active steps in the matter before knowing what would be required by the authorities. Now, however, the matter is definitely settled, and it is expected that by next summer we shall see a double-track electric tramway stretching along the whole length of eight miles between Dublin and Dalkey.

The contract is to be carried out by the British Thomson-Houston, Limited, at a total cost of £70,000 for laying the double line, rearranging the present terminal depôt as a power station, and equipping the line with an overhead conductor system and motor cars. This means that the present capital of the Dublin Southern District Tramway Company is to be doubled, since the ordinary shares—all held by the Imperial Company—have a nominal value of £70,000. On the total capital of £140,000—half of which now issued bears preferential charges, the other half being represented by the ordinary shares—it is confidently expected that profitable dividends will be paid, owing to the greatly diminished working expenditure and the correspondingly increased receipts due to a quicker and more frequent through service. Those engaged in the work have, at any rate, the courage of their convictions in this respect, as they propose themselves to find all the debenture or preferential capital: the Imperial Company contribute £10,000 in cash and the contractors—both electrical and permanent way, etc.—offer the balance.

We enter thus minutely into the particulars of this enterprise, not only because it bids fair to be the most important of its kind yet undertaken, but also by reason of the fact that the chief obstacle in developing other lines elsewhere has been the apparent impossibility of arranging satisfactory financial conditions. All the more credit, then, is due to those in charge of the Dublin enterprise for being able to secure the construction of their lines without having to wait for public investors to think so highly of electric traction as to offer the necessary capital. It shows decided confidence in the prospects of the change, and they deserve to reap the reward of increased traffic at less working cost.

Another event that to our mind tends also to show the flowing tide in electric traction development is the recent opening of the Douglas and Laxey Electric Tramway in the Isle of Man, particulars of which were given in our last issue. This being an absolutely new line, the title given to our remarks does not apply to it in the manner that will probably be the case very soon at Dublin, but in other respects—actual length of track, novelty of constructive details, etc.—the Laxey tramway has features of most striking interest. It may be regarded as embodying all the improvements yet developed on sound mechanical lines, not the least of these being the use of cross-bars instead of the clumsy device of a trolley wheel for making contact with the overhead conductor.

The ball is now, we think, fairly set rolling in electric traction matters: just how far and how fast it will go remains yet to be seen. We may hope, at any rate, that it will "gather no moss."

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CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

LOWRIE'S INTRAPOSED SYSTEM.

SIR,—I regret that owing to the holidays I did not see Mr. Faber's letter in time to reply to it in your last issue. I am entirely at issue with the opinion he has expressed respecting my controller switch, and he is in error in supposing that I would patent an invention before I had practically tested and proved it. My system is—as to its several parts, and as a whole—the outcome of practical work.—Yours, etc.,

W. LOWRIE.

August 17, 1894.

SOME OF THE ELECTRICAL COMPANY'S MANUFACTURES.

Two or three weeks ago we referred to the new manual brought out by the Electrical Company, of 122 and 124, Charing Cross-road, W.C., who are the English representatives of the Allgemeine Elektricitäts Gesellschaft, of Berlin. A selection from this manual of some of the company's manufactures should prove interesting at the moment. Fig. 1 shows the S-type of direct-current dynamo which is made in various sizes, is of solid construction, and of high efficiency. The dynamos run smoothly and without sparking, and they are arranged for belt driving. Of the various kinds of regulating apparatus made by the company for dynamos, the automatic shunt regulator represented in Fig. 2 is an example. The regulator is constructed according to the Thury system. In Fig. 3 is shown an electric lift. For passenger lifts the motor shaft is coupled direct to the

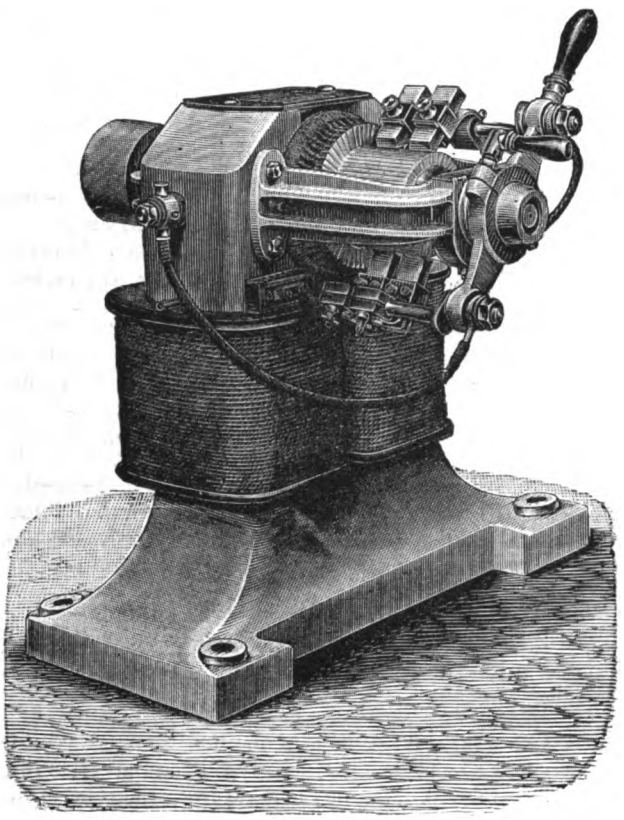

FIG. 1.

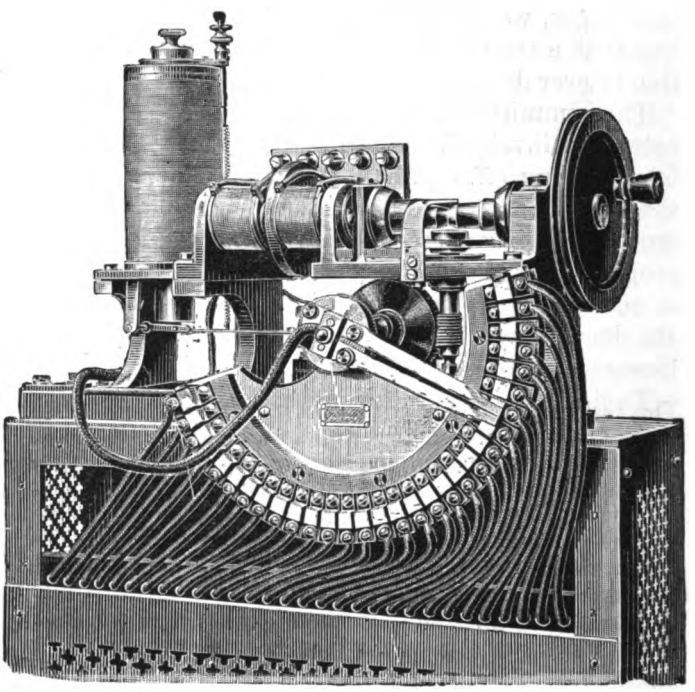

FIG. 2.

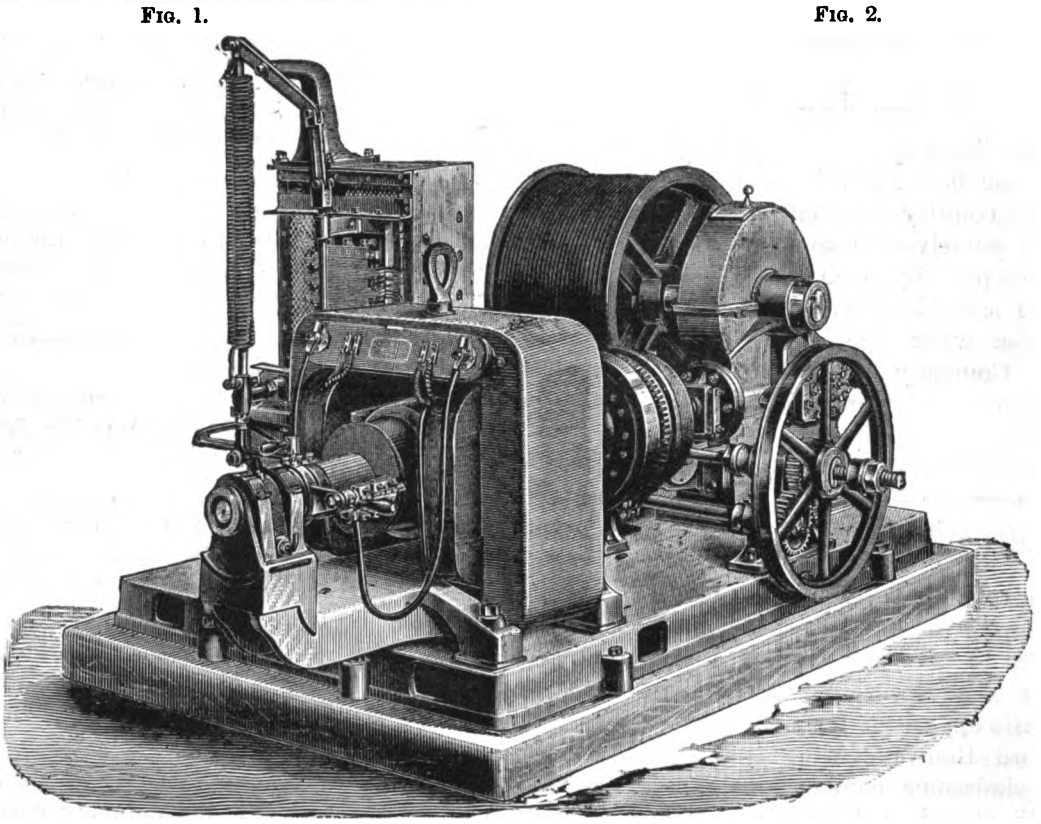

FIG. 3.

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worm shaft, but in the case of lifts for goods the motor either drives the worm by means of wheels, or the worm shaft by means of a bevelled countershafting. A starting resistance is provided to set the motor in operation, being connected with the governor by bevel wheels and pulleys.

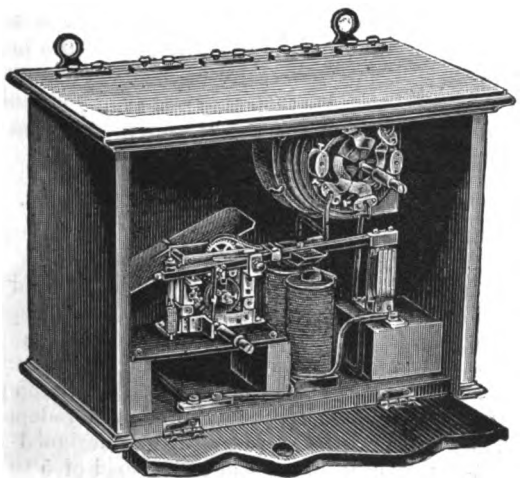

FIG. 4.

This resistance can be arranged with a current-reversing apparatus, if no bevel gear is fitted, to enable the motor to run to the right or left, thereby effecting the upward or downward movement of the lift. A further arrangement is provided for automatically throwing the motor out of gear when the lift attains its final position. The lifts are constructed for double carrying capacity, and for the use of double counterweight ropes. Fig. 4 represents an apparatus for the intermittent lighting of staircases. It comprises a switch which closes and breaks a circuit automatically after a given time—three or five minutes, according as it is set.

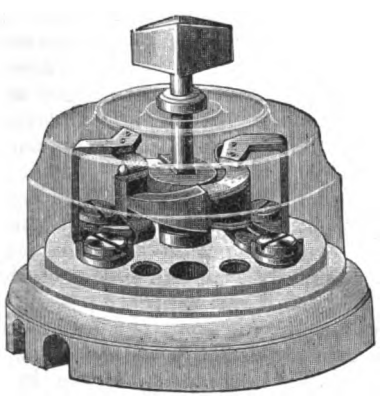

FIG. 5.

By pressing a button the clockwork of the apparatus is set in operation and the lights are switched on. The last illustration shows the A.E.G. switch.

SOME FACTS ABOUT POLYPHASE MOTORS.*

BY LOUIS BELL.

In connection with the long-distance transmission of power, most engineers will, I think, agree with me in the position that alternating-current motors of some kind, and of alternating current, preferably the polyphase variety, are almost a necessity. We have been forced to their use by the exigencies of long-distance service, which compel either the total abandonment of continuous current or its use under very embarrassing conditions.

There has, however, been a tendency to look upon the polyphase motor as a somewhat undesirable resort to which we have been driven by long-distance work. Such, indeed, was my own belief from *a priori* reasoning, and before I had obtained that practical knowledge of the subject which can only come from personal experience both with the design and application of any class of apparatus. By such experience, and by the commercial demands which have been coming in with steadily increasing frequency, I have been forced into taking the position that the polyphase motor is intrinsically preferable to the continuous-current motor for a vast majority of all the uses to which such machinery may be applied.

At present appearances indicate that not only will the polyphase motor displace direct-current apparatus for most long distance transmission plants, but will prove a formidable competitor in all applications of motors to industrial purposes, and this although the polyphase apparatus is the growth of only a few years, while the direct-current motor is the outcome of more than a decade of experience.

We may, then, in instituting a comparison between polyphase and direct-current motors, consider the various properties which a good motor of any kind must necessarily have. Mechanically speaking, we would all agree that it should be simple in construction, strong, not liable to frequent or considerable repairs, convenient in form, and not excessive in weight. As regards its properties, it should, in general, run cool, stand overloading without serious danger, run at a nearly constant speed, or be capable of considerable variation in speed if necessary. It should be capable for certain uses of sudden and violent exertion, and of easily changing its direction of rotation. In a purely electrical way, it should be simple, efficient both at high and low loads, and should not take excessive amounts of current either in starting or in running.

This represents a difficult list of conditions to fulfil with any one motor, but I believe they can be met better by polyphase than by direct-current machines. A direct-current motor, for instance, of a given construction and reasonable weight, cannot run both at a constant speed, independent of load, in a particular case, and at the same time be capable of running at a wide variety of other speeds. It usually will not stand considerable overloads without sparking and at the same time give a fair efficiency at low loads, and so one might go on piling up difficulties. The polyphase motor, too, cannot meet all these conditions with equal success, but examining them one by one you will find that on the whole we can obtain very excellent results.

Taking up seriatim the desirable properties which I have enumerated, and applying them to polyphase motors, we find as regards the first count that their construction is singularly free from complexity. They consist, in general, of two concentric masses of lamination, forming respectively the fields magnet and armature. The armature is assembled on its shaft much as in direct-current machinery, while the field laminations are held together by a clamping spider of very simple construction. The bearings are supported either on end spiders fitted to the field spiders by lathe work only, or on pillow blocks of the ordinary kind. Commutator or commutator connections there are none, nor should there be collecting rings except in rare instances. The armature need be exposed only to low voltages, and should preferably be wound with a comparatively small number of rather massive conductors, united at the ends either by a single plate or by very simple connectors, the latter form being preferable. The field winding is usually in a greater number of coils than is a direct-current field winding, but each coil has a comparatively small number of convolutions, making the total winding by no means complicated.

In lieu of the starting rheostat of the direct-current motor, we have a starting resistance which should preferably be placed within the armature, and consists of a few zigzags of metal united at one end and connected at the other to three or more contact-pieces. A solid collar short-circuiting these contacts, and a forked lever to move the collar, completes the equipment, as I am accustomed to employ it. Its most noticeable feature is that the revolving armature, the most troublesome and delicate part of a direct-current machine, is free from complication, and that it is almost as solid as if it were a solid mass of metal, and scarcely more liable to injury.

*A paper read at the Philadelphia meeting of the American Institute of Electrical Engineers.

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This very obvious simplicity of construction and mechanical strength is strong evidence of unusual freedom from repairs, and as a result of experience I have found that the induction motor is singularly free of liability to accidents of every kind. I have never succeeded even by the severest kind of experimental work in burning out a field coil or doing any serious injury whatever to a motor, although I have kept some of them on static torque tests in rapid succession for hours at a time, and have held them at rest and poured current through them until the leads burned off, the motor still remaining undamaged. If there is a test of extraordinary severity that I have not applied to induction motors, I have yet to learn of it. These properties are invaluable in commercial work, inasmuch as they practically remove the danger of crippling the motor even under exceptionally unfavourable conditions.

As regards the convenience of the form of polyphase induction motors, I think an inspection of any of the types which have been brought out will render argument unnecessary.

The magnetic necessities of the case have led all makers of such apparatus in this country and elsewhere to adopt a species of barrel shape as the general outline of the motor, modified only in the proportions of diameter to length, and in the adoption of one form or another of bearing. The tendency of this construction is to bring the centre of gravity of the machine very low, thus ensuring unusual stability and freedom from general vibration. This form, too, enables one to place the motor in almost any position which is convenient in applying it, upside down, as a side bracket, and the like.

The largest installation of induction motors in the world, just put in operation in Columbia, S.C, aggregating over 1,200 h.p., is composed of inverted motors with their bases bolted to the ceiling timbers of the rooms.

As regards weight, the abolition of any sparking limit to the output, and the excellent magnetic material used, might naturally be supposed to lead to motors of unusually light weight, and such is, in fact, the case; 60lb. to 70lb. per horse-power in motors of moderate size is a figure easily reached without any sacrifice of efficiency, and if occasion requires, these limits can be passed with great facility, 25lb. to 30lb. of material per horse-power being quite attainable in large units, while still retaining satisfactory general properties. I must say, however, that for most uses I do not consider extreme lightness either necessary or desirable, although it is important to be able to secure it if necessary. So much for the mechanical character of induction motors.

Electrically speaking, the case is just as favourable. Unless forced to a very large output per pound of weight, an induction motor will run quite cool, at a heating limit, in fact, below that of most direct-current machines of similar weight and output. This advantage is mainly due to the very substantial character of winding which can be conveniently employed, and to the fact that the winding is distributed so that the losses in the copper are not localised, while the laminated character of the structure facilitates thorough ventilation. This freedom from excessive heating indicates that the polyphase motor can stand considerable overloading without any serious results, and experience has shown this to be the case. The worst that can really happen is that the motor may fall out of synchronism when the load is sufficiently great, thereby blowing the fuses in the primary line.

As sparking is obviated in this type of machine, it can readily be rated at such output as will give a proper limit of heating, and this output will in most cases allow from 30 to 60 per cent. of overloading before the machine will drop out of step. A wider range than this can be obtained if desirable, which it is generally not.

The limit of possible overloading fixes in a general way the possible static torque that can be obtained from a given machine, and this is apparently purely a matter of convenience in design, anything that can reasonably be required being quite attainable. There is no special difficulty in arranging polyphase motors for a starting torque four or five times the running torque, although this would be unnecessary except for severe hoisting and tramway work. At running torque the starting current taken may readily be no greater than the running current. From this it will readily be seen that a properly-planned polyphase motor is easily capable of very great and violent exertions in a case of necessity. It will even endure complete reversal under full load within 10 or 15 seconds on motors of ordinary sizes, this time being sufficient for the machine to pass from full load in one direction to full load and speed in the other direction. This reversal is, as is well known, accomplished simply by reversing any two of the primary wires, the effect being to rotate the field in the opposite direction from the armature, thus causing an enormous rate of cutting lines of force, and consequently immense effort, causing the motor to stop and reverse.

Speed Variation in Polyphase Motors.

This subject has been for the most part in rather a hazy condition up to the present time. The induction motor has been generally known as nonsynchronous, and such, indeed, it is. The name, however, has been frequently used in ignorance of the fact that an induction motor always tends towards synchronous running.

Under ordinary conditions the polyphase induction motor can be made to run at nearly constant speed independent of load, resembling in this respect a well-designed shunt motor. A variation from no load to full load of 5 to 6 per cent. in speed would represent ordinary good practice, either in a shunt motor or a polyphase one, this limit being exceeded only in small motors or types which may be regarded as special. It is by no means difficult, however, so to design a polyphase motor that the speed shall possess very remarkable uniformity. This condition has been valuable in the Columbia plant previously alluded to. In this case tests of 17 motors showed a maximum variation in speed from an output of 75 h.p. to friction load of the motor, of only 2·2 per cent., individual motors showing slighter variations down to 1½ per cent.

The task of these particular motors is driving a cotton mill, hence the necessity for uniform speed. And this uniformity in speed is not greatly affected by variations in voltage, which would be quite sufficient to cause considerable speed variation in a shunt-wound motor; in fact, the induction motor is remarkably insensitive to moderate variations in voltage, unless it is heavily loaded. This uniformity in speed has frequently been urged as an objection to the induction motor, barring its employment in cases where speed variation is necessary. This point is not well taken.

The induction motor cannot be made successfully to run at reduced speed by varying the primary voltage. Under these circumstances the output of the machine falls off somewhat more rapidly than the square of the voltage, so that only trifling speed variations are possible. It is a fact not generally known, however, that the speed of a polyphase motor can be varied with the same facility and within the same wide range as is possible in the case of a series-wound continuous-current machine, such as a railway motor. This is accomplished in the induction motor by a rheostat in the secondary circuit, just as it is accomplished in the series motor by a rheostat in the main circuit. Thus equipped, the two machines behave almost exactly alike. The speed at constant torque can be made to vary from full speed down to almost no speed, thus simulating the action of the series motor in the closest possible fashion. At any given speed an increase or decrease of the torque will decrease or increase the speed substantially alike in both classes of motors. In both, too, the efficiency is initially similar, and falls off in practically the same ratio. A non inductive resistance is necessary in case of the polyphase motor, an inductive one throwing the armature current so far out of phase as to interfere with the proper action of the motor.

Fig. 1 gives an excellent idea of the behaviour of a polyphase motor with resistance in the secondary circuit.

Curve A shows the speed and output of a certain motor under these circumstances. It was a four-pole machine operated at 50 cycles per second, and the initial speed was reduced to 1,400 by the resistance of the leads reaching across the room to the rheostat, composed of loops of manganin strip which could be systematically varied. It will be seen that the word curve is almost

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a misnomer, the ratio between the speed and output at constant torque being almost a linear function, even when the speed fell to as low as 150 revolutions per minute. It was not carried lower than this only because of lack of adaptability in the rheostat. No series motor could show a more satisfactory result.

Curve B shows the power factor under these varying conditions. It is high at all loads and speeds, varying slightly, with a maximum at about half speed.

Curve C shows the variation in current. This, as can be seen, is almost constant, falling off slightly at the lower speeds, the voltage being uniform throughout the test.

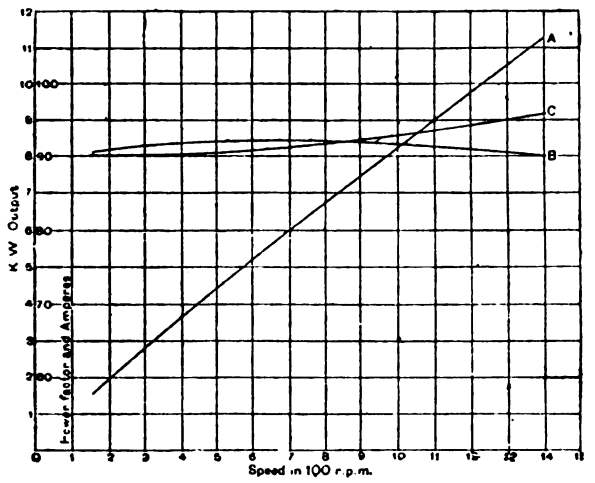

FIG. 1.

Speed variation by this method is not as efficient as might be wished, but still compares favourably with that obtained in a series motor with rheostatic control. Some modified methods of control promising a somewhat better efficiency have been suggested, but it seems probable that in the net result we shall find that continuous-current and polyphase motors are about on a par in this respect. It should be noted that in continuous-current motors, speed variation by weakening the field is only practicable within a very limited range, and requires an abnormally heavy motor. I think that with a similar change in design the polyphase motor could be made to operate nearly as well by change in its field strength. An efficient speed variation through a very wide range is attainable in either class of machine only by extraordinary means, as an elaborate combination of direct-current machines, or frequently changing devices in the polyphase machines. From what has been said it will be apparent that the polyphase motor is perfectly capable of a complete control of speed on the same terms generally obtained with continuous-current motors.

(To be continued.)

EXPERIMENTS FOR IMPROVING THE CONSTRUCTION OF PRACTICAL STANDARDS FOR ELECTRICAL MEASUREMENTS.

Report of the Electrical Standards Committee of the British Association, consisting of Prof. CAREY FOSTER (chairman), LORD KELVIN, Profs. AYRTON, J. PERRY, W. G. ADAMS, and LORD RAYLEIGH, Drs. O. J. LODGE, JOHN HOPKINSON, and A. MUIRHEAD, Messrs. W. H. PREECE and HERBERT TAYLOR, Prof. J. D. EVERETT, Prof. A. SCHUSTER, Dr. J. A. FLEMING, Profs. G. F. FITZGERALD, G. CHRYSTAL, and J. J. THOMSON, Messrs. R. T. GLAZEBROOK (secretary), W. N. SHAW, and T. C. FITZPATRICK, Dr. J. T. BOTTOMLEY, Prof. J. VIRIAMU JONES, Dr. G. JOHNSTONE STONEY, Prof. S. P. THOMPSON, and Mr. G. FORBES.

APPENDIX.

I.—Report of the American Delegates at the Chicago Conference to the Secretary of State at Washington.

II.—Experiments on the Value of the Ohm, by J. Viriamu Jones.

III.—Comparison of the Standards employed by Prof. Jones with the Standards of the Association, by R. T. Glazebrook.

IV.—Comparison of some of the Standards of the Board of Trade with those of the Association, by J. Rennie.

V.—Values of Certain Coils belonging to the Indian Government, by E. O. Walker.

VI.—On the Specific Resistance of Copper and of Silver, by Rev. T. C. Fitzpatrick.

The work of testing resistance coils at the Cavendish Laboratory has been continued. A table of the coils tested is given.

TABLE—OHMS.

Number of coil.	Value of coil.	Temperature (deg.)
Nalder 3,876 C.L.C. 376	·99916	14
Nalder 4,320 C L.C. 381	·99922	14·1
Nalder 4,322 C L.C. 382	·99743	15·6
White C.L C. 383 ...	1·00095	15 15
Nalder 4,087 C.L.C. 384	10 0079	17·35
Paul C.L.C. 385	·99993	13·7
Paul C.L.C. 386	10 0041	13·7
Paul C.L.C. 387	100 (1 – ·00059)	13·7
Paul C.L.C 388	1,000 (1 – ·00197)	14·2
Nalder 4,274 C.L.C. 389	·100050	15 2
Nalder 4,275 C.L.C. 390	·100053	15·2
Nalder 4,051 C.L.C. 391	·99988	13·4
Nalder 4 338 C.L.C. 393	·99902	13 6
Nalder 4,339 C.L C. 394	·99916	13 7
Nalder 4,302 C.L C. 395	·99925	14 8
Nalder 4,303 C.L C. 396	·99933	14·6
Nalder 4,304 C L.C. 397	·99932	14·6
Nalder 4 273 C.L C. 398	·99908	13·55
Nalder 4,555 C.L.C 399	·99923	13 9
Nalder 4,562 C.L C 400	·99938	13·9
Nalder 4,556 C.L C 401	9·9929	13·8
Nalder 4,559 C.L.C. 402	9·9924	13·8
Nalder 4 563 C L C. 403	9·9935	13 8
Nalder 4 557 C.L.C. 404	100 (1 – ·00097)	14·1
Nalder 4 560 C.L.C. 405	100 (1 – ·00113)	14·2
Nalder 4 564 C.L.C. 406	100 (1 – 00093)	14·1
Nalder 4,565 C L.C. 407	100 (1 – ·00003)	14·2
Nalder 4,558 C.L.C. 408	1,000 (1 – 00126)	13·9
Nalder 4 561 C L C. 409	1,000 (1 – ·00092)	14
Nalder 4,566 C.L C. 410	1,000 (1 – ·00007)	13·9
Paul 15 C.L.C. 411 .. .	·99950	14·7
Paul 27 C L.C. 412	1·00016	16·4
Paul 13 C L C. 413	9·9973	14·8
Paul 19 C L.C. 414	10·0038	14 75
Paul 30 C.L.C. 415	100 (1 – 00091)	14·15
Paul 29 C.L.C. 416	1,000 (1 – ·00094)	14·1
Burstall C.L.C. 417 . ..	1·00026	13 4
Elliott 307 C.L.C. 418 ...	·99971	13 4
Nalder 4,340 C L C. 419	1·00009	16·85
Paul 20 C.L.C. 420	·99760	16 4
Paul 32 C.L.C. 421	9·9997	16·5
B.A. Units.		
Elliott 87 C.L.C. 81	1·00080	16·7
Muirhead C.L.C. 392	·99996	13·7

The committee regret that the insulation of some of the coils referred to in their last report which had been selected for the new standards of resistance, as defined by the resolutions adopted at Edinburgh, has proved defective. Traces of acid have been discovered in the paraffin with which the coils were filled. The two one-ohm standards of the association (Report 1893, p. 3), as well as two of the one-ohm standards of the Board of Trade (Report 1892, p. 3), were found in January last to have so low an insulation resistance between the coil and the case as to be useless. Thus the labour spent in the testing of these coils has been wasted; much of it will need to be done again.

The insulation of some of the other standard-ohm coils is not satisfactory; the single-ohm standards have, therefore, been remade, and the others are being refilled with carefully selected paraffin. The original B.A. units have not, so far as comparisons between them can show, changed their values during the year, and one set of new ohm standards also have shown no sign of change.

The committee print, as an appendix to the report, the report of the proceedings at the international congress at Chicago presented to the Secretary of State at Washington by the American delegate to the conference.

During the year Prof. J. V. Jones has determined by the aid of his Lorenz apparatus the absolute resistance of certain wire coils of about ·1 ohm. These have been compared with the standard of the association by the secretary. An account of these experiments is contained in Appendices II. and III. The resistance standards of the association have been compared with

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those of the Board of Trade by Mr. Rennie and the secretary. Details of this comparison will be found in Appendix IV., while in Appendix V. is given by Mr. E. O. Walker an account of a comparison between five coils belonging to the Indian Government, which have been 24 years in India, and Dr. Muirhead's standards. Mr. Fitzpatrick has continued his work on the specific resistance of copper, and has drawn up a table (see Appendix VI.) reducing to the same units experimental results recently obtained by various observers. Appendix VII.* contains an account of a special form of standard of low resistance devised by Prof. Jones. In consequence of the difficulty met with in the insulation of some of the coils, it was thought well to defer the purchase of other coils for which the grant of £25 was obtained last year. The committee are of opinion that it is desirable to complete their set of standards by obtaining from Germany certified copies of the standards of the Reichsanstalt. They recommend therefore that they be reappointed, with the addition of the name of Mr. Rennie, with a grant of £25; that Prof. G. Carey Foster be chairman, and Mr. R. T. Glazebrook secretary.

APPENDIX I.

Report of the Action of the International Electrical Congress held in Chicago, August, 1893, in the Matter of Units of Electrical Measure.

Washington, D. C., November 6, 1893.

The Hon. W. Q. Gresham,
Secretary of State, Washington, D.C.

SIR,—The undersigned, having been designated by you on May 12, 1893, as delegates to represent the United States in the International Electrical Congress to be held in August at Chicago, beg to submit herewith a brief report showing the definitive action of said congress in the matter of defining and naming units of electrical measure. The consideration of this important subject was left to what was known as the "Chamber of Delegates" of the congress, consisting only of those who had been officially commissioned by their respective Governments to act as members of said Chamber. After conference and correspondence with the leading electricians of Europe, it had been agreed that the maximum number of such delegates to be allowed to one nation should be five, and this number was allotted to the United States, Great Britain, Germany, and France. Other nations were allowed three or two, and in some instances one. Delegates present and taking part in the discussions and action of the Chamber were as follows:

Representing the United States.—Prof. H. A. Rowland, Johns Hopkins University, Baltimore, Md.; Dr. T. C. Mendenhall, superintendent of U.S. Coast and Geodetic Survey, and of Standard Weights and Measures, Washington, D.C.; Prof. H. S. Carhart, University of Michigan, Ann Arbor, Mich.; Prof. Elihu Thomson, Lynn, Mass.; Dr. E. L. Nichols, Cornell University, Ithaca, N.Y.

Representing Great Britain.—W. H. Preece, F.R.S., engineer-in-chief and electrician, Post Office, England, president of the Institution of Electrical Engineers, London; W. E. Ayrton, City and Guilds of London Central Institution, Exhibition-road, London; Prof. Silvanus P. Thompson, D.Sc., F.R.S., principal of the City and Guilds Technical College, Finsbury, London; Alex. Siemens, 12, Queen Anne's-gate, Westminster, London, S.W.

Representing France.—E. Mascart, membre de l'Institut, 176, rue de l'Université, Paris; T. Violle, professeur au Conservatoire des Arts et Métiers, 89, Boulevard St. Michel, Paris; De la Touanne, telegraph engineer of the French Government, 13, rue Soufflot, Paris; Edouard Hospitalier, professeur à l'École de physique et de chimie industrielle de la ville de Paris; vice-president de la Société internationale des Eléctriciens, 6, rue de Clichy, Paris; Dr. S. Leduc, 5, quai Fosse, Nantes.

Representing Italy.—Comm. Galileo Ferraris, professor of technical physics and electrotechnics in the R. Museo Industriale, Turin, Via Venti Settembre, 46.

Representing Germany.—H. E. Hermann von Helmholtz, präsident der Physikalisch-technischen Reichsanstalt, professor a. d. Universität, Berlin, Charlottenburg bei Berlín; Dr. Emil Budde, Berlin N.W., Klopstockstrasse 53; A. Schräder, Regierungsrath, Mitglied des Kaiserl. Patentamts, Berlin; Dr. Ernst Voit, professor an der technischen Hochschule, München, Schwanthalerstrasse 73-3; Dr. Otto Lummer, Mitglied der Physikalisch-technischen Reichsanstalt, Charlottenburg, Berlin.

Representing Mexico.—Augustin W. Chavez, city of Mexico.

Representing Austria.—Dr. Johann Sahulka, Technische Hochschule, Wien.

Representing Switzerland.—A. Palaz, professeur, Lausanne; René Thury, ingénieur, Florissant, Genève.

Representing Sweden.—M. Wennman, Byrachef i Rougle Telegrafstyrelsen, Stockholm.

Representing British North America.—Ormond Higman, electrician, Standards Branch, Inland Revenue Department, Ottawa.

His excellency Dr. H. von Helmholtz was made honorary president of the congress; Dr. Elisha Gray, of Chicago, was chairman of the General Congress; and Prof. H. A. Rowland, of Baltimore, was president of the Chamber of Delegates.

Meetings of the Chamber continued during six days, at the end of which its members unanimously agreed in the adoption of the following resolution:

Resolved, That the several Governments represented by the delegates of this International Congress of Electricians be, and they are hereby, recommended to formally adopt as legal units of electrical measure the following: As a unit of resistance, the *international ohm*, which is based upon the ohm equal to 10^9 units of resistance of the C.G.S. system of electromagnetic units, and is represented by the resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice 14·4521 grammes in mass, of a constant cross-sectional area and of the length of 106·3 centimetres.

As a unit of current, the *international ampere*, which is one-tenth of the unit of current of the C.G.S. system of electromagnetic units, and which is represented sufficiently well for practical use by the unvarying current which, when passed through a solution of nitrate of silver in water, and in accordance with accompanying specifications,* deposits silver at the rate of 0·001118 of a gramme per second.

As a unit of E.M.F., the *international volt*, which is the E.M.F. that, steadily applied to a conductor whose resistance is one international ohm, will produce a current of one international ampere, and which is represented sufficiently well for practical use by $\frac{1000}{1434}$ of the E.M.F. between the poles or electrodes of the voltaic cell known as Clark's cell, at a temperature of 15deg. C., and prepared in the manner described in the accompanying specification.†

As a unit of quantity, the *international coulomb*, which is the quantity of electricity transferred by a current of one international ampere in one second.

As a unit of capacity, the *international farad*, which is the capacity of a condenser charged to a potential of one international volt by one international coulomb of electricity.

As a unit of work, the *joule*, which is equal to 10^7 units of work in the C.G.S. system, and which is represented sufficiently well for practical use by the energy expended in one second by an international ampere in an international ohm.

As a unit of power, the *watt*, which is equal to 10^7 units of power in the C.G.S. system, and which is represented sufficiently well for practical use by the work done at the rate of one joule per second.

As the unit of induction, the *henry*, which is the induction in a circuit when the E.M.F. induced in this circuit is one international volt, while the inducing current varies at the rate of one ampere per second.

The Chamber also voted that it was not wise to adopt or recommend a standard of light at the present time.

A more complete report of the operations of the Chamber will shortly be forwarded. This brief *résumé* of its definite action in reference to the matter of units is now submitted to facilitate the prompt dissemination among representatives of foreign Governments of the important results of a congress of whose success and fruitfulness the United States may justly be proud.

H. A. ROWLAND. ELIHU THOMSON.
T. C. MENDENHALL. E. L. NICHOLS.
H. S. CARHART.

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* We are unable to publish this in this issue.

* In the following specification the term silver voltameter means the arrangement of apparatus by means of which an electric current is passed through a solution of nitrate of silver in water. The silver voltameter measures the total electrical quantity which has passed during the time of the experiment, and by noting this time the time average of the current, or if the current has been kept constant, the current itself, can be deduced. In employing the silver voltameter to measure currents of about one ampere, the following arrangements should be adopted: The cathode on which the silver is to be deposited should take the form of a platinum bowl not less than 10 centimetres in diameter and from 4 to 5 centimetres in depth. The anode should be a plate of pure silver some 30 square centimetres in area and 2 or 3 millimetres in thickness. This is supported horizontally in the liquid near the top of the solution by a platinum wire passed through holes in the plate at opposite corners. To prevent the disintegrated silver which is formed on the anode from falling on to the cathode, the anode should be wrapped round with pure filter paper, secured at the back with sealing-wax. The liquid should consist of a neutral solution of pure silver nitrate, containing about 15 parts by weight of the nitrate to 85 parts of water. The resistance of the voltameter changes somewhat as the current passes. To prevent these changes having too great an effect on the current, some resistance besides that of the voltameter should be inserted in the circuit. The total metallic resistance of the circuit should not be less than 10 ohms.

† A committee, consisting of Messrs. Helmholtz, Ayrton, and Carhart, was appointed to prepare specifications for the Clark's cell. Their report has not yet been received.

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APPENDIX II.

On a Determination of the International Ohm in Absolute Measure.

BY PROF. J. V. JONES, F.R.S., PRINCIPAL OF THE UNIVERSITY COLLEGE OF SOUTH WALES AND MONMOUTHSHIRE, CARDIFF.

The apparatus for the absolute measurement of electrical resistance in my laboratory at Cardiff was completed in 1890, and I first used it for the determination of the specific resistance of mercury in absolute measure (*Phil. Trans.*, 1891, A). This determination was made by direct measurement on a mercury column contained in a trough of paraffin wax. The results of five complete sets of observations were as follows :

94103
94074
94093
94045
94021

The mean of these is 94067 ; and the extreme variation from the mean is 46, or about four parts in 10,000.

I suspected that much of the variation was due to the paraffin trough, the temperature of which varied slightly (about half a degree) during the observations, and was not accurately measurable owing to the low conductivity of the material. With variation of temperature there was variation of breadth, and the breadth of the trough entered as a primary factor into the calculation of the specific resistance.

When I proceeded to use the apparatus for the measurement of low-resistance standards of solid metal this was conclusively shown to be the case. I brought a set of measurements made on such a standard under the attention of the section last year (at Nottingham), in which the extreme variation from the mean was only about one part in 12,000.

This may be taken to be the normal performance of the apparatus, and seeing that it is an instrument of such precision it seemed to me of interest to determine by the use of solid metal standards the relation between its indications and the results obtained by other observers for the value of the ohm.

With this end in view I obtained four coils from Messrs. Nalder Bros.—two platinum-silver 10-ohm coils, and two manganine tenth-ohm coils. Mr. Glazebrook has measured them in terms of the international ohm ; and I am much indebted to him for the pains he has been kind enough to take in making the determination. The following table gives their resistances and temperature coefficients :

Coil number.	Resistance in I. O. (Glazebrook).		Temperature coefficient (Nalder).
3,873	9 9919	at 14° 8 C.	·000300
3,874	9 9926	,, 14° 9 C.	·000276
4,274	·100050	,, 15° 2 C.	·000013
4,275	·100053	,, 15° 2 C.	·000013

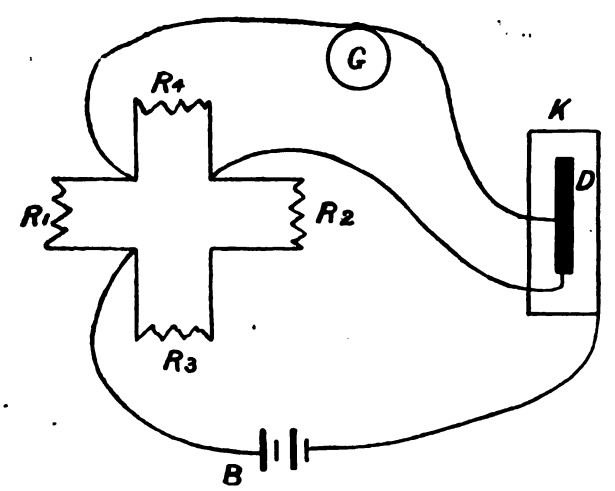

FIG. 1.

These coils were arranged in manner similar to that adopted by Lord Rayleigh in his determination of the ohm by the method of Lorenz (see Fig. 1). If there is no current through the galvanometer, there is equality between the E.M.F. due to the rotation of the disc in the field of the standard coil and the E.M.F. due to the current through R_4 ; and we have, if R_1, R_2, R_3, R_4 are the values of the four resistance coils in international ohms, and if x is the value of the international ohm in absolute measure,

$$\frac{R_2 R_4 x}{R_1+R_2+R_3+R_4} = M n,$$

where M = the coefficient of mutual induction of the standard coil and the circumference of the disc, and n = the rate of rotation of the disc.

The resistance coils are of B.A. pattern. They were immersed in water, and the temperatures of the thermometers within the coil frames were read before and after each observation. A wooden box surrounded the four cans containing the coils.

The method of making the observations was the same as that described in the paper I read before the section last year (*vide* Electrical Standards Committee Report, 1893). In making them the rate of rotation of the disc is controlled with reference to a tuning-fork with riders electrically maintained in vibration, and it is measured on the tape of a Bain's electro-chemical telegraph receiver, on which the make and break of a platinum wire over a mercury-cup worked by an eccentric lever attached to the axle record the turns of the disc side-by-side with the time record of the laboratory clock.

At the same time, the observer at the galvanometer continually reverses the direction of the main current, and calls out the corresponding galvanometer readings. As a result, we have for each set of observations :

(1) The temperatures of the coils.
(2) The rate of rotation of the disc.
(3) The change of galvanometer ready consequent on reversal of the current obtained as the mean from a number of reversals proportional to the time during which the observation lasts. This time has, in the observations to be brought before the section to-day, been either one minute or three minutes—generally three.

The change of rate of rotation corresponding to a change of one division on reversal was previously determined, and hence from each set of observations the speed corresponding to the true equilibrium position could be calculated. The results are as follows, the figure in each case giving the value of the international ohm in true ohms :

July 7.—Standard coil carefully adjusted. Three minutes tapes :

·999703
·999761
·999806
·999758

Mean ·999757

July 9.—No readjustment of standard coil. One minute tapes.

999757
·999711
·999683
·999782

Mean ·999733

July 10 (morning).—Standard coil readjusted. One-minute tapes.

·999734
·999818
·999726

Mean ·999759

July 10 (afternoon).—No readjustment of standard coil. Three minutes tapes.

·999708
·999742
·999764

Mean ·999738

July 11 (afternoon).—Standard coil readjusted. Three minutes tapes.

·999693
·999692
·999679

Mean ·999688

July 12 (morning).—No readjustment of standard coil. Resistance coils reversed.

·999713
·999711
·999692

Mean ·999705

July 12 (afternoon).—Standard coil readjusted. Resistance coils removed from the mercury-cups and replaced. Three minutes tapes.

·999774
·999787
·999759

·999773

July 13 —Standard coil readjusted. Resistance coils removed from mercury-cups and replaced. Three minutes tapes.

·999847
·999809
·999782
·999842 (morning of the 14th)

·999820

July 14 (morning).—Standard coil readjusted. Resistance coils removed and replaced. Three minutes tapes.

·999695
·999692
·999717

·999701

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July 14 (afternoon).—Standard coil readjusted. Resistance coils removed and replaced. Three minutes tapes.

·999853
·999866
·999875

·999865

It is clear that in the above series the chief variations are due to changes consequent on readjustment of the standard coil and the removal and replacement of the resistance coils in their mercury-cups. Counting as independent only those of the observations before which there was readjustment of the standard coil or removal of the resistance coils from the mercury-cups, the general mean is

·99976.

The maximum variation from the mean is ·000106, or about one part in 10,000.

Assuming that the international ohm is the resistance of a column of mercury at 0deg. of one square millimetre sectional area, and 106·30cm. long, we have as a result of the above measurement that the true ohm is the resistance of a column of mercury of the same sectional area and 106·326cm. long.

The figure I arrived at in 1890 working direct on mercury was 106·307, with a probable error of ·011. The new result is, therefore, a little larger than I was prepared for. The accuracy of the result depends primarily on :

(1) The accuracy with which the resistance coils are known in terms of the international ohm.

(2) The accuracy with which their temperatures are known at the times of observation.

(3) The accuracy with which the coefficient of mutual induction of the coil and disc has been determined.

Upon the first point I can say little. Mr. Glazebrook knows better than anyone to what figure the values of the resistances may be relied on.

The effect of error in the estimation of the temperatures of the coils can be but slight. The observations have been made in two ways—viz., with one-minute tapes, the current being put on only during the time of observation, and with three-minute tapes, the current being kept on continuously, whether observations were being made or not. During the last few days of the observations the current was kept passing through the coils night and day. I have calculated the effect that would be produced on the result obtained with one-minute tapes if all the heat generated by the current were to remain in the coils—an extreme case obviously less favourable than the actual conditions. It is something less than two parts in 100,000. The smallness of the effect is due to the fact that if x is the main current, a current equal to $\frac{200}{201}x$ passes through the tenth ohm maganine coil with its small temperature coefficient, and only $\frac{1}{201}x$ through the platinum-silver coils, while the effect of underestimating the temperature of the manganine tenth ohm coil is to produce an error in the result opposite in sign to that produced by underestimating the temperature of the platinum-silver coils.

There cannot, then, in the case of the one-minute tape observations be an appreciable error due to underestimation of the temperature. But the first four sets of observations show that the results of the one-minute tape observations and the three-minute tape observations are practically the same. Hence, it follows that to the degree of accuracy aimed at our results are unaffected by errors due to underestimation of the temperature.

It remains to consider the accuracy with which the coefficient of mutual induction of the coil and disc is known. To calculate this coefficient we must know the radius of the disc and the mean radius of the coil. The circumference of the disc is a sufficiently true circle, the disc having been ground true in place. The measurement of its diameter presented no difficulty. It was determined on my Whitworth measuring machine to the ten-thousandth of an inch.

The mean radius of the coil cannot be determined with the same accuracy, but I believe that it is known to the thousandth of an inch. The coil consists of a single layer of silk-covered wire wound in a screw thread cut on a brass frame. It was measured along 18 diameters in the Whitworth machine, with the results shown in Table 1.

The measures clearly show that the coil is elliptical in section, the difference between the major and minor axis being about ·008in.. or about one part in 1,300.

In considering the possible effect of this ellipticity on the result, it must be borne in mind that the formula $R = M n$ implies that the coil is circular. The true formula is $R = 2\pi n \int_a^b \frac{r}{H} H\, d\, r$, where a and b are the distances from the centre of the disc at which the internal and external brushes are applied, and H is the magnetic force at a distance, r, from the centre when unit current is passing through the coil.

This is an unpleasant integral for an elliptical coil, and it has not yet yielded to persuasion. It is, however satisfactory to note that as in my apparatus the brush radius makes but a small angle with the minor axis (about 15deg.), I am, in so far as the ellipticity of the coil affects matters at all, underestimating the integral, and hence underestimating the international ohm. Any correction for ellipticity hereafter calculated will make the value of the international ohm deduced from any observations nearer, and not further, from the true ohm.

It is further to be noticed that the formula $R = M n$ applies only if there is exact coincidence of the axes of the disc and coil. It has been customary to consider the adjustment for centre as of secondary importance in Lorenz's method. It would be so if the formula $R = M n$ were applicable when the centres of coil and disc do not coincide, for a slight displacement only affects the coefficient of mutual induction to a secondary degree. But we are not concerned with the coefficient of mutual induction in this case. We are concerned with another integral—viz., $2\pi \int_a^b \frac{r}{H} H\, d\, r$; and the adjustment for centre is, in truth, of primary importance. Special attention should, therefore, be paid to it in designing apparatus for the absolute measurement of resistance by this method.

One other point remains to be noticed in this connection—viz., the possible effect of the difference of the temperatures of the coil and disc when measured and when in use. On calculating the correction to be applied for this cause I find it negligible.

Again, I would say, as I said last year, that the chief value of these observations consists in the proof they afford of the precision with which the absolute measurement of resistance may be made by this method. A well-constructed apparatus of the kind in a national laboratory—say the laboratory of the Board of Trade—will, I believe, prove to be the best ultimate standard of electrical resistance.

TABLE 1.

Diameter.	Measurements.
0 – 180	21·0898
10 – 190	21·0929
20 – 200	21·0951
30 – 210	21·0933
40 · 220	21·0960
50 – 230	21·0998
60 – 240	21·1017
70 – 250	21·1026
80 – 260	21·1044
90 – 270	21·1038
100 – 280	21·1056
110 – 290	21·1041
120 – 300	21·1014
130 – 310	21·0979
140 – 320	21·0945
150 – 330	21·0924
160 – 340	21·0900
170 – 350	21·0910
Max. 21·1056	Mean 21·09757
Mm. 21·0898	t = 17deg. C.
·0158	

APPENDIX III.

Comparison of the Standard Coils Used by Prof. Jones with the Standards of the Association.

BY R. T. GLAZEBROOK.

The tenth-ohm standards of manganin wire whose value in absolute measure was determined by Prof. Jones by means of the experiments described in Appendix II., were compared with the standards of the association in the following manner : A Wheatstone's bridge was formed in which the arms were the tenth ohm to be tested, two single-ohm coils and a 10-ohm coil. If the coils had these values exactly, there would, of course, always have been a balance ; since, however, the coils were not accurately correct, there was usually a small current through the galvanometer. The balance, however, could be obtained by placing a large resistance as a shunt either to one of the one-ohm coils or to the 10-ohm coil. This resistance, which varied from 10,000 to 20,000 ohms, was taken from a good box of coils. The resistances of the 10-ohm and of the two one coils being known, that of the tenth-ohm coil could readily be found.

The four coils dipped into four mercury-cups cut in an ebonite block ; the bottoms of these cups were copper pieces some 3mm. to 4mm. thick. Binding screws screwed into these copper pieces, and rising above the mercury, serve to connect the bridge to the galvanometer and the battery.

The mercury-cups were somewhat large, about 2·5cm. in diameter, and it was found on January 16 that distinct differences could be observed by moving the tenth-ohm coils slightly, so as to bring their terminals either close to or as far as possible from the feet of the one-ohm coils which dipped into the same cups. After this date these two sets of measurements were made for each coil at each observation : in the one the terminals

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of the coils in any cup were put as close together as possible; in the other the terminals of the ·1-ohm coils were placed at some distance from those of the other coil in the same cup.

Both sets of values are given in the table as a means of showing the delicacy of the observations and the error arising from this cause. The tenth-ohm coils were weighted so as to press firmly on to the copper bottoms. Now variation was produced by shifting the 10-ohm coil in its cup.

One or two Leclanchés were used in the various experiments, the coils were in water baths, and the temperature read by a standardised Kew thermometer.

The standard coils used were:

Elliott 264 = 1 + ·000312 (t − 15·45).
Nalder 3,715 = 1 + ·00026 (t − 14·95).
Elliott 289 = 10 + ·00260 (t − 15·4).

The results of the experiments are given in the following table. In the results of the experiments made after January 15 the two values given correspond to the two positions of the coil in the mercury-cup. They are included to show the magnitude of the error which may be due to the resistance of the copper bottoms of the cup.

TABLE GIVING VALUES OF NALDER No. 4,274, [C.L.C. No. 389, IN TERMS OF THE OHM STANDARDS OF THE ASSOCIATION.

Date.	Temperature (deg.).	Value of resistance.	
December 29, 1893	14·4	·100052	
January 13, 1894	15·2	·100051	
,, 15, ,,	14·8	·100056	
,, 16 ,,	15·5	·100051	·100056
,, 17 ,,	16·4	·100049	·100058
,, 27 ,,	16 9	·100057	·100066
February 20 ,,	14·1	·100036	·100041
March 17 ,,	14·1	·100045	·100046
Mean	15 2	·100050	·100054

Values of Nalder 4,275, C.L.C. 390.

Date	Temperature (deg.).	Value of resistance.	
December 29, 1893	14·6	·100059	
January 13, 1894	15	·100053	
,, 15 ,,	15	·100058	
,, 16 ,,	15·8	·100055	·100061
,, 17 ,,	16·4	·100051	·100059
,, 27 ,,	16·6	·100058	·100065
February 20 ,,	14·1	·100043	·100047
March 17 ,,	13·8	·100051	·100051
Mean	15·2	·100053	·100057

Thus the value of the coils at 15·2deg. are respectively for

C.L.C. 389, ·100050 ohm,

and for

C.L.C. 390, ·100053 ohm,

while in each case the resistance introduced by placing the contact-pieces of the tenth-ohm coils at some distance from those of the other coils is ·000004 ohm.

APPENDIX IV.

Comparison of Certain Ohm-Standards of the Board of Trade.

In the accompanying table are given the results of comparisons which I made on May 29 and 30, 1894, at the Cavendish Laboratory between the three unit coils

Elliott's No. 261,
,, No. 263,
Nalder's No. 3,876,

belonging to the Electrical Department of the Board of Trade, and the B.A. standards, Flat, F, G, and H.

No. 261 Coil.

B.A. coil.	Temp. of B.A. coil.	Temp. of B. of T. coil.	Observed value.	Chart* value.	Difference chart-observed.
Flat	12 54	12·58	·999156	·999142	− ·000014
F	12·53	12 45	064	106	+ 042
G	12·90	12 97	217	262	+ 045
No. 263 coil.					
Flat	12 50	12·53	·999136	·999140	+ ·000004
F	12 60	12·48	074	124	+ 050
G	12 80	12 98	217	271	+ 054
H	12·85	13 08	299	304	+ 005
No. 3,876 coil.					
Flat	12 60	12·45	·998808	·999,79	− ·000018
F	12·50	12·36	727	76	+ 049
G	12·70	12·23	697	74	+ 043
H	12·40	12·30	768	76	- 008

* The chart referred to, for No. 261 and No. 263 coils, is one supplied for these coils by Mr. Glazebrook, and is dated March, 1892. The chart referred to in the case of No. 3,876 was constructed from comparisons made by Nalder Bros. between it and their "master" coil, No. 3,717.

The bridge was of the Carey Foster pattern, constructed for the Department by Messrs. Nalder Bros. and Co., and the slide wire used was the one marked B, having a value of ·0000509 ohm per division.

A 100-ohm coil, Elliott's No. 291, was placed in parallel with the Board of Trade coil for each comparison; this being effected by a large mercury-in-paraffin bath.

Temperatures were measured by a mercury-in-glass thermometer, which had been standardised at Kew.

J. RENNIE.

Board of Trade Laboratory,
June, 1894.

APPENDIX V.

Table showing values of five standard coils, B.A. units, belonging to the Indian Government, as compared with Dr. Muirhead's standard at his laboratory. Standard used, Nr. 78, marked right at 15·7deg. C., taken as correct. This standard, tested April 27, 1893, against a Nr. 68 Glazebrook, gave a ratio $\frac{\text{coil}}{\text{standard}}$ of 1·00015 at 16deg. C., and 1·00018 at 15deg. 4 C.

Temperature of water, 20·2deg. C.

Number.	Marked right at.	Difference.	Correct at.
106 ...	15·1deg. C. ...	+ ·023 per cent. ...	15·0deg. C
108 ...	15·3deg. C. ...	+ ·126 per cent. ...	11·7deg. C.
110 ...	15·3deg. C. ...	− ·028 per cent. ...	16·6deg. C.
111 ...	15·5deg. C. ...	+ ·055 per cent. ...	13 9deg. C.
114 ...	15·1deg. C. ..	+ ·004 per cent. ...	15·6deg. C.

Apparatus used—one metre bridge of platinum-iridium wire with a supplementary coil at each end of 20,012mm.; suspended coil galvanometer, resistance 15 ohms (Muirhead and Co.'s); trough 45in. by 7¼in. by 5in., depth of water 2⅜in., quantity of water 6¼ gallons; battery used, one Hellesen's dry cell, Nr. 3; E.M.F. 1·4 volt.

The interest attaching to these tests lies especially in the fact that the standard coils have been exposed to the climate of Calcutta for 24 years. They were made, I understand, by Dr. A. Muirhead when in Dr. Matthiessen's laboratory, under the supervision of the latter.

In reducing the observations from 20·2 to the temperatures given it has been assumed that all the coils have the same temperature coefficient.

E. O. WALKER, C.I.E., M.I.E.E.,
(late Superintendent in the Government Telegraph Department in India).

APPENDIX VI.

On the Specific Resistance of Copper and of Silver.

BY REV. T. C. FITZPATRICK.

As lately several observers have published the results of measurements made on the specific resistance of copper, it may be worth while to collect these results together in tabular form.

The resistances of metals may be expressed in terms of equal weight or of equal volume—that is, as the resistance of a wire of the given material such that one metre of it weighs one gramme, or as the resistance between opposite faces of a cube of the material, each face of which is one square centimetre.

I have pointed out that Matthiessen* considered the first as the most satisfactory mode of expressing resistances, and for these results alone did he make all the actual experiments. The results for specific resistances were calculated from these, with the help of specific gravity values obtained in many cases from tables, and not determined directly for the wires used.

Only in the cases where considerable masses of the material are used can the specific gravity from this the cross-section of the wires be accurately determined. There is therefore an evident advantage in expressing results in terms of weight when the determination of the cross-section of the wires becomes unnecessary, and there is no reason why an accuracy of one in two or three thousand should not be attained.

Again, it is found that different samples of copper have different densities according to the method by which they have been prepared. In a table* which I published on a previous occasion the variation is from 8·86 to 8·95. Mr. Swan† gives a value as high as 8·9587.

From samples of copper of the same quality I have had wires drawn which differed in density. It was always found that the denser the copper the less is its resistance, and the difference affects much more the results expressed as specific resistances than when expressed as the resistance of a gramme per metre.

This is another reason for expressing the results in these terms at least as well as in specific resistances, and for actual practical purposes it is a question of weight rather than volume.

In the following tables the results are given for a temperature of 18deg. C. in C.G.S. units:

* B.A. Report, 1890, p. 129; *ibid.*, p. 125. † *Nature*, vol. l., p. 165.

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TABLE A.—Hard-Drawn Copper Wires.

Resistance of wire such that one metre weighs one gramme	Specific resistance per cubic centimetre.	Observer.
$1,550 \times 10^5$	1,743	Matthiessen.[1]
—	1 720	Swan and Rhodin.[2]
1,550	1,726	Fitzpatrick.[3]
1,527	1,708	,, (copper supplied by Messrs. Bolton).

TABLE B.—Annealed Wires.

Resistance of wire such that one metre weighs one gramme.	Specific resistance per cubic centimetre.	Observer.
1,516	1 704	Matthiessen.
—	1,681	Fleming and Dewar.[4]
—	1,680	Swan and Rhodin.
$1,488 \times 10^5$	1,665	Fitzpatrick (copper supplied by Messrs. Bolton).
1,488	—	(Wire sent by Mr. Swan.)

[1] B A. Report, 1864 [2] *Nature*, vol. l., p. 165. [3] B.A. Report, 1890, p. 125. [4] *Phil. Mag.*, vol. xxxvi., p. 287.

From Table A, it will be seen that Messrs. Swan and Rhodin obtained a value rather lower than that which I got for copper which I had prepared myself, and which expressed as the resistance of a wire one metre long weighing one gramme is identical with the value that Matthiessen obtained; but the resistance of all these specimens is distinctly greater than that of the copper kindly sent me by Messrs. Bolton, which seems to bear out the statement which I have previously made that it is impossible to prepare wires on the small scale which are of the same quality—*i.e.*, probably due to density—as the best specimens specially prepared by large manufacturers.

In Table B are given the results of measurements with three specimens of copper prepared by Mr. Swan. One was given to Messrs. Dewar and Fleming, a second was examined by Mr. Swan himself, and a third specimen he kindly sent to me; the quality of the copper in the three cases may therefore be expected to be the same.

The results of Messrs. Dewar and Fleming and Messrs. Swan and Rhodin are expressed only as specific resistances, whilst the result of my measurements is only given for a wire one metre long weighing one gramme. The weight of the copper wire, as measured, was only three grammes, and that does not allow the accurate determination of the specific gravity of the sample; the value I obtain for it is identical with that for the sample of annealed copper wire sent me by Messrs. Bolton.

If I consider it to have the same specific gravity as that sample (8·94), I get as its specific resistance in C.G.S. units, 1,665, a value distinctly smaller than that obtained by Messrs. Swan and Rhodin, whose result is practically identical with that of Messrs. Dewar and Fleming.

Not only may wires drawn from the same specimen of copper have different densities and different resistances, but the variation of that resistance with change of temperature is also different.

In the following table are given the temperature coefficients of various specimens of copper :

$$R_t = R_0 (1 + a\,t).$$

R_0	a.	Observer.
—	·00387	Matthiessen.[1]
1,561	·00428	Dewar and Fleming.[2]
1,603*	·00408	Swan and Rhodin.[3]
1,563	·00417	—
1,592*	·00405	Fitzpatrick.
—	·00406	Kennedy and Fessenden.[4]
—	·00364	Benoit.[5]

* Hard-drawn wires.

[1] B.A. Report, 1864. [2] *Phil. Mag.*, vol. xxxvi., p. 287. [3] *Nature*, vol. l., p. 165. [4] *Electricity*, vol. v., p. 165. [5] *Comptes Rendus*, vol. lxxvi., p. 345.

Influence of Annealing.—As is well known, annealed wires have a less resistance than hard-drawn wires; but the variation of resistance according as the wires are annealed or hard drawn differs considerably for different materials. For silver it is as much as 10 per cent., whereas for copper it is less than 3 per cent.

I have made observations from time to time on the resistance value of specimens of hard-drawn copper wire, all pieces of the same coil, which was sent me in 1889 by Messrs. Bolton and Son. Given the results of these measurements, it will be seen that a hard-drawn wire seems to fall in resistance with lapse of time; the coil of wire has been left laying in the laboratory, and has not been treated with any special care :

Date.	Temperature.	Resistance of wire one metre long weighing one gramme.
July, 1890	18deg.	$1,528 \times 10^5$
August 26, 1891	18deg.	1,525
March 7, 1892	18deg.	1,522
January, 1894	18deg.	1,520
July, 1894	18deg.	1,519

The fall in resistance is small, and for the period of nearly five years does not amount to more than one-third per cent. I have, for the sake of comparison, made a measurement of the resistance of a specimen of annealed copper wire sent me by the same firm, and for this the resistance value is identical with that obtained at a previous date :

Date.	Temperature.	Resistance of wire one metre long weighing one gramme.
October, 1889	18deg.	$1,488 \times 10^5$
July, 1894	18deg.	1,487·8

This, on the whole, is what one would expect. In the case of wires of other material the change would probably be greater, as the difference of resistance between annealed and hard-drawn copper wires is less than that for wires of other materials.

In my previous communication a method* of annealing was described which gave satisfactory results; the wire was packed in asbestos or fine carbon in a copper vessel, and heated for 24 hours.

The following results, amongst others, were obtained :

Hard-drawn at 18deg	Annealed. 18deg.	Difference.
$1,527 \times 10$	1,489	·39
1,526	1,488	·38

Matthiessen's values are :

1,550	—	—

Messrs. Swan and Rhodin give for the values of the specific resistances :

1,720	1,680	·40

I have recently been annealing copper wires by heating them in boiling paraffin (220deg), and at this temperature, after slow cooling, the wires seem to be completely annealed.

1,526	1,486	·40

A wire sent me as annealed gave the result :

—	1,488	—

This wire was then hardened and reannealed, and gave the above-described value :

—	1,489	—

Either of these two methods seemed to give satisfactory results. But for annealing silver wires completely the temperature of the paraffin bath is not sufficiently high, but from the results of my measurements for silver, for which the influence of annealing is very considerable, it could be seen that the results given for the first method are very consistent.

Silver.

Many of the older measurements for resistances and conductivities are expressed in terms of the resistance of pure silver. This was the case with Matthiessen's earlier results. Some measurements, therefore, made on silver wires are given, together with the results obtained by Matthiessen and Messrs. Dewar and Fleming for the sake of comparison.

Several samples of silver wires were supplied me by Messrs. Johnson and Matthey. One of these was stated to be absolutely pure. The results are expressed for wires weighing one gramme per metre :

	Hard-drawn.	Annealed.
Silver I.	(*a*) $1,816 \times 10^5$	$1,739 \times 10^5$
	(*b*) 1 814	1,741
	(*c*) 1,816	1,721
Silver II.	1,799	1,722
Silver III. pure	(*a*) 1,777	1,666
	(*b*) 1,773	1,666
	(*c*) 1,767	—

The difference between the values for the hard-drawn wires is probably due to the fact that they had to be further drawn down after I had received them to enable me to measure them on my bridge.

Matthiessen's values.	For wire one metre long weighing one gramme.	R. per c. cm.
Hard-drawn	$1,779 \times 10^5$	1,694[1]
Annealed	1 639	1,561

[1] Using the value 10·5 as the specific gravity of silver.

Messrs. Dewar† and Fleming give as the value for an annealed pure silver wire, 1,468 C.G.S. at 0deg. C., with the temperature coefficient of ·004; the value at 18deg. is, therefore, for the specific resistance, 1,574.

For most of the wires which I measured I determined the specific gravity. For the wires silver I. there is practically no difference between the values obtained for the annealed hard-drawn wires, the values varying from 10·496 to 10·511.

For the wires silver III. the values varied from 10·49 to 10·50; using the mean value, 10·495, I get for the specific resistances the following values :

	Hard-drawn wire.	Annealed.
Specific resistance in C.G.S. units at 18deg.	1,689	1,587

In the case of copper,‡ with increase of purity, there is a

* B.A. Report, 1890, p. 126. † *Phil Mag.*, vol. xxxvi. ‡ B.A. Report, 1890, p. 196.

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decrease in the difference in resistance between annealed and hard-drawn wires. With silver the reverse is the case :

Silver	I. Difference	75
	II. ,, ...	77
	III. ,, ...	107

The value that I obtained for the hard-drawn wire is very nearly the same as that given by Matthiessen, but he obtained a greater decrease in resistance on annealing. He states* that for different pieces of the same wire there was a variation of from 6 per cent. to 10 per cent., so that the difference between his value and that which I have obtained for the sample of pure silver is not greater than might be expected.

The considerable variations in all the values given above make it clear that the value of the specific resistance depends not simply on the purity of the material, but on a number of other factors, which will be different in the cases of different wires of the same material, and that, therefore, we cannot expect to attain to any great degree of accuracy in the determination of specific resistances.

WOODHOUSE AND RAWSON UNITED, LIMITED.

We quote the following from the *Financial News* of Tuesday's date :

"On Thursday last Mr. F. L. Rawson attended at Bankruptcy-buildings, before Mr. Registrar Hood, in order to put in his statement with regard to the affairs of the above Company. He was asked no questions by the Official Receiver on this statement. He said that he would like to thank the Official Receiver and his officials for the courtesy that had been shown to him since it had been found that there were no grounds for the statements that had been made against him. Mr. Rawson further asked for payment of his costs incurred during the public examination, and was requested to make such application upon resumption of the usual sittings.

"Mr. Rawson's statement consists of 129 pages of foolscap, together with many documents giving proof of various remarks made by him. With regard to the return of the guarantee fund, he showed that, even after allowing for no profits being made the last year, the surplus profits the first year were so large that the whole of the guarantee fund would have had to be returned—this being by the terms of the agreement. He gave particulars to show that had the guarantee fund not been returned in debenture stock, the debenture-holders, shareholders, and creditors of Woodhouse and Rawson United would have been worse off even under the special circumstances that had arisen. He went fully into the prospects of the Company, and claimed that the directors were not then over-sanguine. He put in various documents and letters as to the value of the different securities held by the Company at that date, and gave details of the 10 companies in which the United held securities, stating that three shareholders were chosen at the meeting in 1891 to examine the securities held by the Company, and they were perfectly satisfied. Most of the securities had a Stock Exchange quotation, none were taken over the market price, and in two cases they were taken below. Witness then put in a large amount of correspondence to show the care with which the valuations had been made, also correspondence to show that both the chairman (Sir Rawson Rawson) and he had gone carefully into the valuation of plant and stock, and had insisted upon large reductions, notwithstanding what the managers stated with regard to the values. As to the sole valuation which had been challenged—that of Kidsgrove—witness gave details to show that the plant and stock had been properly and carefully valued at the amount taken in the balance-sheet. Woodhouse and Rawson United had dealt with their patents in a conservative way, as they only put in new patents at the cost of the patent fees, and in 14 years the total cost of their patents would have stood in their books at under £2,000, whereas, in the ordinary course of business, by that time they would have considerably improved in value. He then dealt with the evidence of Mr. Stutchbury, and gave 17 instances in which he alleged that the statements of that witness were incorrect, referring to various documents for confirmation, and proving several of them from the witness's own letters at that date.

"With regard to Mr. Stutchbury's analysis of trading in 1890 and 1891, Mr. Rawson gave a large number of instances of mistakes in these analyses, and claimed that in 1890, when he had charge of it, there was a profit in every branch of the industrial business except one small one. Quotations were put in from various reports of meetings to show that the position with regard to industrial profits and profits made from the patent side of the business had been made clear to the shareholders. He stated that the industrial business of the Company largely increased in the first year, and had doubled by the end of the second year. Going into details of his interviews with Mr. Pixley, Mr. Rawson stated that that gentleman was most conservative and careful, and that all his proposals with regard to writing off and reducing valuations of plant, stock, patents, etc., were carried out; that Mr. Pixley had admitted that, owing to the Company's contract with him (Mr. Rawson) and Woodhouse and Rawson, Limited, they were obliged to value all the securities, which had been properly done, and to put them in the balance-sheet at the price of such valuation ; that in 1891, if this had not been done and the next year had turned out as well as was expected, even the shareholders who retained their holding in the Company would have had a right to complain, as it would have brought profits properly belonging to the year 1891 into the year 1892, and so largely increased his (Mr. Rawson's) commission. Witness drew attention to the large reserves after payment of this dividend, the amount shown in the books being £46,996, and stated that if they had not written off various items which they were allowed by the articles of association to carry forward, and had put in the shares at the quoted prices, instead of in some instances below those prices, this amount would have been increased to £66,362. Even if the value of the shares in the Phœnix Trust and the Epstein Company had been taken at Mr. Stutchbury's cost-price estimate, and the other unquoted shares at present break-up prices, it would have left a balance to reserve of £17,296, or £36,662 including the additional amounts. He did not see any difference between paper profits which were not realised and profits represented by plant or stock, for if the securities were in companies intrinsically sound, as was the case in Woodhouse and Rawson United, they improved in value, whereas plant and stock deteriorated. He gave details of the sales of shares and debentures amounting the previous year to over £100,000.

"With regard to the suggestion that he had over estimated the profits in the first year in order to get a larger commission, he gave instances of various sums, amounting to over £5,000, which had not been treated as profits that year, but which were profits, and turned out to be so the following year ; whilst the directors need not have written off that profit and loss the large sums they had. All the shares that they held at the date of the balance-sheet that year were actually sold and paid for before the dividend was paid, and they had cash profits sufficient to pay the dividend. With regard to the Phœnix Trust, he stated that Woodhouse and Rawson United refused to do a financial business, and that this company was formed to underwrite various companies, from the formation of which Woodhouse and Rawson made a profit which they would not otherwise have done. In showing that the directors were not unduly swayed by him he stated that the industrial business was taken out of his hands after the first year against his wish, and later, when it was being put into the hands of Mr. Stutchbury, he objected to the arrangement on the ground that Mr. Stutchbury had not had sufficient experience, and he (witness) offered personally to pay half the cost of a competent manager. Having given a number of instances where he had sacrificed himself in order to help the various companies, and his reasons for so doing, Mr. Rawson went into particulars to show that the United Company did not do a financial business, there only being five pieces of business that could be called financial, only two of these being strictly so-called. They never underwrote, never bought any shares in the market, never discounted acceptances for others, did not lend money, and, in fact, did not do a financial business in any way. Other electrical companies had just as much to do with the promotion of companies from which they made profits by undertaking contracts for works as Woodhouse and Rawson United, who had got profits from the sale of patents to four different companies. He then dealt with the report of the committee of consultation, giving 22 instances of statements made by them, nearly all of them of importance, which had turned out in the public examination to be incorrect, and concluded by giving the points against the directors which had been raised during the examination, and summarising the answers, which, he claimed, fully explained and refuted them."

ELECTRIC LIGHTING PROVISIONAL ORDERS.

BOARD OF TRADE REPORT.

We give below the report by the Board of Trade respecting the applications to and proceedings of the Board of Trade under the Electric Lighting Acts, 1882 to 1890, during the year ended June 29, 1894. The following is a list of the applications for provisional orders since the date of the last report, together with the title of order and description of area, the names of promoters, and how dealt with by the Board of Trade :

Aberdare Electric Lighting Order. A Portion of the District of the Aberdare Local Board.—J. C. Howell, Limited.—Order granted.

Barrow-in-Furness Corporation Electric Lighting Order. The Borough of Barrow-in-Furness. — The Corporation. — Order granted.

Bedford Electric Lighting Order. The Municipal Borough of Bedford. Bedford Electric Light Company, Limited.—The promoters failed to produce the consent of the local authority, or to satisfy the Board of Trade that it should be dispensed with, and the Board of Trade refused to grant the order.

Birmingham Electric Light and Power Order. A Portion of the City of Birmingham —Birmingham Electric Supply Company, Limited.—Order granted.

Buxton Electric Lighting Order. The Urban Sanitary District of Buxton.—The Local Board.—Order granted.

Chelmsford Electric Lighting Order. The Borough of Chelmsford.—Crompton and Co., Limited.—Order granted.

Chepping Wycombe Electric Lighting Order. The Municipal Borough of Chepping Wycombe.—The Corporation.—Order granted.

Chesterfield (Corporation) Electric Lighting Order. The Borough of Chesterfield.—The Corporation.—Order granted.

Phil. Trans., 1862, p. 7.

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Clonmel (Corporation) Electric Lighting Order. The Borough of Clonmel and portions of the District of the Clonmel Union.—The Corporation.—Order granted.

Collier-Marr Moss Side Electric Lighting Order. The Urban Sanitary District of Moss Side.—Collier-Marr Telephone and Electrical Manufacturing Company, Limited.—Order granted.

Grimsby (Corporation) Electric Lighting Order. The Borough of Grimsby.—The Corporation.—Order granted.

Guildford Electric Lighting Order. The Borough of Guildford.—Holloway Electricity Supply Company, Limited.—The local authority consented to the grant of the order subject to certain conditions as to purchase. These conditions the promoters were unable to accept, and the Board of Trade, for the reasons stated in the special report made by them and presented to Parliament, decided to grant the order.

Harrow Electric Lighting Order. The Urban Sanitary District of Harrow.—The Local Board.—Order granted.

Leyton Local Board Electric Lighting Order. The Local Government District of the Leyton Local Board.—The Local Board.—Order granted.

Monmouth Electric Lighting Order. The Municipal Borough of Monmouth.—The Corporation.—Order granted.

Oswestry Electric Lighting Order. The Borough of Oswestry.—Oswestry Electric Lighting and Power Company, Limited.—Order granted.

Peterborough Electric Lighting Order. The Municipal Borough of Peterborough.—The Corporation.—Order granted.

Plymouth Corporation Electric Lighting Order. The Borough of Plymouth —The Corporation —Order granted.

St. Austell Electric Lighting Order. The District of the St. Austell Local Board.—Veale and Co, Limited —Order granted.

St. Helens Corporation Electric Lighting Order. The Borough of St. Helens.—The Corporation.—Order granted.

Shropshire Electric Lighting Order. A Portion of the Borough of Shrewsbury.—Shropshire Electric Light and Power Company, Limited —Order granted.

Stirling Electric Lighting Order. The Royal Burgh of Stirling.—Caledonian Electric Supply Company, Limited.—The promoters failed to produce the consent of the local authority or to satisfy the Board of Trade that it should be dispensed with and the Board of Trade refused to grant the order.

Wakefield Corporation Electric Lighting Order. The City of Wakefield.—The Corporation.—Order granted.

West Hartlepool Electric Lighting Order. The Municipal Borough of West Hartlepool —The Corporation.—Order granted.

Yeadon Electric Lighting Order. The Urban Sanitary District of Yeadon —The Local Board.—Order granted.

The County of London :

Crystal Palace District Electric Lighting Order. Portions of the District of the Beckenham Local Board; the Borough of Croydon; the Parish of Lambeth; the District of the Lewisham District Board of Works; and the Parish of St. Giles's Camberwell.—Crystal Palace District Electric Supply Company, Limited —Order granted.

Of these applications (26 in number) 15 were made by local authorities and 11 by companies, only one relating to the county of London.

Bills Nos. 1 and 2, to confirm the orders relating to Barrow-in-Furness, Buxton, Chepping Wycombe, Chesterfield, Grimsby, Harrow, Leyton, Monmouth, Peterborough, St. Austell, St. Helens, and West Hartlepool were introduced into the House of Commons on April 16. Bills Nos. 3 4, and 5 to confirm the orders relating to Aberdare, Birmingham. Chelmsford, Clonmel, Crystal Palace district, Guildford, Moss Side (Collier-Marr). Oswestry, Plymouth, Shropshire (Shrewsbury), Wakefield, and Yeadon were introduced into the House of Lords on the following dates—viz., No. 3 on April 30, No. 4 on May 4, and No. 5 on May 7.

The Bills to confirm provisional orders granted by the Board of Trade last year, which were before Parliament at the date of the last report, all received the Royal assent.

In the following instances the Board of Trade have, since the date of the last report, approved deeds transferring to limited companies the powers, duties, and liabilities (with certain exceptions) under provisional orders granted to local authorities :

Aberystwith Electric Lighting Order, 1892. Originally granted to the Corporation of Aberystwith. Transferred to the Bourne and Grant Electricity Supply Company, Limited.

Chiswick Electric Lighting Order, 1891. Originally granted to the Local Board for the District of Chiswick. Transferred to the Bourne and Grant Electricity Supply Company, Limited.

Dover Electric Lighting Order, 1890. Originally granted to the Corporation of Dover. Transferred to the Dover Electricity Supply Company, Limited.

Scarborough Corporation Electric Lighting Order, 1891. Originally granted to the Corporation of Scarborough. Transferred to the Scarborough Electric Supply Company, Limited.

LICENSES.

The following applications for licenses have been received since the date of the last report, and have been dealt with in the manner shown below :

The Corporation of Bournemouth. The Borough of Bournemouth.—License granted April 16, 1894. (The license authorises the supply of energy for certain public purposes only).

The British Insulated Wire Company, Limited. The District of the Prescot Local Board.—Still under consideration.

The Collier-Marr Telephone and Electrical Manufacturing Company, Limited. The Urban Sanitary District of the Moss Side Local Board.—The promoters subsequently applied for a provisional order, and the application for the license was not proceeded with.

Of applications for licenses referred to in previous reports, that of the Shropshire Electric Light and Power Company, Limited, was granted on August 10, 1893, and that of the Crystal Palace District Electric Supply Company, Limited, on August 21, 1893. The Dundalk Electric Lighting License, 1886, the original term of which expired on July 1, 1893, was renewed by the Board of Trade for a period of three years from that date. Appended is a list of the provisional orders confirmed by Parliament (prior to the present session) and of the licenses granted by the Board of Trade since the passing of the Electric Lighting Act, 1882, showing those which have since been revoked or repealed.

THE RATING OF MACHINERY.

It has been a matter for comment that none of the semi-agricultural unions in the neighbourhood of the Chard Union have attempted to follow the example of the Chard Board of Guardians in trying to rate the machinery of the few scattered and struggling factories established in their districts. The very qualified success which attended the Chard authorities is probably the correct explanation of this state of things.

At last, however, the Tiverton Assessment Committee have been induced to attempt to increase the ratable value of the union by attacking the manufacturers who have for years brought business into the district and given employment to large numbers of the population.

Before the increased assessments came before the Assessments Committee, the clerk issued to every member a circular letter showing how the assessments in the Chard Union had been increased.

Among the firms attacked were Messrs. Fox Bros., of Wellington and Uffculme, who are among the founders of the Machinery Users' Association, which arose out of the notorious case of Fox and Co. *v.* Chard Union. The firms affected combined to resist the attack, and placed the matter in the hands of the Machinery Users' Association.

The Assessment Committee, however, remained obdurate, and, contemptuously declining an offer of arbitration, referred the appellants to their legal remedy of an appeal to the Quarter Sessions. July 31 was fixed by the Court as a special day to try the cases, but the Assessment Committee did not put in an appearance to support their valuations.

The appellants, who had had all the trouble and expense of getting up their cases, were duly represented by Mr. Edward Boyle (specially retained) and Mr. Cleare. The chief evidence relied upon was that of Mr. Humphreys-Davies, the consulting surveyor to the Machinery Users' Association, who was supported by Mr. Sheldon, J.P., and Mr. R. Howard Leaker, of Bristol. The Court, after going carefully into the merits of each case, allowed all the appeals with costs against the respondents.

This result is very encouraging to machinery users, and shows the value in these cases of combined action for mutual defence. It will be remembered that the difficulties as to the rating of machinery arose in the neighbouring town of Chard about seven years ago, and it is noteworthy to find that the Machinery Users' Association, which has been fighting the battle in the interval in all parts of the country, has now inflicted a signal defeat upon the Tiverton authorities in their attempt to reopen the contest in the West of England.

COMPANIES' MEETINGS.

CUBA SUBMARINE TELEGRAPH COMPANY, LIMITED.

The forty-sixth ordinary meeting of this Company was held on Wednesday at the offices, 58, Old Broad-street, under the presidency of Mr. T. Greenwood.

The **Chairman** moved the adoption of the report, which recommended a dividend on the ordinary shares at the rate of 8 per cent. per annum, leaving £3,429 to be carried forward. He said that the directors were pleased to be able to present so favourable a report. The expenditure and receipts were nearly the same as in the corresponding period of last year. Fortunately, they had had no repairs during the past half-year, so that that was the second period they had passed without repairs, while they had had payments in the previous year of £1,647 for repairs. They had also added £1,000 to reserve, as compared with £1,500 last year, against losses by deposits with banks, the result being that they were able to increase the amount carried forward to the reserve fund by £2,500, and also to improve their balance carried forward to the next half-year. That would be highly satisfactory to the shareholders, and they would have no difficulty in approving of the report and accounts submitted.

Mr. C. W. Parish seconded the motion, which was adopted.

THOMAS PARKER, LIMITED.

The statutory meeting of this Company took place last Friday at the registered offices in Wolverhampton, Mr. C. T. Mander (the chairman) presiding. After the usual formal business, a **Shareholder** enquired how the matter stood with the Electric

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Construction Company in respect to the Eickemeyer dynamo winding patents. The **Chairman** reported that the purchase of the Eickemeyer patents had been completed, and that the legal proceedings commenced by the Electric Construction Company remained as they were, but that his Board were considering the question of granting a license to the Electric Construction Company for the use of those patents on terms to be agreed. He informed the meeting that the works of Thomas Parker, Limited, were rapidly approaching completion, and that there was every prospect of the Company at once entering upon a large and remunerative business.

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Woodbridge.—The Local Board require tenders for street-lighting for 12 months.

Dundee.—Messrs. Urquhart and Small, of 17, Victoria-street, Westminster, S.W., are authorised by the Dundee Gas Commissioners to invite tenders for a steam-engine and dynamo, in connection with the supply of electric light. Copies of the specification and form of tender can be obtained from the above-mentioned firm. Tenders will be received by them on or before the 30th inst.

Birmingham.—Tenders are invited for the electric lighting of the glasshouses, etc., at the Botanical Gardens, Edgbaston, Birmingham. A copy of the specification may be obtained from Messrs. Henry Lea and Thornbery, 38, Bennett's-hill, Birmingham. Tenders must be sent in on or before September 1, addressed to Prof. Hillhouse, M.A., hon. sec., Birmingham Botanical and Horticultural Society, Botanical Gardens, Edgbaston, Birmingham.

RESULTS OF TENDERS.

London, W.—The tender of Messrs. Graham and Biddle, at £320, has been accepted for electric light fittings and heating apparatus, for Mr. Stephen Rath, at 32, Park-lane.

Hull.—On Monday the Hull Corporation Electric Lighting Committee accepted Mr. G. Strachan's tender for Kilnhurst coal at 13s. 8d. per ton of 21cwt. A new dynamo and engine were ordered to meet the growing requirements of the electric light station. These machines will be equal to supplying 6,280 8-c.p. additional lamps. The engine is from Messrs. Willans and Robinson, of London, at a cost of £1,247, and the dynamo from Messrs. J. H. Holmes and Co., of Newcastle, at a cost of £1,230. The steam-piping is being ordered in Hull.

Cheltenham.—The Electric Lighting Committee of the Town Council recently received for the supply of transformers nine tenders, which were handed to the electrician to examine and report. They were:

Brush Company	£394	15	0
Crompton and Co.	450	0	0
Electric Construction Company	455	10	0
Johnson and Phillips	468	0	0
Slade, Templeton, and Co.	500	0	0
Swinburne and Co.	522	0	0
C. A. Parsons and Co.	606	12	0
Siemens Bros. and Co.	677	0	0
J. Fowler and Co.	783	5	0

The electrician's report was subsequently considered, and the tender of the Brush Company was recommended for acceptance. The Town Council have since adopted this recommendation.

Electro-Chemical Company, Limited.—The tenders received for engines and dynamos for the first section of this Company's plant—viz., 1,000 e.h.p. with water consumption guaranteed under a penalty of £1,000 per pound of water, were as follows: Parsons and Co, two steam-turbines 15¾lb., 1,100 e.h.p., £4,800; Yates and Thom, horizontal engines and Holmes's dynamos 15¼lb., with extras, about £8,300; Willans and Robinson, four engines with Holmes's dynamos £9,700, four engines with Crompton's dynamos £9,950, four engines with Siemens's dynamos £9,980, four engines with Mather and Platt's dynamos £10,100; Electric Construction Company, four Willans engines and E.C.C. dynamos, 17·384lb., £10,023; Easton and Anderson, 17¾lb. (with extras) £8,816, Willans engines £10,850 to £11,140; Musgrave and Sons, engines only, 13½lb. per indicated horse-power, £6,224; Crompton four Willans engines, 17½lb., £10,780 to £11,140; Johnson and Phillips, dynamos only, £2,675. The water consumption is under 160lb. per square inch, and includes steam used for feed and condenser pumps. Messrs. Parsons and Co.'s tender was recommended for acceptance by the consulting electrician (Mr. Swinburne), and has been accepted by the directors. Mr. T. Beeley, of Hyde, Manchester, has secured the contract for the boilers.

Thetford.—The Town Council have accepted the gas company's tender for lighting the public lamp as usual. The committee had recommended an all-night lamp at the Bell corner, but as St. Peter's clock has been lighted with the electric light with great satisfaction, it was suggested that if instead of putting it out at 11.30 p.m. it could be continued till daylight it would dispense with the gas lamp and be cheaper, and this was recommended to the Lighting Committee to adopt, if arrangement can be so made. Permission was given the electric light and power company to carry some of their cables underground.

BUSINESS NOTES.

Margate.—Two companies propose to apply for electric lighting powers.

Arbroath.—The Corporation intend to oppose the application of the Northern Electric Supply Company.

Dewsbury.—The expenditure of £2,150 for lighting the workhouse by electricity has been sanctioned.

Western and Brazilian Telegraph Company.—The receipts for the week ended August 17 were £2,106.

Derby.—The St. John's Schools, which have been rebuilt at a cost of £2,000, will be lighted by electricity.

Dover.—The breaking up of the streets by the electric light company engaged the attention of the Town Council last week.

Broadstairs.—The Local Board do not intend to oppose the application of the County of London and Brush Provincial Company.

St. Saviour's, Southwark.—Messrs. Strode and Co. have obtained the contract for the electric lighting of the baths and washhouses.

Ship-Lighting.—The Japanese steamer "Islam," which has been detained on the Clyde under the Foreign Enlistments Acts, is lighted electrically.

Sheffield.—Mr. Edmund Welding intends to build a new theatre of varieties on the site of the Grand Theatre. It will be lighted by electricity.

Coventry.—The City Council have affixed the corporate seal to mortgages of the general district fund for raising £2,000 at 3½ per cent. for the electric lighting.

Personal.—Messrs. E. W. Dickenson and Mr. W. J. Piling have been appointed assistants to Mr. John H. Rider, electrical engineer to the Bolton Corporation.

Barrow-in-Furness.—The Town Council having obtained a provisional order, it is expected that a committee will shortly be appointed to push the matter forward.

West India and Panama Telegraph Company.—For the two weeks ended August 15 the receipts show a decrease of £225 as compared with the corresponding period.

Thurstonland.—The Local Board have granted permission to Mr. Mitchell to erect the necessary wires over the road at Brockholes for supplying electric light to his house.

Speller and Co., Limited.—This Company has been registered, with a capital of £5,000, to carry on business as manufacturers of lamps, etc., and of gas and electric light fittings.

Ariel Arc Lamp Syndicate, Limited.—This Company has been registered, with a capital of £20,200, in £10 shares, to carry on business as electricians and suppliers of electricity.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending 19th inst. amounted to £1,126, as compared with £822 in the corresponding week of last year.

Submarine Telephony.—It is stated that a company has been formed to develop a subaqueous telephone, and by means of gongs communicate between ships without the intervention of wires.

Lancaster.—The trustees of the Palatine Hall have decided to have the building lighted by electricity, and the arrangements of Mr. Barnard, the borough electrical engineer, have been adopted.

Rollason's Wind Motor.—A meeting of the shareholders of the Rollason's Wind Motor Company was held on Monday at Winchester House, Old Broad-street, E.C. The proceedings were private.

Llanelly.—The arrangements for lighting the Dafen Tinplate Works by electricity have been completed by Messrs. J. C. Howell and Co., and the works were illuminated by electricity for the first time on Monday.

Leeds.—A new building for the Yorkshire Penny Bank has been opened, with offices above. Electric lighting has been adopted throughout. Messrs. Dixon and Son, of Leeds, have done the electric light wiring.

Brush Electrical Engineering Company, Limited.—This Company notify that the transfer books of the 4½ per cent. debenture stock of the Brush Electrical Engineering Company, Limited, will be closed from August 25 to September 3, inclusive.

Appointments Vacant.—The Electric Lighting Committee of the county borough of Halifax require the services of an assistant electrical engineer and a foreman to take charge of the underground mains. Further particulars will be found in our advertisement columns.

Church-Lighting.—Messrs. Bennett and Druce, of Preston, have been instructed to instal the electric light in the Saul-street Chapel, Preston, together with the adjoining vestries, schoolrooms, classrooms, etc. The current will be taken from the supply company's mains.

Bath.—Messrs. Alex. McTavish and Co., of Old Bond-street, have secured the contract for the electric lighting of Messrs. Charles Bayer and Co's new factory at Oldlands Common, near Britton. The plant will comprise an engine, boiler, dynamo, and wiring for 120 16-c.p. lamps.

Cardiff.—On Tuesday evening a meeting of the Machinery, Electricity, and Local Industries Committee of the Cardiff Exhibition for 1895 was held at the Town Hall. The committee considered in detail the plans for their portion of the exhibition, and prepared a report to be laid before the general council.

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London-Platino Brazilian Telegraph Company, Limited.—The half-yearly coupons, due on September 1 next, of the £100,000 6 per cent. debentures, will be paid on and after that date by Messrs. Glyn, Mills, Currie, and Co., Lombard-street, E.C.

Carlisle.—The County of London and Brush Provincial Electric Lighting Company have given notice of intention to apply to Parliament next session for a provisional order to supply Carlisle with the electric light. The subject of the electric light is also under the consideration of the Gas Committee of the Town Council.

City and South London Railway.—The receipts of the Company for the week ended August 19 were £861, against £862 for the corresponding week of 1893, or a decrease of £1. The total receipts for the current period of the present half-year amount to £6,064, as against £5,928 in the corresponding period of 1893.

Warminster.—Owing to the success of the electric light on the fountain in the Market-place, it has been suggested to the Local Board that six more lights should be placed between the fountain and the obelisk, the cost of the necessary plant being estimated at £184. The matter has been referred to a committee for consideration and report.

Richmond (Surrey).—The Town Council have passed the payment of £105 to Messrs. Urquhart and Small for superintending the erection of the electric lighting works and the laying of mains, now completed. Councillor Heasler has undertaken to supply a statement showing the total expenses of the town in connection with the electric light.

Larne.—The Larne Town Commissioners have received a letter from Mr. J. W. M'Ninch, solicitor to the Board, enclosing a letter from Mr. J. D. A. Norris, receiver and manager for Messrs. J. E. H. Gordon and Co., Limited, electrical contractors for the town of Larne, in which Mr. Norris stated the agreement for the public lighting had been accepted by the Court.

Taunton.—Mr. Harold W. Couzens, the electrical engineer to the Town Council, reported to that body last week that during the past quarter the improvements and alterations suggested by Dr. Fleming had been completed, and had been examined and approved of by him. The new consumers connected to the mains during the past quarter make a total equivalent of 219 16-c.p. lamps.

Slough.—The Rural Sanitary Authority have received a letter from the Board of Trade enclosing a copy of a letter from the town clerk of Windsor applying on behalf of the Corporation for the revocation of the Windsor Electric Supply Order, 1890, and stating that, subject to any representations the Authority might wish to make, they proposed to revoke the order forthwith. The members resolved to take no further action in the matter.

Stafford.—The Town Council have accepted the tender of Messrs. Hart, Son, and Peard, at £47. 15s. 6d., for the supply of ornamental cast-iron window-frames at the electric lighting works, instead of the one sent in by the General Iron Foundry Company. A commemoration stone, bearing the Mayor's name and the date, is to be placed inside the works, and a tablet with the name of Alderman W. H. Peach, the chairman of the committee, is to be inserted in the chimney stack.

Sale of Stock.—In connection with Woodhouse and Rawson United, Limited, the whole of the stock, now at 88, Queen Victoria-street, E.C., and at Bradford, Birmingham, Glasgow, and Chiswick, consisting of dynamos, motors, distributing boards, switches, lamps, holders, cables, casing, electric and steam launches, and every requisite for electric lighting, is now open for inspection, and is for sale until September 30. Mr. F. D. Leslie, receiver and manager, 74, Coleman-street, E.C., will furnish particulars of the sale.

The War in the East.—The ss. "Islam" belonging to a Japanese firm, which has been seized on a warrant issued by the Foreign Secretary to the British Government, is being elaborately and carefully fitted up thoroughout with Messrs. Baird, Thompson, and Co.'s latest improved mechanical system of ship ventilation which is claimed to be capable of changing the whole atmosphere of the ship once every minute if necessary. This system can be used with closed hatches and everything battened down, is perfectly weatherproof, and under perfect control.

Wolverhampton.—The Corporation scheme for illuminating a central area of Wolverhampton with the electric light is nearing completion, the lines having been laid beneath the footways, and the generating station will be finished shortly. Out of the 22 competitors, Messrs. Fletcher and Hurst, of Burnley, have secured the contract for putting the necessary wires and the selected fittings into the municipal buildings. The amount of the tender, which was the lowest, was £609. 11s. The tender for the pendants and other fittings has not yet been agreed upon.

Worcester.—The Watch Committee have resolved to ask the Mayor (Mr. G. H. Williamson) to perform the ceremony of opening the electric light works at Powick on October 11. As ladies will be present at the exhibition at the Public Hall, it will be gracious to ask the Mayoress to open the exhibition. The Mayor observed that the Mayoress and himself would be pleased to do anything calculated to benefit the city. The Council have authorised certain alterations and improvements in the wiring and fittings of the Guildhall buildings for the electric light, at an additional cost of £18. 16s. 2d., and similar alterations at the Public Hall, at an additional cost of £14. 16s. 2d.

St. Austell.—The Local Board have had mentioned to them by Mr. B. Andrew that there had recently been many complaints by the inhabitants of the town being badly lighted. The matter was referred to the Lighting Committee, with a view to a rearrangement of the time of lighting the lamps. A letter from Messrs. Veale and Co. offered to supply the fountain lamp in Fore-street with an electric light at the rate of 2½d. per hour, a reduction of ½d. During the past year the hours during which the light had been used numbered 1,200, and it was pointed out that if the number was reduced to 853 at the stipulated price the cost would be £8 per year, the sum which the Board decided to pay for the light. The light would be 200 c.p. The offer was accepted.

Bromsgrove.—As mentioned in our last issue, the Town Local Board at their last meeting decided to consult the ratepayers as to the application of Messrs. Hemming and Co., Birmingham, for permission to lay down plant for electric lighting in the district, and in consequence notice was issued by Mr. Jeffries, chairman of the Board, convening a public meeting of ratepayers to be held at the Town Hall at 11 a.m. on Monday last, "to consider the subject of lighting the town by electricity." At the time appointed there was a considerable attendance of tradesmen, working-men, and others. Mr. D. Laing, who was voted to the chair, read letters from Messrs. A. Dipple, G. Bown, and C. Field (member of the Board) expressing dissatisfaction at the meeting being called at an inconvenient hour, and suggested evening as a more suitable time. The Rev. E. Vine Hall proposed the following Thursday (yesterday), and after other propositions had been made this was carried.

New Installations.—Messrs E. H. Berry and Pope, of Burnley, have received the contract for the electric lighting of the Corporation Technical School, Nelson. They have also received instructions for the electric lighting of the Empress Hotel, Burnley, where about 150 lights are to be installed; the Royal Oak Hotel and the Rose and Thistle Hotel, Burnley; besides several smaller installations in Southport, Nelson, Burnley, etc. The firm have lately supplied and fixed a gas-engine and dynamo and change-over switchboard for the G.W.O.O.F. Club, Keighley Green, Burnley. The club authorities are able to use either their own plant or the Corporation supply. The gas-engine is by Messrs. Tangyes, Limited, and capable of giving 16 b.h.p. The dynamo has been made by Messrs. Rosling and Matthews, of Bradford. The firm have also installed the electric light in the Union Club, Burnley, and the contract for supplying and fixing the electric light fittings for the art gallery, free library, and museum, for the Blackburn Corporation.

Hammers and Heating Forges.—Mr. H. F. L. Orcutt, of 145, Cannon-street, E.C., has sent us a copy of the illustrated list of hammers and heating forges made by Messrs. L. Loewe and Co., of Berlin. The drop hammers may be used to advantage in place of steam hammers for forging by hand. The cushioned helve hammer is recommended as an efficient and durable tool for making circular-formed stampings and for gun work, etc. The motion is imparted to the hammer through an eccentric and an adjustable connecting-rod. The eccentric is driven by means of a belt and a tightener, which is operated by a foot lever. The rapidity and weight of the blow depends upon the tension given the belt by this lever. A brake, which is connected with the foot lever, arrests the motion of the hammer as soon as the foot lever is released. The anvil rests on a separate foundation, so that the other parts of the machine are free from vibration. The forges are intended for heating a number of pieces at a time, where stampings are made from the ends of rods of material.

Monmouth.—A special meeting of the Corporation was held on Monday to consider the report of Messrs. Bramwell and Harris, C.E., London, as to the best and least expensive system of drainage and electric lighting in the borough. The report deals first with a scheme for sewage alone, which it is estimate would cost £12,000, equal to a rate of 1s. in the £ for 30 years. The second part of the report deals with a combined scheme of electric lighting and drainage, which would increase the first outlay to £17,600, but deducting the present cost of gas for public lamps, and adding the earnings of the 2,500 8-c.p. incandescent lamps (or their equivalent) provided for in the scheme for lighting public places and for private use, the work can be carried out at a cost of only 7d. in the £. The combined scheme was unanimously adopted, and a committee of four, with the Mayor as president, was appointed to arrange the details. The Chairman read a letter from Lord Llangattock, offering £100 a year for lighting the Hendre House by electricity, his lordship paying all cost of laying the mains.

Mill-Lighting.—The Chancelot Flour Mills, Edinburgh, which have been erected by the Scottish Co-operative Wholesale Society, Limited, are lighted by electricity. A small compound engine drives the dynamos, which are of 30 units each, made by Messrs. Mavor and Coulson, of Glasgow. Each machine is capable of lighting up the whole mill, the installation of which consists of 500 incandescent lamps of 16 c.p., and eight outdoor arc lamps. The wiring throughout the mill is on the concentric wire system. Messrs. E. H. Berry and Pope, of Burnley, have received instructions for a complete installation for the electric light for the Monton Mills Company, Sabden, Lancashire. This mill is being lighted throughout, including the weaving-shed. Two dynamos will be used, which will be driven from the large engine, and a 50-light machine will be driven from a donkey engine. The total number of lights to be installed is over 400. This firm have also received instructions to instal about 150 lights at the Hob-lane shed, Brierfield, near Burnley, for Mr. J. S. Veevers. The shed is not being lighted, but the remainder of the mill. The dynamos for the mills have been made by Messrs. Rosling and Matthews, of Bradford.

Fareham.—A special meeting of the Local Board has been held to discuss the agreement between the Board and the electric light company as to the purchase of the company's undertaking. The Clerk

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informed the Board that he had received a letter from the electric light company accepting the amended terms for the purchase of the works by valuation instead of for £5,000. He had had the agreement prepared accordingly. It set forth that the purchase was to be by valuation as a going concern, an arbitrator being appointed by each side, and should they not agree as to the price, the final decision to be given by an umpire. It was also stipulated that the company should lay down the mains in the greater part of West-street, underground, these mains being armoured cables. For this the Board would pay £1,000, receiving back any surplus there might be over the actual cost of the work, but not having to pay the company any additional cost over the £1,000. After some discussion it was agreed to fix the seal of the Board to the contract. The appointment of the Board's arbitrators was next considered. It was eventually agreed to appoint Dr. Fleming at a fee of 50 guineas, and failing him, Mr. Arthur Preece at a fee of 25 guineas.

Search-Light at Hawarden Castle.—A three days' fête was held last week in the grounds of Hawarden Castle, and was opened by the Right Hon. W. E. Gladstone, M.P. In spite of the somewhat unsettled weather it was a great success, and there will be a considerable sum to hand over to the credit of Hawarden Institute, etc., for the benefit of which it was held. Each evening the greatest interest and amusement was created by the powerful search-light, worked from the castle roof, which lighted up the grounds in a most picturesque manner, and caused roars of laughter when its searching rays disclosed two ardent lovers who little thought that their quiet nook was to be changed into a *tableau vivant*. In addition to these personal attentions, the light varied its extraordinary powers by throwing congratulations on to the clouds and belts of trees, etc. On two evenings Mr. Herbert Gladstone, M.P., personally inspected the apparatus and spent a considerable time on the castle roof watching its working, and expressed great astonishment to see "God Bless Victoria R I.," "Blessings on the Gladstone Family," as well as other words, written clearly on the clouds in brilliantly white letters of immense size He warmly congratulated Captain Ronald Scott, and thanked him on behalf of the committee for having given his services and lent the apparatus for the benefit of the Hawarden Institute.

Islington, N.—A committee of the Islington Vestry has been making enquiries as to the relative cost of gas and electricity, especially with regard to street-lighting. The members report that they have been unable to obtain any definite data from actual experience of the relative cost of lighting public streets by gas and electricity. In nearly every town where the streets are lighted by electricity, the current, the committee state, is supplied by a private company, and the charges made by these companies cannot be taken as representing the cost of street-lighting. With regard to St. Pancras, the committee learned that there the cost of electric lighting in the main streets was not likely to exceed the previous cost of gas. Finally, the committee say they have come to the conclusion that the lighting with arc lamps of the route from The Angel to Finsbury Park—viz., High-street, Upper-street, Holloway-road (as far as The Nag's Head), and thence along Seven Sisters-road, to the park—which is projected as a commencement, would cost little (if any) more than the present cost of gas, particularly if arrangements are made for switching off half the lamps at midnight, or for fixing incandescent lamps to take the place of the whole of the arc lamps after that hour. Moreover, the illumination of the streets would be at least quadrupled, and the light would make the thoroughfares named much more attractive, and thereby tend to promote trade in the neighbourhood.

Sunderland. — The sub-committee on electric lighting has just issued a circular containing terms for the supply of electricity which they propose to recommend to the Highways Committee for adoption. According to the circular the charges for a supply of electricity will be as follows: for lighting, 6d. per Board of Trade unit; for heating, cooking, or driving motors, if supplied through a separate fuse and meter, 3½d. per Board of Trade unit. The annual charges for fuse and meter (which are the property of the Corporation and maintained by them), payable quarterly, will be as follows:

Heating, cooking, and power.

h.p.	h.p.	h.p.	h.p.	h.p.	h.p.	h.p.
1 ...	2½ ...	4 ...	5 ...	6 ..	7 .	8 ... 10

Lights of 8 c.p. or their equivalent.

10 ...	25 ...	40 ...	50 ...	60 ..	70 ...	80 ...	100
lights.	lights.	lights.	lights.	lights.	lights.	lights.	lights.

Fuse and meter.

8s. ... 10s. ... 12s. .. 13s. ... 14s. ... 16s. ... 18s. ... 23s.

Above 10 h.p., or 100 lights, special terms will be quoted for the above apparatus. These charges include all repairs due to fair wear and tear; any damage done by fire or negligence on the part of the consumer will be repaired at his expense. One Board of Trade unit will supply electrical energy to one 8-c.p. incandescent lamp for (approximately) 31 hours. One thousand Board of Trade units will supply a 1-h.p. motor for (approximately) 1,000 hours. The circular then goes on to set forth the advantages of electricity, both for lighting and motive power.

Winchester.—The Public Works and Buildings Committee of the Hants County Council have reported that, in accordance with the request made to them at the last meeting of the Council, they had fully considered the cost which would be incurred by introducing the electric light into the new county buildings. The cost of wires, irrespective of brackets, etc., would be approximately £187, and inasmuch as the placing of those wires in position while the buildings were in progress would cost materially less than their introduction at a later period, they recommended that this should now be done, and that the committee should be instructed to obtain an estimate for the wires. Should it be thought desirable to adopt electric lighting, a further sum of, say, £138, would be required for brackets, pendants, etc. The total cost for fittings in connection with this lighting would thus amount to £325. The cost of gas fittings allowed for in the contract for the new buildings was £230. If an independent system for producing electric light were adopted in the new county buildings, the total cost, inclusive of fittings, was estimated at £800. This additional expenditure would, however, not be necessary if the city of Winchester (which now had the question before it) decided on adopting any such scheme as would enable the county offices to be associated therewith. The recommendation with regard to electric lighting was supported by Mr. Lemon, who stated that the electric light at the Southampton Free Library cost less than gas. Mr. C F. Wilson also thought they should have electric lighting. The recommendation was agreed to.

The Leeds Tramways.—The Tramways Sub-Committee of the Highways Committee of the Leeds Corporation are going to the Isle of Man on the 29th inst. to inspect the electric tramway there. Mr. W. Owston writes to a local paper as follows: "Would it not be a great convenience if the electric trams could be run through from Sheepscar to Briggate? I think this might easily be done without having posts and wires put down if the cars were fitted with small accumulators, which might be charged from time to time. As the distance is only about one mile each way, only small accumulators would be required. If this system could be worked at a reasonable rate, it might be applied in many cases, leaving the ordinary wires and posts in the outskirts of the town. Possibly some of your readers well up in electricity will let us know if electric cars can be worked as stated." Another correspondent, signing himself "Motive Power," writes: "It may not improbably be the ultimate outcome of working tramcars to make each car self-contained, and worked with its own motor from accumulators carried along with it. The tendency of invention makes that way, for men naturally reason it out that it is, on the whole, the best that each vehicle or machine should be independent in itself, and if aught goes wrong with it, removing it does not interfere with the work of others similar to itself. Where cars or machines are worked by some connected system from a fixed station at the centre or terminus, should aught go wrong with the operating system every car or machine may be rendered useless till things are put right. Three weeks ago an account appeared of trials in France of motive-power carriages for common roads. The entries showed an interest and a desire to solve this problem, which is very lukewarm in this country. It would not seem an unwise or costly proceeding for our Corporation to invite offers for the construction of a self-contained electric motor car. The cost of this would be a mere item compared with an entire electric tram system, and a successful car such as Mr. Owston suggests may solve the whole problem of what is the best system for Leeds."

Telephony at Worsley. — The Parochial Committee at a meeting a short time ago received a communication respecting the connection of Walkden with a telephonic system, and a sub-committee was appointed to investigate. Mr. Davies now reported that in company with Mr. W. A. Booth, who had been acting in the matter independently of the Parochial Committee, he waited upon Mr. M'Lean, the representative of the New Telephone Company. The National Company wanted £2 per wire more than the New Company. Mr. M'Lean said they would put a central call office in Walkden, and would lay down a line direct to Manchester without having to connect with Bolton. There would be two wires for each person (whereas the National Company only put down one), and the charge would be £8 per year for places within a mile of the central office, and £10. 10s. for connections within a mile and a half. Government did not allow any company to send messages, but anyone could go to the central office and for the sum of 3d. speak to anyone having a connection; the conversation could be kept up for 10 minutes for this amount, or longer if the wire was not required. The company required a guarantee of £80 for the first year, and so far four names had been given in, and others had said they would secure a connection when the central office was established. The company could have the system completed within two months after the guarantee was given. There was no doubt in the minds of the sub-committee that it would be an advantage to the business people of Walkden, but they did not recommend that the rates should be pledged as a guarantee against any deficiency. He had no doubt that sufficient subscribers could be obtained to constitute the necessary guarantee. For an additional £2 the subscribers could have the advantage of being connected also with any member of the National Telephone system. Mr. Marsh said it was very necessary that subscribers should have this last-mentioned advantage, because so many of the Manchester people had connections with the National Company. He thought every subscriber would pay the additional £2, and that really eight subscribers would then be sufficient to form the guarantee, and of these four had already been secured. No resolution was passed, the committee making no recommendation, being of opinion that the matter could be brought about without any guarantee from the rates.

Yarmouth.—On the advice of their expert, the Electric Light Committee of the Town Council recommended that the charge for electrical energy be fixed at 6d. per Board of Trade unit, equivalent in his opinion to gas at 3s. per 1,000 cubic feet. On this basis it was stated an 8-c.p. lamp would cost rather less than ¼d. per hour, and taking an average of 300 hours per annum, the yearly cost

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would be 6s. 6d., including incandescent lamp renewals. The cost of installation was put at from 20s. per lamp, and the current could be used for lighting, motive power, cooking, or heating purposes. The surveyor on July 11 reported that the trials with the light on the parade and Regent-road were satisfactory, and was directed to keep these lamps lighted for six weeks from that date from one hour after sunset till 11.30 p m. In response to a request from the Mutual Drift Net Fishing Boat Owners' Protection Society, the committee recommended the Council to fix three additional lamps on temporary posts between the south end of the covered market and the Lower Ferry. The committee appointed Mr. A. W. Ranken clerk of the works at £3. 3s. per week from June 27. Mr. Preece recommended Mr. Ranken very highly, he having qualified by study at King's College, London, by a three years' pupilage under the Electric Supply Company, Wolverhampton, and two years' further service, and by 12 months as second engineer at Bristol. Mr. Ranken will act as engineer-in-charge of the present temporary installation. If desired, the light will be supplied to the free library at a reduction of 33 per cent. Mr. E. A. Durrant objected to the position in which it was proposed to place the electric light lamps at the Fish Wharf, asserting that those positions would be a hindrance to trade, and involve an outlay of £550 with but little advantage. He moved that the paragraph be referred back to committee. Mr. Goate seconded. Mr. Suffling said that the lights were fixed on the recommendation of Mr. Preece and of a meeting of smackowners, who quite understood the requirements at the Fish Wharf. On a division the amendment was lost. Mr. Lee failed to understand the appointment of Mr Ranken. Surely Mr. Preece, getting £750 for his services, might wait till he had handed over the job complete. He therefore moved that the appointment be deferred until the installation was completed. Mr. Stanley seconded. Mr. Clowes could not understand what the position was. Mr. Ranken was to be paid by the Corporation, and yet he was a nominee of their electrical expert, and could have no power over the contractors. Mr. Green said that when the Town Hall was built they had a clerk of the works who was a nominee of the contractor, and got into sad trouble. The Mayor said that Mr. Ranken was appointed because it was necessary that there should be a clerk of the works to watch over the interests of the Corporation. Mr. Williment said that it was asked that they should pay him from June 27. Who employed him? The Surveyor: Mr. Preece sent him down. Mr. F. Palmer said that there had been a gross irregularity, and they ought not to pay him. For Mr. Lee's amendment five voted, and 16 against. Messrs. Crampton and Co.'s tender for an electric light installation at the school of art has been accepted by the Town Council at £57. 18s. 6d.

PROVISIONAL PATENTS, 1894.

AUGUST 13.

15376. **Improvements in holders for globes or shades of electric, gas, or other lamps.** John Whitehead, 36, Temple-street, Birmingham.

15403. **Improvements in automatic alarm devices for use in connection with telephones and microphones.** Chr. Hugo Krützfeldt, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

15414. **Improvements in telephone annunciators and call bells.** Frederick George Warrell, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

AUGUST 14.

15424. **Improvements in electromotors.** David Cook, 30, Lancaster-park, Richmond, Surrey.

15429. **Improvements in conducting and economising electricity.** Joseph Lindley and George Edward Sutcliffe, Britannia Mill, Mirfield, Yorks.

15452. **Improvements in electric arc lamps.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Robert Drysdale, United States.) (Complete specification.)

15455. **Improvements in telegraphic transmitters.** Frank F. Howe, 46, Lincoln's-inn-fields, London. (Complete specification.)

AUGUST 15.

15506. **Improvements relating to voltmeters, which are applicable to ampere-meters.** Frederick Brown, 36, Temple-street, Birmingham. (Complete specification.)

AUGUST 16.

15573. **A new method of utilising running vehicles and machinery for the production and storage of electric force.** James T. Cathcart, Pitcairlie, Newburgh, Fife.

15617. **Improvements in apparatus for registering the number or duration of telephonic conversations.** August Münch, 4, South-street, Finsbury, London.

15632. **Improvements in methods of and apparatus for heating crucibles by means of electricity.** Adam Charles Girard and Ernest Auguste Georges Street, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, 19th February, 1894, being date of application in France.)

AUGUST 17.

15694. **Improvements in or relating to electric arc lamps.** Eugene Henry Maret, 323, High Holborn, London.

15675. **An improved vehicle to be used on ordinary roads and propelled by electricity.** Edmund Seymour Colchester, 18, Endwell-road, Brockley, London.

15698. **Improvements in electric appliances for boiling or heating liquids.** Friedrich Wilhelm Schindler, 433, Strand, London.

15712. **Improvements in what are known as dry voltaic cells or batteries.** Donald Barns Morison, 46, Lincoln's-inn-fields, London.

AUGUST 18.

15770. **Improvements in electric heating apparatus.** John Augustine Kingdon, 54, Beresford-road, Canonbury, London.

15774. **Improvements in electric cables.** Henry Alfred Charles Saunders, 24, Southampton-buildings, Chancery-lane, London. (Robert Greey and Walter John Murphy, ——.)

15782. **Improvements in the manufacture of carbon for electrical and other purposes.** Charles Percy Shrewsbury, Frank Laurence Marshall, John Cooper, and John Laskey Dobell, 57, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1893.

15907. **Insulator for telegraph and telephone wires.** Koster.

17493. **Thermo-electric batteries.** Dion.

17981. **Magneto-electrical igniting apparatus.** Drach.

18019. **Electrical switches.** Tucker.

18530. **Conductors for electric railways.** Siemens Bros. and Co. and Thornton.

18674. **Electrical receiving instruments and relays.** Phonopore Company and Spagnoletti.

21629. **Telegraphy.** Delany.

1894.

1776. **Electric arc lamps.** Walton.

9117. **Electromagnetic tools.** Jensen. (Fonda.)

10393. **Arc lamps.** Claremont.

11219. **Incandescent electric lamps.** Hussey.

12099. **Dynamo-electric machines, etc.** Joel.

12131. **Electric brake for vehicles.** Freedley.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	5	5¼-5¾
Bournemouth Electric Company	—	—
Brighton and Hove Company Original	100	210-215
—— "A" Ordinary	—	162-166
Brush Company, Ordinary	3	2⅞-3
—— Nom. Cum., 6 per cent. Pref.	2	2¼-2½
—— 4½ Debenture Stock	100	110-113
Charing Cross and Strand	5	4¼-5¼
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	12¾-13½
—— 6 per cent. Cumulative Pref.	10	14-14½
—— 5 per cent. Debenture Stock	115	128-131
City and South London Railway, Consolidated Ordinary	100	36-38
—— Debenture Stock	100	121-123
—— 5 per cent. Pref. Shares	10	12¾-13
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¾-2¼
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	95-100
Electric Construction, Limited	2	½-¾
—— 6 per cent. Debentures	—	87-92
—— 7 per cent. Cumulative Pref.	2	1¼-1⅞
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1-1¼
Elmore's French Company	2	⅛-¼
Elmore's Wire Company	2	¼-1
Fowler-Waring Cables	5	½-1½
W. T. Henley's Telegraph Works, Ordinary	10	7-8
House-to-House Company, Ordinary	5	1-1½
—— 7 per cent. Preference	5	5¼-5½
India Rubber and Gutta Percha Works	10	23-24
—— 4½ per cent. Debentures	100	103-105
International Okonite, Ordinary	—	—
Kensington and Knightsbridge	5	4¾-5¼
—— 6 per cent. Pref.	—	6¼-6⅝
Liverpool Electric Supply, Ordinary	5	6⅜-6⅞
—— Pref.	—	—
Liverpool Overhead Railway	10	7 13/16-7 15/16
—— Pref.	10	12¾-13
—— 4 per cent. Mortgage Debentures of £100	100	111-113
London Electric	5	⅞-1⅛
Metropolitan Electric Supply	10	8¼-8¾
—— 5 per cent. Reg. Debentures, 1-10,000 in Bonds of £10, £20, and £40	—	—
National Telephone, Ordinary	5	4⅞-5⅛
—— 6 per cent. Cum. First Pref.	10	14-15
—— 6 per cent. Cum. Second Pref.	10	13¾-14½
—— 5 per cent. Nom. Cum. Third Pref.	5	5⅛-5⅜
—— 4½ per cent. Deb. Stock	—	108-111
Notting Hill Company	10	4⅜-5⅛
Oriental and Electric Company, £1 shares	1	1-1¼
—— £5 Shares	—	6¼-6¾
—— £4½ shares	—	5¼-5¾
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	6¾-7¼
—— 7 per cent. Pref.	5	8¼-8¾
Swan United	—	—
Telegraph Construction and Maintenance	12	40-42
—— 5 per cent. Bonds	100	102-105
Westminster Electric Supply, Ordinary	5	6-6½
Yorkshire House-to-House	4½	4¼-4¾

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NOTES.

Ship-Lighting.—The latest P. and O. steamer, the "Caledonia," is lighted by electricity.

Generally the Case.—The consumption of gas in Bristol, notwithstanding the use of the electric light, is increasing.

Evening Classes.—The Drighlington School Board are arranging for evening classes in electricity during the coming winter.

Telephony in Germany.—Telephonic communication has been established between Frankfort-on-the-Maine, Bockenheim, Offenbach, and Bruchsal.

Search-Lights as Advertisements.—A Birmingham resident waxes highly indignant in the columns of a local paper because some tradesman uses a search-light for advertising purposes.

Electric Clocks for Liverpool.—Complaints having been made as to the inaccuracy of the public clocks in Liverpool, a correspondent suggests the introduction of a system of electric clocks.

Electric Welding.—At the annual meeting of the Institute of British Carriage Builders, which has been held this week at Birmingham, Mr. E. Manville read a paper on the application of electric welding to carriage building.

Book Received.—We have received from Messrs. Whittaker and Co. a copy of "An Introduction to the Differential and Integral Calculus," for the use of students reading without the aid of a tutor. The author is Mr. Matthew Wyatt, F.R.G.S., F.I.I.

Modern Lighthouse Service.—A paper on this subject, accompanied by illustrations, is published in *Cassier's Magazine* for August, from the pen of Mr. Edward P. Adams, C.E. The paper will be followed by others dealing with this branch of work.

Lightning the Lifter.—"A Man Carried Over a Hedge by Lightning" is the sub-heading of a paragraph in a Welsh paper. As some of our contemporaries are fond of filling up their columns with details of such occurrences, we leave this matter for their consideration.

The "Electra."—The steamer "Electra," belonging to the Eastern Telegraph Company, arrived in the Bosphorus on Tuesday morning from the Black Sea with a distinguished company, consisting of Lord Wolseley, the American Ambassador in London, Sir Evelyn Wood, Sir John Pender, and others.

London County Scholarships.—The London County Council have issued the report of their Technical Education Board on the examination for intermediate county scholarships held in June last. The examiner stated that in electricity and magnetism "very few showed any practical knowledge of laboratory work."

Visits to Works.—The members of the Manchester District Institution of Gas Engineers inspected on Saturday the gasworks and electric light station at Huddersfield. The members of the Junior Engineering Society on Friday last visited the Cardiff electric lighting works, Mr. Fletcher, the electrical engineer, explaining the various features.

Large Overhead Traveller.—It would be interesting to learn whether there is an overhead electric traveller in existence larger than that in operation at the Seraing works of Messrs. John Cockerill and Co., in Belgium. This traveller, which was inspected by the members of the Iron and Steel Institute last week, has a capacity of 60 tons, and is used, among other purposes, for the lifting of huge ingots for pressure under a hydraulic forging press. Perhaps some of our readers may be able to give us information on the subject.

Electric Lighting in Natal.—The Durban Town Council have approved of the borough engineer's recommendation that the best advice in England should be obtained on a general scheme for lighting the whole borough by electricity. It has been decided to take steps at once to carry out the details, and to employ such assistance as may be needed. The Seaman's Institute have applied to the Natal Harbour Board for their terms for supplying the institute with the electric light. The application has been referred to the Government.

Glasgow and West of Scotland Technical College.—This college grants diplomas in the following departments of engineering and other branches of applied and general sciences: civil engineering, mechanical engineering, naval architecture, electrical engineering, architecture, chemical engineering, metallurgy, mining engineering, agriculture, chemistry, and mathematics and physics. The session 1894-95 commences on Monday, October 1. Mr. John Young, B.Sc., the secretary, will supply particulars as to fees, scholarships, etc.

Ealing Exhibition.—Great efforts are being made to obtain a good exhibition at the opening of the central station. Not only are exhibitors invited, but special attention is being paid to get visitors to the exhibition. Thus arrangements have been made to obtain lectures during the time of the exhibition, and Sir F. Bramwell, F.R.S., has promised to deliver a lecture on the opening day. Among others who will lecture are Mr. E. Graham Harris and Mr. C. W. Lynd. There will also be a phonographic night and several musical evenings. The promises of support already received go far to ensure a great success.

Pacific Cable Question.—The *Post*, discussing the Ottawa conference, says the colonies will do well to keep the decision of the late conference before the Home Government, and not let the matter remain in abeyance, as was done with regard to the resolution passed at the colonial conference in 1887, when it will be remembered that the same conclusion about a survey was come to, and yet during the seven years that have elapsed since that time no steps whatever have been taken in the matter. Doubtless a survey would in any event be a wise preliminary before laying a cable in unknown waters, but at the same time it seems from the expert evidence given at Ottawa that with the modern methods of cable work a survey is not altogether indispensable. But that is a matter, the *Post* concludes, for the colonies to decide, and as they have decided in the affirmative it is not for us to find fault with the increased delay.

Obituary.—The death took place on Tuesday of the Earl of Albemarle—the Right Hon. William Coutts Keppel. The deceased, who was born in 1832, took a great interest in the applications of electricity, and was chairman of the late General Electric Power and Traction Company, Limited. It will be remembered that in 1890, when Lord Bury, he wrote to the *Times* a letter asking for suggestions for a verb to express progression by electric power, which called forth a large number of answers. "To motor," was the verb which was selected as the most suitable, but neither that nor any other of the words proposed seem to have been adopted.—A long obituary notice appears in a German contemporary on Carl Grawinkel, who recently passed away. The deceased was a well-known telephone and telegraph engineer, and was the author of several works dealing with these branches of industry.

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Lighting in Calcutta.—It passes understanding, *Indian Engineering* remarks, how the metropolis of the East—the greatest of Asiatic cities—the centre of the civilisation introduced from the West—carries on month after month and year after year without the aid of electricity. To think of lamps that rarely require trimming and that are wind and stormproof, of punkahs that do not necessitate the employment of a dirty, lazy class of creature, and do not swing with such irregularity as to render them a serious risk to health, besides numerous other uses to which electrical power might be put, form a dream to Indians, but to the scientific and professional men of Europe and America these are now every-day achievements, and to them the remark would occur: "Well, if Calcutta has not these modern means and necessary appliances, it is entirely its own fault, and someone or other requires a little life shaken into him."

Platinum.—The Ural platinum deposits in Russia are said to be the only ones in the world, as this metal is worked nowhere else, and is known simply as a mineral finely disseminated in certain rocks. Platinum occurs in the Ural Government of Perm, where it is found on various private properties and State lands. In the district of Goroblagodat there are 70 allotments for the exploitation of platinum under different private individuals. At present all the platinum extracted in the Urals is forwarded in the crude state to St. Petersburg, whence it is sent abroad. Although there are two laboratories in the Russian capital for refining platinum ore, the greater quantity is sent abroad in the crude state. The largest quantity of platinum is now extracted at the deposits of Nizhni-Tagilsk, belonging to Prince Demidoff San Donato, and at the Krestovosdvigensk deposits of Count Schouvaloff. In 1890 there were 6,000 workmen employed in the exploitation of platinum.

Employment of Electricity to Follow the Phases of Certain Chemical Reactions.—Mr. J. Garnier, in the *Compt. Rend.*, observes that a mixture of nickel oxide and wood charcoal was placed in an earthenware tube, closed by two plugs of soft steel, by which the mixture was compressed. The two steel plugs were placed in an electric circuit, and the earthen tube, supported horizontally, was heated in a small reverberatory furnace. The resistance of the powder in the tube was at first extremely high, but gradually became less and less, until it became almost nil. It then increased again, finally becoming very high. The decrease of resistance corresponds with the gradual reduction of the oxide, the reduction being complete at the moment when the resistance was almost nil; as the nickel became carburetted, however, the resistance increased. In a similar experiment, with a mixture of copper, iron, and nickel oxides and wood charcoal, the successive phases of reduction were indicated by the variations in the resistance. In the same manner, the process of refining might be followed, and the method has the advantage that the readings of the ammeters and voltmeters can be made at a point removed from the position of the furnace, etc.

Three-Wire System in Italy.—A central electric light station has recently been set in operation at Jesi, in Italy. The station is situated in the lower part of the town, where a turbine-house has been erected close to the Canal Pallavicino. The available water supply amounts to 4,300 litres per second, the useful fall being 16½ft. There are installed two 100-h.p. turbines, constructed by Messrs. Calzoni, of Bologna, on the American reaction type, and provision has been made for the laying down of a third turbine. The turbines drive by means of bevel gear two horizontal shafts, which, by means of Raffard flexible couplings, actuate two dynamos at 360 revolutions a minute. Messrs. Siemens and Halske have supplied the whole of the electrical plant. At present two dynamos giving 510 amperes at 130 volts are installed, the current being distributed on the three-wire system. A separate circuit is provided for the requirements of the town, a second for the arc lamps, and a third for private consumers. The town is supplied with 300 16-c.p. lamps, which are alight throughout the night, and 18 nine-ampere arc lamps, eight of which are switched out at midnight. Messrs. Moleschott, of Rome, the representatives of Messrs. Siemens and Halske, have carried out the whole of the electrical and hydraulic portions of the work.

Two-Phase System in Hungary.—The central electric light station in operation in Budapest is the property of the Austrian General Gas Company. It has been built in the outskirts of the town on a site leaving ample room for future extensions. The generators comprise three two-phase alternators each of 400 h.p., and two smaller alternators of 70 kilowatts. From the generating station the current is transmitted to a sub-station, where it is converted into direct current. The transmission along the line is effected by a system of diphase alternating current, produced by an alternator having a "continuous" winding. This winding is arranged in four sections, each of which is connected to a ring. The current collected on these rings is led by four wires to the sub-station, where it energises alternating synchronous motors constructed in a similar manner to the generators. These motors drive direct-current dynamos, which feed into the mains and also charge accumulators. Each alternator at the generating station is provided with an exciter; common exciting bars form a kind of reserve, these being fed from the sub-station by means of a separate feeder.

Personal.—"There is something of historic interest," says the *World*, "in the nomination by Lord Kelvin of Mr. Charles Bright, C.E., to fellowship of the Royal Society of Edinburgh, for which the latter is now a selected candidate. Lord Kelvin and the late Sir Charles Bright were old shipmates, as the electrician and the engineer respectively of the old Atlantic cable, for the successful laying of which Sir Charles received knighthood at the unprecedentedly early age of 26. His eldest son, Lord Kelvin's nominee at Edinburgh, seems to be gradually coming to the front on the same lines as his distinguished father, one of whose well-remembered feats was laying down, when only 18 years old, the telegraph lines under the streets of Manchester in a single night, to avoid disturbance to the traffic, thus for the first time putting Liverpool and Manchester into telegraphic communication with London. Mr. Charles Bright's recently published volume on "Subterranean Telegraph Cables" marks him as a close scientific observer with keen practical instincts, and embraces a wider range than its title implies. There have been books before giving the history of submarine cable-laying expeditions, but never one furnishing the precise course of events from start to finish, and showing with minute detail how the inevitable difficulties in a treacherous climate, that of the West Coast of Africa, where Mr. Bright was in charge of the enterprise on behalf of the Silvertown Company, are grappled with and overcome."

Electric Lighting in Germany.—The local authorities have authorised the laying down of electric light mains in various parts of Berlin by the Berliner Elektricitätswerke. The machinery and boiler house in connection with the central electric lighting station at Frankfort-on-the-Maine is completed structurally, and good progress is being made with the large chimney. Three of the six boilers required are in place, and one of the three

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750-h.p. tandem steam-engines has been erected. The boilers and engines are made by Mr. G. Kuhn, of Stuttgart-Berg. The dynamos are lying ready at the works of Messrs. Brown, Boveri, and Co. A concession has been given by the municipal authorities of Leutkirch to Mr. Schöllhorn, of Unterzeil, for a central electric lighting station. The concessionaire is to pay the town £20 a year and 10 per cent. of the net profits, and provision is made for the taking over of the works by the local authority under certain conditions if they desire to do so. The local authorities at Schaffhausen will themselves carry out the central station, and tenders are to be invited. The Arms Factory at Dantzic is to be lighted electrically. A central station is projected for Landstuhl. The new central station which has been built at Haardt by Messrs. Schuckert and Co., of Nuremberg, has been opened. The plant comprises two Lancashire boilers, two steam-engines each of 60 h.p., two Schuckert dynamos, and two batteries of accumulators.

The London-Ostend Telephone.—In our last issue we recorded the intelligence issued by Dalziel's Agency with respect to the proposed establishment of telephonic communication between London and Brussels, *vid* Ostend. The London correspondent of the *Liverpool Courier* now writes as follows: "The report of the establishment of direct submarine telephone communication between London and Ostend being impending has already been contradicted, but enquiries which I have made point to the conclusion that the report was much more 'previous' than was at first supposed. The fact is that as yet the project exists merely as an idea in the minds of enthusiastic electricians and enterprising men of business. The writer of the original report spoke as if the establishment of such a telephone would be a comparatively easy matter; as if, indeed, it would only be necessary to give the order and the thing would be done. But the fact is that telephone cables have to be made with exceptional care. They take a long time to construct, and are very expensive. Happily, this country is still in the proud position of having, by the admission of all electricians, the two finest telephone cables in the world. These are the cables between Dover and Calais for the communication between London and Paris, and the cable between Belfast and Glasgow. Both are of English manufacture and laying down. They are in daily increasing demand. Business on the cable between Belfast and Glasgow was rather slow at first, and it looked as if the enterprise would be a financial failure, but with the adoption of a reduced tariff of charges business has gone up rapidly."

Dielectric Constants and Chemical Equilibrium. Mr. W. Nernst, in the *Zeit. Physikal. Chem.*, states that as the energy of an electrically-charged system is lowered when placed in a medium of higher dielectric capacity, there is hence an attractive force on electric points towards the medium with the higher capacity. From this he deduces, by considering the ions as electrically-charged points, that the greater the dielectric constant, κ, of a medium, the greater will be the electric dissociation of a dissolved substance. Data for verification are few, but the known facts support this view, thus:

	κ	Electric dissociation.
Gases.....	1·0	Not at ordinary temperatures.
Benzene	2·3	Very slight; traces.
Alcohol.....	25 0	Distinct.
Water	80·0	Very strong.

Experiments also on the dissociation of hydrogen chloride gave: benzene, xylene, and hexane, very slight; ether, slightly stronger; then isobutylic alcohol, ethylic alcohol, and methylic alcohol, the order being the same as that of the dielectric capacity. Many organic acids contain molecular complexes, which decompose first into simple molecules and then into ions. The decomposition would also probably follow this law. This action is observable in the following order, according to the measurements of Eijkman and Beckmann: hydro-carbons ($\kappa = 2·2—2·4$); carbon bisulphide ($\kappa = 2·6$); chloroform (κ ?); ether ($\kappa = 4·4$); ethereal salts ($\kappa = 6—9$); alcohols ($\kappa = 16—33$); acids (κ ?); and water ($\kappa = 80$). A short indication is also given of a method for the simple and accurate determination of the constants.

Lighting of Tramcars.—A system of lighting tramcars by electricity has been devised by Mr. W. M. Miner, the electrical engineer of the American Manufacturing and Engineering Company, New York, and a demonstration of it was recently given as installed in a car in Hoboken, N.J. The visitors were conveyed in the car, and in running over the line the trolley circuit was frequently broken in order to show the value of this system in always keeping the car illuminated whether the trolley wheel is on or off. The system consists in the use of a small storage battery of six Donaldson-Macrae storage cells, which are used to light a duplicate set of lamps should the trolley come off, or the motor current gives out or be interrupted in any way, the battery being switched on automatically when the motor circuit is broken. A trolley current is passed through an electromagnet, which completes a circuit through incandescent lamps connected in series in the usual manner. The same current also passes through the storage battery, keeping it charged. If the trolley comes off, or the current gives out or is interrupted in any way, the armature of the magnet is drawn back against its backstop, closing the supplemental circuit from the storage battery through a switch to the armature of the magnet, backstop and lamps, returning to the storage battery, thereby ensuring light in the car whenever lights are required independent of the action of the trolley. When the main circuit is restored by replacing the trolley or otherwise, the current takes its original course through the main circuit lamps, energising the magnet (drawing its armature away from the backstop), storage battery, and ground, recharging the storage battery and lighting the car as before, thus automatically ensuring a constant light in the car under all circumstances.

Champagne, Good and Pure.—Our French contemporary, the *Bulletin International de l'Electricité*, frequently endeavours to discover new ideas, the latest of which is a method for hermetically sealing champagne and other bottles. In order that the lucidity of the system may not be destroyed, we quote the following from our contemporary's issue of August 27: "Under the title of electric capsuling is designated the operation of surrounding an article with an envelope which is generally metallic. Hitherto, the coating of pills in pharmacy, for instance, has been done by hand, but, judging from some special applications, electric capsuling may be called upon to dethrone the old method. The electrical system has at first been applied to the corks of champagne and beer bottles. It would appear that the cork and the metallic capsule alone of a champagne bottle cost 3d.—being 2d. for the cork and 1d. for the capsule. The neck of the bottle and the cork are covered with a conducting layer; the cork is then driven in the bottle, and the whole placed in a copper, nickel, or aluminium bath. The metallic deposit closes the pores of the cork, and effects a perfect connection between the cork and the neck of the bottle. It seems that the producers of champagne lose 5 per cent. of the wine by the old method through defective corking, which loss can be avoided by the adoption of the new system. Beer bottles also require to be hermeti-

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cally closed, and this result can be obtained by covering the neck of the bottle with a ring of pure cellulose cardboard (*carton de cellulose*), upon which a metallic deposit is made. Finally, the latest success of the new method is an application to the preservation of rolls of butter, which are covered with plumbago and a film of copper electrically deposited."

Association of Chambers of Commerce. — A special meeting of the Association of Chambers of Commerce will be held at Huddersfield in September. The following are among the resolutions on the agenda: "That this association expresses its hearty approval of the resolutions adopted by the inter-colonial congress recently held at Ottawa in favour of inter-Imperial postal and telegraph routes between this country and the colonies and between the colonies themselves respectively without such routes passing through other countries. And this meeting would urge on the Postal and other Governmental Departments the importance of aiding as far as possible the proposals of the congress, and that memorials be sent to the Prime Minister, the Chancellor of the Exchequer, and the Postmaster-General." "That in the opinion of this association it is unfair to the public that the telegraphic department of the Post Office should for financial purposes be treated as a separate establishment, thereby causing unwarrantable delay in carrying out urgent and much needed reforms. That inasmuch as the postal establishment and its various departments are in their entirety a financial success, the time has arrived when the address of not exceeding four words should be allowed free of charge in all telegrams, and that telegraphic communication should be extended to rural districts where practicable. That a deputation wait upon the Postmaster-General to urge upon him the desirability of adopting this suggestion"; and "That this association reaffirms the desirability of the law relating to the rating of machinery being settled in accordance with the principles in the Bill which was introduced into Parliament, and that her Majesty's Government be requested to give facilities during the next session for the passing of an Act to settle the law upon the subject."

The Ferranti Effect.—Before the Electrotechnical Institute of the Technical High School in Vienna, Mr. J. Sahulka recently read a paper explanatory of the Ferranti effect. The paper, which is reproduced in the *Zeitschrift für Elektrotechnik* of August 15, deals with the question from a mathematical point of view. The author stated that the Ferranti effect comprises a series of phenomena which arise if the secondary circuit of a transformer, the primary circuit of which is connected to an alternating-current machine, is closed through a condenser. The most remarkable of these phenomena is this: that the ratio of transformation of the converter increases. At the same time, the primary difference of potential also becomes greater and the primary current weaker. The condenser, the author observed, must not have too great capacity, as very large condensers in alternate-current working have only a small apparent resistance, and a condenser of infinitely great capacity might have the same effect as if the secondary circuit was short-circuited through a piece of wire. The ratio of transformation through the insertion of the condenser in the secondary circuit can be greater than the relation of the number of windings of the transformer. According to Mr. Sahulka, a correct explanation of this phenomenon has not hitherto been given. The cause of the effect, he states, lies in the so-called distribution of the magnetic lines of force in the transformer. This assertion is shown theoretically, and was confirmed by experiment. If all the magnetic lines of force produced by the primary circuit were passed through the whole of the windings of the secondary circuit and reversed, the Ferranti phenomenon would not arise. After having gone into the question mathematically, the author describes the experiments made which led him to the above conclusion.

Electricity in Nishni-Novgorod.—At the world-famed Nishni-Novgorod Fair, according to a correspondent of the *Elektrotechnische Zeitschrift*, considerable business is done in electric bells, batteries, wire, indicators, and lightning conductors, mainly of German and Austrian manufacture. Moreover, according to the police regulations in the district in which the fair takes place, the use of any light save the electric light is prohibited. Thus arc and incandescent lamp lighting are to be found in the meanest booths as well as in the governmental palace and in the theatre. The central station for the electric light is situated in a one-storey building at the side of a tributary of the River Oka. The boilers, steam-engines, and dynamos are in the basement, and the regulating and measuring instruments on the ground floor. The whole might serve as an electrical exhibition, for apart from the boilers and engines, which have been made by Messrs. Dobrowich and Nabgoltz, the rest of the appliances show samples from the works of Messrs. Ganz and Co., Schuckert, the Allgemeine Elektricitäts-Gesellschaft, and many other German and Austrian firms. The dynamos work at 230 volts, and 30 volts is lost by the time the periphery of the district is reached; on account of which two 100-volt incandescent lamps of 10, 16, 25, or 32 candle-power are always arranged in series. The arc lamps are supplied from a special dynamo. Overhead conductors are employed. The leading spirit of electricity at Nishni-Novgorod is Mr. Rjumin, a former naval officer, who is proud of the 8,000 incandescent lamps and 150 arc lamps which now constitute the lighting of the fair. The manager of the central station is Prof. Popoff. It is proposed to erect a new large central station to be ready for the fair of 1896.

Use of Rectified Current.—It will be remembered that in connection with the utilisation of Niagara Falls, the Cataract Construction Company have adopted the plan of generating current primarily at 2,000 volts, alternating, at 25 cycles per minute, on the two-phase system. Where the distance to which electric power is to be transmitted is beyond the limits of Niagara Falls this potential is raised by step-up transformers to the desired E.M.F., but for Niagara and vicinity the 2,000 volts delivered directly from the machine will be furnished to consumers, at whose premises it will be transformed to any potential and character desired. The *Electrical Engineer* of New York states that among those who have already arranged to transfer their works to Niagara is the Pittsburgh Reduction Company, the well-known manufacturers of aluminum. This company has contracted for 1,200 kilowatts of electrical energy to be delivered in the form of continuous current, which they require for the reduction of the aluminium. The contracts for the electrical apparatus and the fittings to furnish 7,000 amperes at 160 volts were awarded to the General Electric Company early in the year, and a recent visit to the works at Schenectady show it to be rapidly nearing completion. In order to carry out the conversion of the primary alternating current into the continuous current, rotary transformers in connection with stationary or "static" transformers, as they are called, to distinguish them from the rotary, have been adopted, the system of conversion being as follows: Starting with the 2,000-volt alternating current at the main generating station, the current is led to the works of the Pittsburgh Reduction Company, a

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distance of about 2,500ft. Here it is led into the static transformers and is reduced to 115 volts alternating. This current is then led to the rotary transformers, which convert it into continuous current at 160 volts, at which pressure it will be used.

Purification of Sugar.—Since the exposure some four or five years ago of the American "electric sugar frauds," which, it will be remembered, deceived some of the English papers, the subject has been practically tabooed. Occasional paragraphs have cropped up in different directions, but nobody seems to know much about the matter. A French contemporary has, however, now returned to the charge. It is, of course, understood that the methods of extracting sugar from sugar juice, which is obtained from the sugar-cane or the beetroot, are practically based upon the treatment of the juices so as to eliminate mineral or organic impurities contained in them. The contemporary in question, *Les Annales Industrielles*, deals with the electrolytic purification of sugar juices mainly from a historical point of view. It would appear from this article that the only place where such a system has been tried practically is at the Hoym Sugar Works, in Anhalt, Germany. We heard of experiments at these works some time ago, but our contemporary declares that the preliminary tests were considered to be so conclusive as to lead to the installation of complete plant, which was used with complete satisfaction during the last campaign. The plant comprises two vats, which contain electrodes of zinc, aluminium, or lead formed of plates of about one metre square, with a thickness varying from 3mm to 5mm., numbering from seven, 10 to 12, and having an active surface of from 12 to 25 square metres. These electrodes are fixed to wooden bars arranged on the boxes, the even number of plates forming the anodes, and the uneven the cathodes. The current is furnished by a small dynamo, which, for a factory working 200 tons of beetroot, can be of about 1 h.p. The juices, heated to 65deg. or 75deg. F., are brought to one of the vats for electrolysis, the other vat being empty or in process of being filled. The current is then switched on and the reaction immediately commences; froth is produced with the freeing of the gases, and is removed by a "diffuser." Certain organic matters are decomposed and give rise to flaky or granulous substances, which are formed in the juice. The operation proceeds for about eight minutes; then the second vat is dealt with and the electrolysed juice is conveyed to the filters, after which it is treated in the ordinary manner.

Electrical Communication with Lighthouses.—The members of the Royal Commission sat on Tuesday in Liverpool, and received evidence as to the present means of communication between the different lighthouses and lightships in and around Liverpool Bay and the shore, and also as to the best means of supplying the present deficiencies. The Earl of Mount Edgcumbe presided, and the other members of the Commission were Sir Edward Birkbeck, Admiral Sir F. Leopold M'Clintock, Admiral Sir George Nares, Hon. H. Mulholland, M.P., Mr. R. Munro Ferguson, M.P., Mr. J. C. Lamb, Mr. W. H. Preece, Mr. J. A. Kemp, and Mr. Ernest Moggridge (secretary). Mr. Harold Bateson, local hon. secretary to the Lifeboat Institution, and the coxswain of the New Brighton lifeboat were examined, and laid before the Commission a scheme for the improvement of the communications. The former stated that it was of great importance that either the Formby Lightship or the Crosby Lightship, or both, should be connected with the shore by means of a telephone, and that that connection should be extended to every lifeboat station and every lighthouse in Liverpool Bay. The coastguards, it was remarked, were the only look-out during the whole of the day, and they in many instances were long distances, sometimes five or six miles, from the nearest telegraph or telephone station. That inaccessibility practically rendered it difficult to summon the assistance of the lifeboat to a vessel in distress within anything like reasonable time. To meet that difficulty his proposition was that a circle of telephonic service was necessary, and that being so he suggested that a connection be established between the Crosby Lightship, the Formby Lightship, and the Formby Lifeboat-house (for the lifeboat crew), thence to Waterloo Coastguard, the Northwall Lighthouse, the Liverpool Landing-stage, the New Brighton Pier, the New Brighton Lighthouse, the New Brighton Coastguard, Bidston Observatory, Hoylake Lighthouse, Hoylake Coastguard, Hilbre Signal Station, Voel Nant Signal Station, and Point of Ayr Lifeboat-house. Then he suggested a subsidiary telegraphic service from Fromby and Crosby to the General Post Office in Liverpool, and through that to New Brighton and Bidston. The Lord Mayor entertained the Commissioners to lunch at the Town Hall; afterwards they visited the Crosby Lighthouse, and on Wednesday they visited the lightships and other stations.

Lightning Flash in a Central Station. — In a recent issue of a French contemporary, M. P. Robert drew attention to a case of this nature. It appears from an abstract published in the *Journal* of the Institution of Electrical Engineers that the central station was struck by lightning during a storm which took place over Paris on April 26 last. The station in question is situated in one of the suburbs of Paris, and transmits power at high tension by means of overhead lines to other stations in Paris itself. This high-tension current works motors driving low-tension dynamos. During the storm, the station was struck, and one of the units broke down in a few seconds. The machine in question was a Marcel Deprez motor of 100 h.p., working two Edison dynamos coupled to each end of the spindle by Raffard couplings. All the electromotors in the station were insulated from earth. The foundation bolts were cemented into the foundation, and were insulated from the bed-plates of the motors by means of ebonite sleeves. The bed-plates themselves were insulated from earth by means of fibre and paraffined oak. The insulation resistance of the whole machine to earth was generally found to be from five to six megohms. Between the armature winding and the frame of the machine the insulation resistance was double these values. The high-tension overhead line, eight miles long, had an insulation of seven to eight megohms to earth. The lightning flash struck the armature of the motor, and appeared to come from the roof of the station. The discharge passed through the shaft of the motor to one of the Edison dynamos, and thence to the switchboard, where a bright flash took place, followed by a loud detonation, and finally found its way to earth through the low-tension network. On the high-tension line all fuses and lightning arresters remained intact, although one of the machines at the generating station was damaged at the same instant. The insulating materials of the motor armature which was struck were completely carbonised, and some of the bars were fused to the gunmetal spiders supporting the discs. On removing the bearings to get the armatures out, it was noticed that at two points on the shaft some of the gunmetal from the bearing had fused on to the shaft. The air-gaps had been the seat of a violent discharge, and traces of copper were found on the polar faces of the magnets. It is therefore very essential that every precaution should be taken, and that the station itself should be protected from lightning as well as the line, or otherwise the consequences may prove most fatal.

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MR. R. A. CHATTOCK,

ELECTRICAL ENGINEER TO THE HAMPSTEAD VESTRY.

In presenting the portrait of Mr. Richard Alexander Chattock, A.M.I.E.E., we have to compliment him on his recent appointment as chief electrical engineer to the Vestry of St. John, Hampstead. The subject of our sketch, who was born in 1865 at Solihull, Warwickshire, was educated at University College School, London, from which he passed in 1881 into the college. He remained there until 1884, going through the full engineering course under Prof. Kennedy, and obtained the senior Gilchrist engineering scholarship. The following year (1884-1885) he devoted his attention to the study of physics and electricity in the college laboratory. In 1886 Mr. Chattock passed the matriculation examination of the London University in the first division, and entered the marine and general engineering shops of Messrs. John Stewart and Son, at Blackwall, London, remaining there until 1889, and serving an apprenticeship as a mechanical engineer. From 1889 to 1892 he acted as assistant engineer to the Metropolitan Electric Supply Company at their several stations in Whitehall, Manchester-square, and Sardinia-street; and in the latter 1892, on the erection of the company's new station in Amberley-road, Paddington, he became superintendent engineer at that station, a position which he

has held down to his appointment to the Hampstead Vestry. In January, 1890, Mr. Chattock was admitted as an associate member of the Institution of Electrical Engineers. The Vestry of St. John, Hampstead, as will be remembered, are putting down plant for public and private lighting, with a view to eventually illuminating the whole of the parish by electricity, and the services of the newly appointed chief engineer are required in the organisation and superintendence of the station. We tender our best wishes for the success of the station under Mr. Chattock's management.

THE USE OF ACCUMULATORS WITH MOTORS.

M. G. Darrieus discusses in *L'Electricien* some of the chief points connected with the simultaneous employment of accumulators and electric motors on a circuit, and the following paragraphs contain the substance of his remarks, which are elementary but well arranged.

At the outset he disclaims any effort to analyse from an economical standpoint the use of accumulators for launches or traction work: this he leaves to hard experience, which can alone, through the logic of facts, give satisfactory conclusions. The chief difficulty which presents itself as a rule in applications of this kind is that of suitably connecting the motor with the source of energy so as to vary the speed of motor at will: but an immediate solution suggests itself at once. By varying the difference of potential at the motor terminals, the speed (which is a function of the potential difference) may also be varied. Quite a number of different methods may be employed to effect this, but, of course, the result must be the same whatever method be adopted. According to one such mode, a variable resistance is switched in between the source of energy and

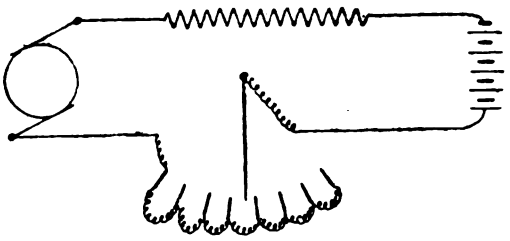

FIG. 1.

the motor in the usual fashion, as is represented in Figs. 1 and 2; in the latter instance, the resistance frame is inserted in the armature circuit, otherwise the variation in voltage produced by moving the resistance switch would vary the motor field, and act upon the speed in a sense opposite to that due to potential difference.

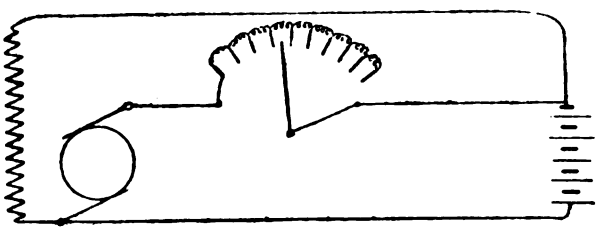

FIG. 2.

This method is only suitable when the speed variations required are few and of very short duration, outside a normal speed corresponding to switching out all the resistance, and it becomes, of course, impossible to use it with an extended scale of speeds. Moreover, it is hardly necessary to remark that this method is very wasteful, since the energy corresponding to the heat developed in the resistance is wholly dissipated without useful effect, and may form a very large fraction of the energy available.

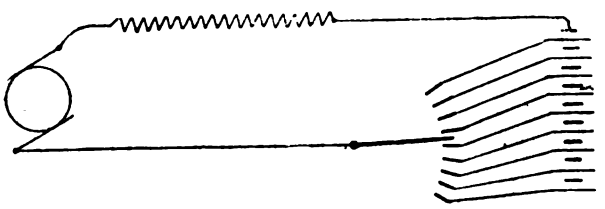

FIG. 3.

A second method of varying the potential difference consists of altering the number of accumulator cells in use. One motor terminal is connected permanently to one battery pole, and the other terminal to an appliance which throws into circuit any desired number of cells. Fig. 3

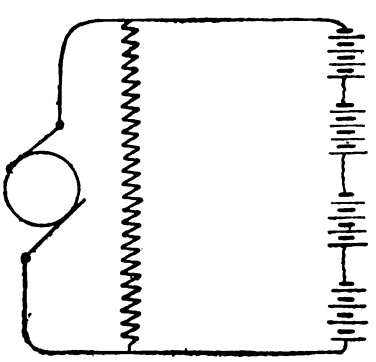

FIG. 4.

shows this device, the potential difference of current supplied to the motor being varied by a movable contact bar and contact plates, each connected to one of a series of accumulator cells. This method, however, has the serious

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disadvantage of causing an unequal discharge in the cells, with consequent difficulty in recharging and maintaining them, so that a further step in developing a satisfactory and economical plan was taken when the accumulator cells themselves were first divided into a number of equal groups, these being coupled in series or parallel, or combinations of both. The cells are, in this method, each drawn upon to the same extent, and the difficulties of charging and maintenance therefore met more easily.

The variation in arrangement of these battery groups is usually effected by an appliance comprising a series of isolated contacts mounted on a rotating cylinder with brushes (joined up to the battery terminals) pressing on them.

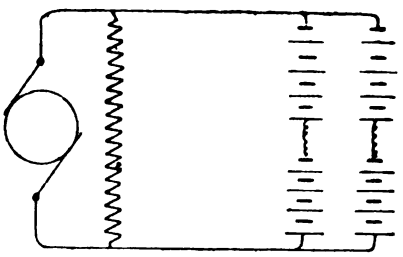

FIG. 5.

Figs. 4, 5, and 6 show a number of combinations possible on this system with four groups of battery cells, the potential differences given being respectively 200, 100, and 50 volts, with corresponding variations in motor speed. It must not, however, be forgotten that, whatever type is adopted for the winding on the motor, variations in the magnetic field produced by different voltages of the current supplied will have an opposite effect on the motor speed to that due to the change in voltage. The waste of energy on a rheostat or set of resistances, however, is avoided.

The chief objection to such a method is that the coupling up of batteries in parallel cannot be relied upon to give satisfactory results, for when we connect accumulator cells by poles of the same denomination, there is a necessary waste of energy due to the fact that the battery plates will never give identically the same E.M.F.'s, although they are to all appearance identical, and have been charged in similar fashion. This fact is readily noticed when a number of cells are charged in series, and then disconnected for separate testing: differences in molecular constitution of the plates—*i.e.*, their want of homogeneity—bad contacts, variations in density of the electrolyte, etc., all have an important effect upon the resultant discharge. The cells of slightly higher voltage discharge into those of lower voltage, the net potential difference being that due to the algebraic sum of the separate voltages.

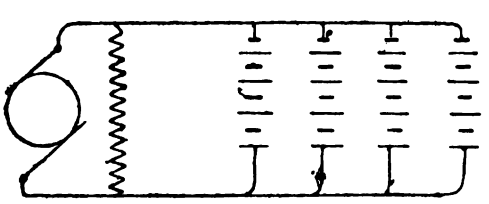

FIG. 6.

Take, for instance, a set of accumulator plates which so far as possible are identical in formation, shape, etc., physically and chemically, and let a battery of 10 cells be made up from these, and be charged in series. They are then disconnected, and joined up into two groups of five cells each; the first group contains five cells arranged, say, in series; the second, five cells in parallel. The two groups are then discharged through external resistances chosen in such a way that the density of current discharge per unit of plate surface is the same in both cases, say, for instance, ·5 ampere per square decimetre.

We ought theoretically to obtain at the battery terminals the same energy in watts, $5 E \times C$ in the first case, and $E \times 5 C$ in the second; but practically this is not the case, and the following table gives the results of tests upon 10 cells, each containing the same weight of plates.

DISCHARGED IN PARALLEL.

No. of test.	Average current. Amperes.	Average potential difference. Volts.	Total capacity. Ampere-hours.	Watt-hours.
1	80	1·87	400	748
2	82	1·86	451	839
3	78	1·875	429	804
4	73	1·865	420	783
5	75·5	1·87	359	671
6	75·3	1·88	565	1,067
Mean	77·3	1·87	437	818

DISCHARGED IN SERIES.

No. of test.	Average current. Amperes.	Average potential difference. Volts.	Total capacity. Ampere-hours.	Watt-hours.
1	16	9·40	96	902
2	16·5	9·40	98	922
3	15·5	9·50	105	988
4	15·2	9·52	90	857
5	14·5	9·49	87·2	828
6	17·1	9·46	116	1,097
Mean	15·8	9·46	98·66	932

The series of discharges in parallel entail a loss of energy of 13 per cent. as compared with the series of discharges in series.

(To be continued.)

THE CORROSION OF IRON PIPES BY THE ACTION OF ELECTRIC RAILWAY CURRENTS.*

BY D. C. JACKSON.

The foundation of this paper is an investigation carried out under my direction by Paul Biefield and Fred. D. Silber, at the University of Wisconsin. I have incorporated the report of their experiments directly into the paper as far as possible. Their work was divided under two heads: first, to determine what chemical action really occurs under the conditions that are met in towns where corrosion of the water and gas pipe systems have occurred through the action of electric railway return currents; second, to examine the action which has actually occurred in various towns, apply the deductions gathered from the results of the first division of the work, and determine the best methods of avoiding difficulty or danger from corrosion.

About two years ago engineers of the West End Street Railway Company of Boston began to connect the reinforcing wire laid between the tracks to the water-pipes, anticipating little or no trouble from so doing. They soon found that the supplementary wire was destroyed in places. They first attributed this to chemical action of the soil, but finally concluded that it was due to electrolytic action. As a remedy, they reversed the polarity of their generators, sending the current out through the rails and back through the overhead trolley wire. This change was followed by disastrous results. The current pumped through the rails took to the water-pipes and lead cable coverings, according to the law of divided circuits, and, leaving these at many points along the line, caused serious corrosions at these places. It was found that lead pipes at some points disappeared inside of six or eight weeks, and galvanised iron and brass pipes deteriorated noticeably in an equal time.

After a conference between representative of the city and the railway company, it was decided to go back to the old way of current distribution. The direction of the current was therefore reversed, and careful tests were made which showed that considerable current flowed along the water-pipes. So great, in fact, was this current that the arc formed at a joint where oakum was used for caulking was sufficient to set fire to the oakum. This loss of pressure on the return circuit was found to be from 25 to 100 volts, or from 5 per cent. to 20 per cent. of the total pressure. As an experiment the water system was connected to the negative pole of the dynamo, and now a new danger was found in the difference of potential between the gas and water pipes, causing a marked electrolytic effect on the former. It was then proposed to connect the gas and water pipes together in all parts of the city in order to arrest

* Paper read before the Western Society of Engineers, July 14.

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the action, and this was done with fair results. The expense to the city and the company was great, and the final solution of the difficulty was far from satisfactory to either party.

The report of the Board of Commissioners of Electric Subways of Brooklyn for 1892 briefly referred to the same trouble as of uncertain character and extent. Since then the problem has become very serious in Brooklyn on account of the growth of the electric railways in that city, and the same report for 1893 calls attention to the fact that discoveries of corrosion have been numerous enough to justify the belief that all kinds of buried pipes are being eaten away in many places. As an example, may be cited the fact that a certain iron service pipe buried at a depth of 4ft. below the track had been completely perforated in a month. In Brooklyn, as in Boston, connection between the return circuit and the corroded service has been tried with some some success. The means for preventing the action in Brooklyn is as yet in an experimental stage, so that proposed extensions of the railway system along the line of one of the largest water-mains in Brooklyn is regarded with anxiety.

Milwaukee has also had her share of trouble from the same cause. O. M. Rau, electrical engineer of the Milwaukee Street Railway Company, tells about it in an article in the *Street Railway Review* in December, 1893. At 2ft. from the power-house on Wells-street a 6in. water-main was so badly corroded after the electric railway had been operating for four years as to render it entirely useless. When taken out of the ground it was so soft in places that a cane could easily be poked through it. In Milwaukee the corrosion was arrested by making numerous low-resistance connections between the pipes and rails, thus keeping the two at the same potential. The connection is made most secure at the pipe station, where both pipes and rails are led to the negative pole of the generator by heavy cables. It is found that as much as 28 per cent. of the total output is now returned by means of the pipes, and no difficulty is encountered. The plan has been working very satisfactorily for over a year.

The Chicago experiences have been set forth in a report made by Prof. Barrett to Mayor Harrison in June, 1893. The destructive effects in Chicago are apparently entirely similar to those of the cities above mentioned. In Prof. Barrett's report some experimental work is referred to, in which a current of ·3 ampere, continued for three weeks, was most destructive to a lead telephone cable, while a cable which was buried in the same soil, but was not subjected to the action of the current, was unaffected.

In Zanesville, O., a 4in. cast-iron water-main was completely perforated in two years. All the neighbouring pipes were affected, some of them lasting only six months.

Columbus, O.; Hamilton, Ont.; Indianapolis, Ind.; Philadelphia; Los Angeles, Cal., and many other cities where considerable electric railway systems are in operation have experienced the same difficulties. In every case the corrosion has exhibited the same general features, and pointed to the same cause.

It is not practically agreed that the reason for the extraordinary corrosion which is referred to here is to be found in the perfect character of the return circuit of the electric railways. When electric railways were first constructed, the rails in connection with the surrounding earth were relied upon to carry all the current back to the generator. It was soon discovered that the current would not confine itself to this path and that the resistance of the earth was far from being as low as was originally supposed. Bonding the rails, cross-bonding, supplementary wires, and ground-plates were then tried. The last were found to be of little avail, while the copper bonds and supplementary wires were often themselves electrolysed, and bond wires up to the present time have frequently been far too small in cross-section for the large current to be carried. The tendency which now obtains, and which is the current one, is to make the return circuit of fully as great conductivity as that of the overhead supply circuit, without relying upon any conductivity from the ground. This is being accomplished by affecting the rail bonds and running heavy track feeders, or electrically welding the rails. There is little doubt that with a perfect return system, which is properly connected to systems of underground pipes, electrolytic disturbances will practically disappear in nearly all cities.

Though the corrosive action of the return current has been so frequently noticed and commented upon, no one has really determined what actually occurs in the ground under the conditions brought about by the operation of electric railway systems. Two theories have been put forward relative to the corrosion: first, that it is simply due to chemical action caused by ammonia, saltpetre, leakage from gas-mains, etc., found in the earth; second, that it is the result of electrolytic action. While simple chemical action undoubtedly has much to do with shortening the life of a pipe, it cannot on the face of it produce effects of the magnitude of these noted above. The ordinary life of water and gas pipes where chemical action alone is met is said to be about 20 years, while the corrosive action with which we are dealing has destroyed new pipes in intervals having from a few weeks to half-a-dozen years' duration. In every case of the corrosion to which we refer, an electric current has travelled along the pipe and the corrosive action has taken place at the point where the current left the pipe. This is conclusive proof of electrolytic action. Secondary chemical reactions play an important part in the final decomposition of the pipe, and these are dependent upon the character of the salts in the soil, but the current sets the ball rolling.

The electrolytic action of the current may occur by means of two processes: (1) direct electrolysis of iron, and (2) electrolysis of chemical compounds which are held in the water of the soil, setting up secondary chemical reactions at the electrodes. In order to have electrolysis at all it is necessary to have the equivalent of an electrolytic cell. In the case of a current leaving a pipe at any point, the pipe is the anode or positive plate of such a cell, the wastes of the soil containing the chemical compounds in solution is the electrolyte, and the rail is the cathode or negative pole of the cell. All corroded iron pipes taken from the earth present practically the same appearance. They are generally "pitted" in many places, and although the pipe is covered with a layer of reddish oxide, the bulk of the corroded metal has generally been entirely carried away in some form or other, presumably by a secondary chemical change.

In order to have the first electrolytic action go on—that is, direct electrolysis of iron—a soluble iron salt must be present in the soil, reaching from anode to cathode. The analysis of street soils shows no such salts, and hence we are safe in concluding that this factor does not enter into the corrosion to any practical extent. The point has been made by several writers on the subject that the phenomenon may be due to the electrolysis of water, the nascent oxygen set free at the anode attacking the iron directly, and forming iron oxide. An examination of the facts of electrolytic action shows that this is not an effect of practical magnitude. This leaves us but one hypothesis to work upon—that is, the electrolysis of substances held in solution in the water of the soils, with a resulting secondary chemical action on the pipes.

In order to determine as exactly as possible what occurs in the soil due to the return current, a series of laboratory experiments were performed, in which the practical conditions were reproduced as fully as possible.

Almost every chemical analysis of street soils shows the presence of some soluble salts of ammonia, potash, soda; and because of their common occurrence an experiment was performed to determine the effect of these salts on the electrolytic corrosion of iron plates per ampere-hour. Six small electrolytic cells were run in series under an electric pressure of about 100 volts, with a current varying from ·2 to ·04 ampere. The cells contained clean glass sand moistened with water containing the salts.

Cell 1 contained NH_4NO_3. (Nitrate of ammonia.)
,, 2 ,, NH_4Cl. (Chloride of ammonia.)
,, 3 ,, KMO_3. (Nitrate of potash.)
,, 4 ,, KCl. (Chloride of potash.)
,, 5 ,, $NaNO_3$. (Nitrate of soda.)
,, 6 ,, NaCl. (Chloride of soda.)

After a run of 14½ hours, the number of ampere-hours was ·7465.

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					Grammes.
Loss of anode of		NH_4NO_3	cell per ampere-hour was	....	·921
,,	,,	NH_4Cl	,, ,,	.....	1·314
,,	,,	KNO_3	,, ,,	....	1·887
,,	,,	KCl	,, ,,	.....	1·346
,,	,,	$NaNO_3$	,, ,,	.. ..	·729
,,	,,	NaCl	,, ,,	.....	1·299

It had been shown by previous experiments upon cells containing these salts that iron was carried off from the positive plates, but was not deposited on the negative plates. The deposit of iron was made in the form of a layer of hydrate or hydroxide of iron near the middle of the cell. The same was true of experiments made with cells containing street soil where only only a comparatively small percentage of carbonates was present. This explains the remark often made in reports of the corrosion of pipes, that the products of the corrosion had disappeared. It was noticed during the experiments that all the cells containing a nitrate gave off a gas at the anode, and this, on being collected, was found to be oxygen. The same cells showed an acid reaction at the anode when tested with methylorange, and the reaction grew less in tensity as the current decreased. In cell No. 1 of the series already referred to, this acidity failed to show itself when the current fell to ·6 ampere, in cell No. 3 at ·045 ampere, and in cell No. 5 it was very faint at ·04 ampere when the current was shut off. The acid reaction and the escape of oxygen in these cells seemed to be associated, and here it becomes necessary to refer to the losses of the anodes in the different cells. It will be seen that the chloride cells exhibit the greater losses, while the nitrate cells show the smaller. Moreover, the cell containing a nitrate in which the formation of acid and oxygen ceased first shows the greatest anode loss; and the one in which it continued to a slight degree to the end of the experiment shows the least. These facts point very strongly to the soundness of the theory of the corrosion which has been finally worked out—namely, in an electrolytic cell with iron electrodes and a soluble salt or salts of the metals of the alkalies or alkaline earths in solution in the electrolyte, the salt is electrolysed by the current, the acid radical attacks the anode, forming an iron salt, while the alkaline metal forms with water a hydroxide at the cathode, liberating hydrogen there. Finally, the meeting by diffusion of these two products precipitates ferrous hydroxide, Fe(OH). As the amount of electrolysis varies with the strength of the current, a comparatively high current will liberate the acid radical more rapidly than it can combine with the iron, the critical point depending upon the affinity of the acid for iron. When this excess is present the radical forms an acid by combining with water and at the same time liberates oxygen. Neither the acid nor the oxygen can combine with the anode, because that is already engaged in the formation of an iron salt with the acid radical, and hence the gas escapes into the air. If the acid is formed in sufficient quantity, it diffuses through the electrolyte, meets the alkaline hydroxide, and forms the original salt and water. In the case of chlorides the nascent chlorine liberated at the anode forms with it a chloride of iron, and if the current is strong enough to form an excess of chlorine it will be dissolved in the water, and may under the influence of light and heat form an acid and liberate oxygen, or, if enough heat is generated, free chlorine will be given off, as is shown by experiment. All conditions of these laboratory experiments are practically parallel in the earth, and hence it is safe to say that similar chemical reactions must go on there. Although the composition of street soils is more complex than the electrolytes of these experiments, they contain the same soluble salts, and as these are diffused through the moist earth they must lend themselves to exactly similar electrolytic influences and chemical changes. In fact, where street soils were used in the experiments as the electrolytes of cells which were placed in series with cells containing known quantities of simple and mixed soluble salts, the losses of the anodes were entirely comparable. It is consequently seen that only such measures as will stop the electrolytic action on salts in solution in the soil can be relied upon to stop the corrosion of iron pipes.

The soil frequently contains carbonate of calcium and magnesium which are dissolved by virtue of the carbonic acid in the water. When carbonates are present in the water to a considerable degree a reddish layer of iron carbonate is found on the pipe. This is generally mistaken by observers for oxide of iron, but we have never found the latter present as a result of electrolytic corrosion. To find the effects of carbonates upon the corrosive powers of soils we ran four electric cells in series. The first two had for electrolytes glass sand moistened with a $\frac{1}{3}$ per cent. solution of chloride of soda in distilled water, and the other two had the same electrolyte with the addition of a solution of carbonate of magnesia and carbonate of lime of uncertain strength. The latter solution was obtained by passing carbonic acid for one and a half hours through water containing equal parts of these carbonates in suspension. The test current was kept at ·09 ampere for seven hours, making ·65 ampere-hour.

The average loss of the anodes of the cells containing chloride of soda alone was ·6565 gramme, while that of the carbonate cells was ·601 gramme. This makes it evident that the presence of the carbonates does not aid in the corrosion of the anode, and even the slight cathode loss due probably to ordinary oxidation is less in these cells than in those containing the chloride only. The difference in the losses of the anode is easily explained. In some previous experiments the loss of anode caused by the electrolysis of a nitrate, a chloride and a mixture of the two was compared. The chloride caused the greatest loss of anode, the nitrate the least, and the mixture caused a loss between the two. In the same way in the case of the carbonate and the chloride, the chloride caused a certain loss of anode, and when mixed with carbonate the loss is somewhat less than when the electrolyte is a chloride alone. The fundamental effect of the carbonates is shown by a further description of the experiment. Soon after the current was turned on, the chloride cells began to show the formation of the ferrous hydroxide layer between the electrodes which has been previously spoken of, while in the other two cells a reddish layer formed at the anode spreading toward the cathode as the action progressed. The reddish layer consisted of carbonate of iron, which was formed by the action of the carbonates upon the products of the electrolysis.

The results of many experiments and the condition of corroded water-pipes as observed lead to the conclusion that under the conditions existing in street soils, the corrosion will primarily go on by virtue of the acid radicals of the hydrochloric, nitric, sulphuric, and other acids, the carbonates held in solution by virtue of the carbonic acid acting merely to change the ferrous salts to the normal iron carbonates and the ferric salts to the ferric hydroxide. Should the carbonates in solution be electrolysed in addition to the salts of the alkaline metals, the carbonic acid radical would not attack the iron, as the corrosive power of the other acids is so much greater, but would again form with the ferrous salts the iron carbonate.

Owing to the doubt which exists as to what minimum voltage is required to induce electrolysis of water-pipes by the railway current, a series of determinations was made by means of the electrolytic cells. The iron electrodes were inserted in clean glass sand 1·5 centimetres apart, and had about 20 square centimetres exposed area. In the first cell a 1 per cent. solution of nitrate of soda was used with a voltage of ·2. As before, the hydroxide layer was formed. The electrolytic action was plain without any other tests. In the following cells the existence of action was shown by chemical tests for the iron salt and the alkaline hydroxide. In the second experiment, a $\frac{1}{3}$ per cent. solution of nitrate of soda was used with five volts. The action was at once apparent.

Cell 3.	Pressure	·25	volt.				Action in	3 min.
,, 4.	,,	·125	,,				,,	5 ,,
,, 5.	,,	·125	,,	$\frac{1}{3}$	per cent.	solution.	,,	5 ,,
,, 6.	,,	·05	,,	,,	,,	,,	,,	40 ,,
,, 7.	,,	·015	,,	,,	,,	,,	,,	50 ,,
,, 8.	,,	·005	,,	,,	,,	,,	,,	1 hour.

In cell 8 the hydroxide layer began to be apparent after one hour.
Cell 9. Pressure ·001 volt. $\frac{1}{3}$ per cent. solution. Action in 1 hour.
,, 10. ,, ·01 ,, Action in 4 hours 45 minutes.
Cell 10. The electrodes were 20mm. apart, and were 40mm. by 68mm. in exposed surface. The electrolyte was street soil.

A surprisingly low voltage produced an appreciable electrolysis in the sand cells. The pressure on cell No. 10

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might undoubtedly have been reduced to a millivolt without stopping the corrosion, but the resistance of the soil was so high and the percentage of soluble salts so low that the time necessary to produce action would have been considerable. A milliammeter showed a barely perceptible reading in the case of the experiments in which very low pressure was used. The observations plainly show that a mere directive force is necessary to produce electrolysis, and the corrosion is simply a question of current.

It is impossible to give in a reasonable space even a summary of the great number of experiments which were made, but the following conclusions are directly drawn from them:

1. In no case is the action due to the electrolysis of water: where oxygen is liberated at the anode it does not attack the iron.

2. Only a mere directive force in the nature of a pressure will cause electrolysis.

3. The actual corrosion is therefore only dependent upon the actual current which flows, and is as much dependent upon the resistance of the soil as upon the pressure tending to cause the current.

4. Only a minute quantity of soluble salt is sufficient to start the action, and it will then continue as long as a current flows.

5. The gravity of a corrosion of a pipe depends on the amount of current flowing from a given area and the nature of the salts present in the soil, the order of the activity of the salts being (1) chlorides, (2) nitrates, (3) sulphates.

The following table gives the average loss of iron from the anode per ampere-hour, due to different salts and mixtures of salts. It must be remembered that the cathode or negative pole in no case showed a gain, but generally showed a slight effect due to simple oxidation.

Electrolyte—	Loss per ampere-hour.	
Street soil from a certain place	·8	gramme
,, ,, ,, Madison Electric Railway route...	1·16	,,
,, ,, ,, ,, ,, ,, ,, (clay)	1·14	,,
,, ,, ,, in front of Madison power station	·91	,,
	1	gramme
Sand with Na_2SO_4	·66	,,
,, ,, KNO_3, ½ per cent. solution	1·03	,,
,, ,, NH_4Cl ,, ,, ,,	1·38	,,
,, ,, KNO_3 ,, ,, ,, mixed	1·084	,,
,, ,, KH_4Cl ,, ,, ,,		
,, ,, NH_4NO_3	·921	,,
,, ,, NH_4Cl	1·314	,,
,, ,, KNO_3	·887	,,
,, ,, KCl	1·346	,,
,, ,, $NaNO_3$	·729	,,
,, ,, NaCl	1·299	,,
Average loss of chloride cells	1·335	,,
,, ,, nitrate cells	·892	,,
,, ,, sulphate cells	·660	,,

One ounce is equal to about 28¼ grammes.

The averages emphasise the fact that the chlorides produce the greatest losses of metal, nitrates coming next, the sulphates last, the mixtures in an intermediate place. This seems to show that the power of the acid radical to corrode varies in general as the activity of the corresponding acids.

In I. H. Farnham's paper on "The Destructive Effects of Electrical Currents on Subterranean Metal Pipes," which appeared in the *Transactions* of the American Institute of Electrical Engineers in April, 1894, the statement was made that when the current was reversed every minute extending over a period of 10 days, no material change took place in either during that time. Our experiments have shown that only the positive plate or anode is affected by the electrolytic action which occurs under practical conditions, and hence we should expect that when the current is frequently reversed both plates will be corroded, since they are alternately positive, unless the frequency of reversal is too rapid for chemical action to occur at all. In order to ascertain the effect of such reversals the following experiments were performed. An electrolytic cell was run containing a weak solution of nitrate of soda. The period of reversals ranged from fifteen seconds to five minutes, the current flowing being ·04 ampere under a pressure of three volts. After a few of the quarter-minute reversals, the presence of the iron salt was detected at both plates of potassium ferricyanide tests. On prolonging the periods the iron reaction diminished at one plate and increased at the other during the same period, and *vice versâ* in the following period. When the period of reversal reached 2½ minutes the electrolytic effect was very evident; the iron salt disappeared at one of the plates with each reversal, giving way to alkalinity. The experiments showed that the minimum period of reversal during which corrosion goes on must lie below 15 seconds, which makes the prevention of corrosion by reversals entirely impracticable from this cause alone.

The problem of preventing the destructive electrolytic effects upon iron pipes of the railway return current is shown to consist simply of the prevention of electrolysis of the salts in the soil when the products of electrolysis are of such a nature as to attack iron. It is a problem that requires a careful study of the local conditions in each case before it can be satisfactorily solved. I am quite confident, however, after carefully studying many cases of corrosion and applying the conclusions of these experiments, that there are very few places where the difficulty cannot be avoided by proper construction and arrangement of return circuits. This can ordinarily be done at a comparatively small expense, and with a resulting advantage to the operation of the railway. Some of the conditions that exert the most marked influence upon the corrosion are the nature and amount of the soluble salts in the earth, the resistance of the earth itself in the locality, and the electrical pressure between rails and pipes. High-pressure differences do not necessarily imply a high degree of action, as is shown by the condition of the Madison water-pipes. Here as much as seven volts is found between the rails and the pipes in front of the power station, and yet only a very small amount of corrosion is shown after 1½ years' time. Evidently the resistance of the path here must be very high, or the quantity of soluble nitrates, chlorides, or sulphates is extremely small. The fact that a special and ingenious instrument made to measure the amount of current showed but ·0003 ampere flowing leads to the former conclusion. On the other hand, with the favourable conditions of a low-resistance path between the pipes and the rails, and a relatively large amount of soluble salts in the earth, there is no doubt that serious electrolytic effects may be produced where a quite small difference in pressure exists between the pipe and rails. The extent of the railway system does not always offer a guide to the destructive influences of the return current. Mr. Farnham, in his paper previously referred to, mentions a small road in Rockland, Me., where much damage was done to pipes in five months, while the system in Madison, which is probably fully as extended, shows up to date (a period of nearly two years) a barely appreciable action.

The use of alternating currents, which produce no appreciable electrolysis, would avoid all difficulty, but their use for driving street-railway motors is not, up to the present time, an assured success.

The use of a double-trolley system of conductors would also avoid the major portion of the difficulty, but I believe it can be equally well avoided by proper construction where the usual single-trolley systems are used. This is not a question which has a real bearing upon the discussion of single *versus* double trolley systems. If single-trolley systems were really well built, less talk of double-trolley systems would be heard. One great advantage of double-trolley construction lies in the absolute certainty of its failure if the insulation of the lines is not excellent. Connecting the pipes and rails with heavy cables at points where the former are positive to the latter proves the most complete method of prevention. The conductivity of the track circuit must be properly reinforced by feeders, so that an undue drop is not experienced in the return conductors. These track feeders should always be insulated, and put on the lines exactly as are overhead feeders, in order to save them from corrosion. The connection of pipes and rails has been practically carried out in Milwaukee, Wis., at a cost of about 8,000dol., and has apparently done away with the trouble, and has at the same time decreased the resistance of the return circuit. In the Milwaukee system there is about 125 miles of track, and over 200 cars in daily operation. The track circuit was originally put down in excellent shape. In the Madison system present indications show that one con-

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nection between rails and pipe systems opposite the power-house, costing all told about 15dol., would prevent any serious action. Investigations have shown that when the negative pole or the generator is connected with the trolley, the pipes are positive to the rails over an extended outlying district, and corrosion goes on over a large area, while with the reversed arrangement the dangerous area is concentrated about the power station. The latter method of connection allows the difficulty to be most easily handled, and after the district within which the pipes are positive to the rails has been accurately determined by proper voltmeter tests, frequent connections of pipes and rails should be made within its limits. This can usually be done at a comparatively small cost, the interest on which may be annually saved by the decrease of lost power if the connections are properly placed. The boundaries of this district should be rechecked from time to time, and the corresponding changes in connections should be made, if the tests show that they are necessary. The outlines of the "danger district" are likely to vary with the growth of the system, and even change slightly with the seasons, and the connecting wires may be eaten away; so that vigilance is here, as everywhere, the price of safety, but safety may be absolutely secured in most cases.

Proper tests with a satisfactorily arranged voltmeter, such as was used in testing the Madison road, seem to give sufficient indications of the density of the current which is leaving the pipes at any exposed point. Such tests, when reinforced by chemical examination of the soil, probably may be used with advantage in determining the extent of the corrosive action which is occurring at any point.

I have not touched upon any argument in regard to the really serious corrosion which has sometimes occurred from other causes than electric railway return circuits. This is a matter which is now generally understood, but is of less magnitude in most cases than the electric corrosion. The owners of pipes are often at fault from the fact that they have filled the soil with electrolysable salts, but even in that case they may generally avoid danger by proper co-operation with the railway companies.

STORAGE BATTERIES.

BY HENRY F. JOEL, A.M.I.C.E.

The recent application of M. Faure for prolongation of his patents has brought this subject of storage batteries into special notice. The important part that Planté and Faure's discoveries have played in the advancement of electric lighting entitle those men to the gratitude of the many electric light engineers and others who have benefited by their labours, and more especially those who, using the pioneer researches of these men as the stepping-stones, have also succeeded in bringing their discoveries into a practical and commercial form—*i.e.*, the modern storage batteries or accumulators; but to Planté and Faure belong the merit of discovering and applying the first practical storage of electrical energy.

The absolute necessity of storage batteries for many installations of electric light, electric power, and the storage of electric energy for medical and other purposes, have induced many inventors to try to improve and perfect the batteries and the constructive details, and it is interesting now to look back and make a *résumé* of the subject, to enable us to find our exact position in the present day, so that we may press onward and continue the progress so worthily inaugurated.

The careful consideration of what has been done, and an examination of the chronological list of patents I have added, will serve to guide the enquirer and inventor in this branch of science, and possibly prevent him from rediscovering and taking out patents for old and exploded ideas and inventions which have already been patented many times over. A brief glance at the chronological list will show how many times almost exactly the same inventions have been patented, at an immense waste of time and money, and it is principally to as far as possible prevent this waste in the future that I have taken the subject in hand.

Before examining the different inventions, and to enable the student to correctly estimate the value of the processes, it will be as well to consider "The Chemistry of Lead Accumulators," taken from Dr. Gladstone and Tribe's book, and other interesting particulars, as follows:

"The sulphuric acid (H_2So_4) would appear to be the electrolyte, because if water only is used no peroxide (PbO_2) is formed.

"The chemical action of the acid on lead plates at first forms sulphate of lead ($PbSO_4$), and does so even with a small current, but a more powerful current causes the sulphate to disappear, and peroxide takes its place on the positive electrode by action of electrolytic oxygen, while the sulphate is reduced to spongy lead by electrolytic hydrogen on negative electrode."

On plates covered with minium (Pb_3O_4), the current reduces and oxidises the material on the respective plates.

The current in charging should not be too strong, as the waste of oxygen under a heavy current become large.

In discharging PbO_2 (neg. plate) | H_2SO_4 (sulphuric acid) | H_2SO_4 (sulphuric acid) | Pb (lead) is converted into = PbO (lead oxide) | H_2O (water) | H_2SO_4 (sulphuric acid) | $PbSO_4$ (sulphate of lead)

which at length becomes $PbSO_4 \mid H_2O \mid H_2O \mid PbSO_4$.

Dr. Frankland says that he considers that the formation depends on the electrolysis of hexabasic sulphuric acid $= SO_6H_6 = SO_3$ (anhydride sulphuric acid) $+ 3H_2O$ (water) which electrolyses as

$$(1)\ SO_6H_6 = \underbrace{\text{eliminated on + electrode}}_{SO_3 + 3O} + \underbrace{\text{eliminated on - electrode}}_{3H_2}$$

In charging, therefore, the chief changes appear to be

1. The electrolysis of SO_6H_6 as equation above (1).
2. The reconversion of SO_3 into SO_6H_6.
3. The chemical action in coating of + electrode
$$SO_4Pb + O + 3OH_2 = PbO_2 + SO_6H_6$$
(lead sulphate) (lead peroxide) (hexabasic sulphuric acid).
4. The chemical action in charging on − electrode
$$SO_4Pb + H_2 + 2OH_2 = Pb + SO_6H_6$$
(lead) (hexabasic sulphuric acid).

In discharging:

1. The electrolysis of SO_6H_6 as in charging.
2. The reconversion as before.
3. The chemical action upon the coating of what was the + electrode, now negative plate.
$PbO_2 + H_2 = PbO + OH_2$ immediately converted into
(lead peroxide) (lead oxide) (water)
$$PbO + SO_6H_6 = SO_4Pb + 3OH_2.$$
4. The chemical action on − electrode now + plate
$$Pb + O + SO_6H_6 = SO_4Pb + 3OH_2,$$

and thus restoring the plates to their original state before charging, and that the strength of the acid is a test for charge in cells if known before charging during discharge. That the most effective strength of acid for economy of conversion of plate is about 1 to 10, somewhere about 1,150 specific gravity.

Faraday said in 1834 of primary batteries "that weak and exhausted charges should never be used at the same time with strong and fresh ones in the different cells." This is more especially the case as regards secondary batteries, where this condition is apt to occur.

MM. Monnier and Guiton estimate that to peroxidise one kilogramme (2·204lb.) of minium it takes 56,560 C.G.S. units = 565,600 coulombs.

MM. Orova and Garbe also say:

Electro equivalent of lead = 1·0867 milligrammes.
" " " sulphuric acid = 0·51445 "

Therefore each coulomb stored up will act on plates, both of them upon 1·0867 milligrammes on each plate, setting free 1·0289 milligrammes of acid at liberty.

This, in practice, is nearly correct, as in a trial case the

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calculated increase in weight of liquid in cell after charging to actual increase of weight was as 15 to 14, fairly close.

I am indebted to my friend, the late Mr. A. P. Margary (a clever chemist and electrician), in collecting the foregoing description of the chemical changes in storage batteries.

In the list of patents it will be noted that I give several patents before Planté or Faure's describing regenerative primary batteries, with polarising and depolarising materials, etc., and, as I have stated specially in reference to Lontin's patents, these patents anticipate all secondary actions; as a fact, storage batteries, or accumulators, were often described in their early days as secondary batteries, and it is interesting to examine this part of the subject. Leclanché describes a secondary battery: the cell is made with two plates of graphite, or two plates of unoxidisible metal, an electric current is sent through the cell, and it is then capable of giving out an electrical current in the reverse direction. A. Varley and F. H. Varley describe a secondary gas battery with two lead or other plates in a cell filled with acid and water.

Planté describes his battery as follows: "First, of a small secondary pair formed of two lead strips, coiled helically, dipping in a glass vessel filled with water acidulated with 10 per cent. of sulphuric acid, and enclosed in a box," etc., and further states "the secondary pair becomes gradually charged under the action of this battery (speaking of a primary battery) after it has been previously prepared or formed by passing the current of a more powerful battery through it alternately in opposite directions, which action is prolonged for a certain length of time." It is a curious fact that Planté did not claim his battery as a novelty, but only the application for heating and other purposes.

Lontin's battery is described: "To reconstitute a galvanic battery the above-named continuous current is sent through a battery whose action is exhausted in the reverse direction to the current produced by the battery." By this process, for instance, an exhausted Smee's battery, which consists of platinum, zinc, sulphate of zinc, and water is returned to its original form of platinum, zinc, sulphuric acid, and water. Any suitable battery, such as lead with a solution of acetate of lead, could be used under this specification.

Houston and Thomson's description of their secondary battery is remarkable as being a clear exposition of the process of reversing and making primary batteries into secondary batteries.

Faure's invention is the most important of all, from a practical and commercial point of view. Faure clearly describes a quick process for forming the previously well-known Planté secondary battery, "the object in view being to deposit upon the element or upon the two elements a thick layer of metal in a rough and spongy condition, and capable of being oxidised to a considerable depth." It is important to note that it was an essential part of Faure's process to reduce the sulphate of lead first and electrolytically to metallic spongy lead, and then by an after operation to form the oxide or peroxide on the plate. Faure's patent contained beyond doubt the first practical description of the modern commercial storage battery.

Muirhead has the merit of first clearly describing the direct polarisation of plates coated with a paste of red lead by the electrolytic action of a dynamo machine.

I have purposely avoided comparing any of the patents with each other; this paper is intended to be an historical analysis of the subject of storage batteries derived principally from the best authentic source of information—viz., the inventor's own description in his sworn information.

CHRONOLOGICAL LIST OF PATENTS FOR STORAGE BATTERIES.

October 10, 1866 (2623), Brandon (Leclanché).—First patent for accumulator (a voltmeter or gas battery).

July 2, 1869 (2003), Smithers.—Chloride of lead depolariser in primary batteries.

August 25, 1869 (2525), Varley.—Gas battery (lead, etc., plates).

December 19, 1870 (3308), FitzGerald.—Primary batteries. Oxide of metals as depolarisers.

February 15, 1872 (485), Highton.—Primary Batteries. Broken carbon and peroxide of lead.

May 10, 1873 (1713), Clark (Planté).—Planté secondary battery. Lead oxidised and peroxidised by current.

February 3, 1874 (439), Highton. — Regenerative (secondary) battery.

July 14, 1874 (2462), Newton (Leclanché).—Pressure to form solid depolarisers in primary batteries.

February 8, 1875 (473), Clark (Lontin).—Regenerative batteries (secondary). Anticipates all secondary actions with solutions and salts of metal, etc.

October 29, 1878 (4348), Wilson.—Secondary. Iron and salts of metal rich in oxygen.

October 29, 1879 (4460), Lake (Houston and Thomson).—Storage battery. Solution of salts to deposit spongy metal, and regulating charge and discharge.

March 22, 1880 (1234), Clark (Reynier).—Regenerative battery (double fluid).

January 11, 1881 (129), Johnson (Faure). — Faure (augmented Planté). Pastes salt of lead in combination with inert matter (coke) to form spongy lead.

January 10, 1882 (129*), Johnson (Faure).—Disclaims felt and application to vehicles, etc.

March 14, 1881 (1097), Johnson (Société Force, etc., Paris).—Cone electrodes (Planté elements).

April 16, 1881 (1676), Johnson (Faure).—Envelopes for electrodes. Mentions use of red lead and peroxide as depolarisers.

April 22, 1881 (1745), Abel (Jablochkoff).—Oil to assist depolarisation. Electrodes of bundles of fine wire or perforated metal, etc.

May 18, 1881 (2175), Lake (Maiche). — Regenerating batteries (secondary). Claims principle (peroxide of manganese).

May 24, 1881 (2272), Swan.—Cellular plates (filled with finely divided or spongy lead). Claims plates only.

May 26, 1881 (2323), Johnson (Société Force, etc., Belgium).—Fine wire ropes, etc., and porous partitions applied by pressure (lead and woollen cloths, etc).

June 15, 1881 (2606), Muirhead.—Paste of red lead, or peroxide of lead, and polarised by dynamo (first patent for).

June 25, 1881 (2782), Newton (Tommasi). — Cellular plates or electrodes filled with finely-divided lead (lead filings). Claims this also: Lead (and tin extracted) and electrolytically deposited lead.

September 10, 1881 (3926), Sellon.—Disclaims spongy or finely-divided lead oxides, salts, etc.; but claims perforated plates, and use with salts, lead, or compounds.

September 15, 1881 (3987), Sellon.—Alloy of lead and antimony. Cage and other forms of electrodes.

September 16, 1881 (4005), Sellon.—Sheets, foil, gauze, wires, etc. Platinised copper, carbon, etc.

September 19, 1881 (4037), Clark (Kabath).—Kabath battery. Laminated corrugated strips enclosed in perforated frames. Rubber bands.

October 1, 1881 (4255), Watt.—Lead plates, or bunched strips, with electrolytical finely-divided lead, or with Weldon mud (dioxide of manganese), or lead oxide compressed on same with layer of woollen cloth between.

October 10, 1881 (4398), Reddie (Volckmar).—Reticulated or perforated plates, filled in holes with granules or filaments of lead, and then submitted to pressure.

October 13, 1881 (4455), Swan.—Abraded, cut, scraped perforated plates, and also forming same by pressure.

October 18, 1881 (4553), Jensen (Edison).—Regulating the charge and discharge.

October 22, 1881 (4632), Sellon.—Peroxide of lead to save forming, etc.

November 22, 1881 (5104), Clark (Fournier).—Lead plates. Oxide and metallic lead powder, combined by glycerine and moulded.

November 25, 1881 (5159), Crompton and FitzGerald.—Alloy of lead, and removable or decomposible metal or material; makes alloyed plates by pressure.

November 28, 1881 (5198), Biggs and Beaumont.—Claim 1: The construction of chambered cells of finely-divided lead alone, moulded by pressure. Claim 2: Construction of cells of pressed plates of finely-divided lead alone.

December 1, 1881 (5261), Newton (Volckmar).—Horizontal batteries; uses gas to assist action.

December 6, 1881 (5322), Imray (Carpentier and de Pezzer).—Thin bent plates, with corrugations to assist escape of gas; different sized plates, + and −, and soldering edges of plates together.

December 6, 1881 (5338), FitzGerald, Biggs, and Beaumont.—Claim 1: Needle-hole plates. Claim 2: Ditto and folding. Claim 3: Electro-deposited lead fabric folded and pressed. Claim 4: Heat and pressure lead granules and oxides. Claim 5: Woven lead wire chemically treated, folded, and pressed. Mentions lead wire made by drawing or squirting.

December 13, 1881 (5451), Pitkin. — Mentions combination of shreds of lead, and red lead, litharge, and other oxides. Claims electrodes made of lead shavings, shreds, etc., encased in special envelopes with central tangs.

December 14, 1881 (5481), FitzGerald.—Carbon plates pressed, and finely-divided lead and oxides.

December 15, 1881 (5494), Swan.—Makes and reduces white lead, and forms finely-divided lead on electrode.

December 17, 1881 (5521), Grout and Jones —Metallic lead dust compressed upon central plates. Mixes oxide of lead with carbonaceous material, and then heat to reduce oxide to lead.

December 23, 1881 (5631), Sellon.—Terminal plates not oxidisable, carbon, etc.

January 3, 1882 (29), FitzGerald, Biggs, and Beaumont.—Electrolytically removing alloy from compound electrode; blowing into molten lead, etc.

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January 6, 1882 (72), KENNEDY.—Making large plates, with oxides laid on plates in shallow troughs, and then submitted to current; cuts up into small plates and paints with compound.

January 9, 1882 (120), LIARDET AND DONNITHORNE.—Chemically made, finely-divided lead, and combination with plaster of Paris.

January 18, 1882 (252), LAKE (Tommasi).—Folded lead plates, corrugated and perforated; perforated plate with lead wire bound round, also charging and discharging accumulators.

January 20, 1882 (289), HUMPHREYS.—Venetian blind and lattice plates.

January 21, 1882 (319), SELLON.—Terminal plates of carbon and lead.

February 3, 1882 (538), LAKE (Barrier and Vernède).—Lead tape rolled into round, square, or other flat plates corrugated, paste of litharge and glycerine, platinised charcoal.

February 24, 1882 (905), SWAN.—Makes finely-divided lead from plumbago.

March 25, 1882 (1437), COHNE.—Lead and sulphate of mercury.

April 1, 1882 (1587), TRIBE.—Peroxide of lead plate. Peroxide pressed upon the retaining frame.

April 13, 1882 (1769), JOHNSON (Faure).—Constructing large cells with Portland cement, and supporting plates by hanging tongues.

April 19, 1882 (1875), FITZGERALD, BIGGS, AND BEAUMONT.—Claim 1: Partially oxidised electro-deposited lead compressed into plates. Claim 2: Electro-deposited lead into mould electrode. Claim 3: Porous lead electrodes, with tangs compressed in same.

April 25, 1882 (1946), BOYS.—Finely-divided lead coated with mercury and compressed, making finely-divided lead by violently shaking molten lead.

May 13, 1882 (2263), TRIBE.—Terminals not acted upon; compounds of lead pressed on to plates.

May 25, 1882 (2491), VINCENT (Elphinstone).—Finely-divided lead pressed upon plates (carbon).

June 2, 1882 (2602), BRIGHT.—Porous cells filled with finely-divided lead, shot, etc.; also treating white lead and use of dioxide of lead.

June 12, 1882 (2762), FITZGERALD.—Peroxide of lead and carbon compressed + tin, iron, lead, etc.

June 15, 1882 (2818), SELLON.—Various forms of perforations to lock or key the active material.

June 20, 1882 (2917), PARKER AND ELWELL.—Strips of lead foil coiled and filled with oxide.

June 30, 1882 (3097), WATT.—Makes finely-divided lead from alloy of lead and zinc, made fibrous or woolly by pouring the molten alloy into water, then fills in pores with finely-divided lead and decomposes zinc compressed, makes connection by strips or fingers.

July 1, 1882 (3108), HADDEN (Brush).—Makes electrodes by electrolysis, also from white lead, coates plates with finely-divided lead and oxides by compression, method of charging and discharging.

July 7, 1882 (3220), WOODLEY.—Machine for making lead-wool.

July 7, 1882 (3221), WOODLEY AND JOEL.—Use of lead-wool, and lead-wool mixed with oxide and compressed, to dispense with envelope, asbestos partitions, charging batteries of large surface. Automatic regulation.

July 8, 1882 (3240), SARNEY AND ALPROVIDGE.—Making electrodes of thin sheets of lead, rolling and folding same, coated with oxide, with paper between.

July 11, 1882 (3296), CLARKE (Planté).—Use of nitric acid to form plates; 1 acid to 2 water.

July 21, 1882 (3464), JOHNSON (Sutton).—Carbon plates, acetate of lead solution.

July 21, 1882 (3465), SOMZEE.—Cellular, mesh, or fabric plates, with cavities filled with oxide paste.

August 9, 1882 (3802), KINGZETT.—Read lead +, litharge −, plates or holders of brush-shaped metal, etc.

August 17, 1882 (3961), HANDFORD (Edison).—Arborescent metallic lead, formed from molten lead, coated on plates, or not.

August 18, 1882 (3941), COOKSON.—Lead wires, and coated with deposited lead.

August 18, 1882 (3964), BARNETT.—Finely-divided lead and felt, asbestos, etc., layers packed in boxes or cells; automatic cut-out.

August 19, 1882 (3975), WOODS.—Oxide of copper. Asbestos or woven spun-glass partition.

September 1, 1882 (4178), FITZGERALD AND JONES.—Cathode of carbon and finely-divided lead or oxide of lead; anode substance other than carbon.

September 9, 1882 (4303), FRANKLAND.—Paints or coats electrodes with hardening mixture of oxide and dilute acid; also soaks plates (12 hours) in dilute acid.

September 11, 1882 (4316), CHEESBROUGH.—Electro-depositing spongy lead on to skeleton plates; uses lead hair or fibre; also oxide and peroxide.

September 11, 1882 (4317), CHEESBROUGH.—Comminated powdered carbon and metallic salts; plates and cells filled between them; also sulphate of copper.

September 15, 1882 (4391), COOKSON.—Claim 1: Manufacture of lead filaments by squirting molten lead. Claim 2: Compressing same on to lead strips.

September 18, 1882 (4431), WATT.—Making films or pulveralent lead by the action of a jet of fluid or molten lead and coating fabric.

September 21, 1882 (4511), ANDREWS.—Apparatus for charging and discharging.

October 5, 1882 (4735), KINGZETT.—Caustic soda or alkaline solution, etc., lead, carbon, litharge; also steel, tin, iron, zinc, coated with lead and oxide; also plates, carbon, etc., coated with oxide of iron.

October 6, 1882 (4756), KHOTINSKY.—Peroxide of lead made up with divided lead plates, spongy films, or network of lead.

October 10, 1882 (4809), TATHAM AND HOLLINGS.—Vegetable fibre and finely-divided lead and oxide.

October 19, 1882 (4991), LIARDET AND DONNITHORNE.—Carbon plates, pores filled with lead, also salts of lead and use of finely-divided lead, etc.

October 24th, 1882 (5078), HILLS.—Oxide of lead in powder, and lead plates in cells or divisions.

October 31, 1882 (5183), WOODLEY AND JOEL.—Claim 1: Lead, wool, and oxide, oxide first coated on the sheets of lead. Claim 2: Plate with projecting tongue, with layer of lead, wool, and oxide. Claim 3: Wood veneers. Claims 4 and 5: Automatic charging and discharging.

January 13, 1883 (217), SELLON.—Working and regulating secondary batteries; uses pressure of gas to do so, etc.

March 1, 1883 (1122), FITZGERALD.—Coating and insulating part of electrode.

April 2, 1883 (1644), SELLON.—Acidometer float for automatically cutting out of circuit, etc.

May 1, 1883 (2214), CAPITO.—Voltmeter for regulating charge and discharge.

June 23, 1883 (3123), HOCKHAUSEN.—Regulating charge and discharge, uses hydrometer contact, etc.

August 30, 1883 (4197), FITZGERALD AND JONES.—Alloy of lead and platinum for plates or terminals.

October 1, 1883 (4657), JOEL.—Lead wool enclosed in frames, or clamping trays of plates together by bolts; also Wheatstone bridge regulator.

October 24, 1883 (5069), SELLON.—V-shaped electrodes, with special ridge edges.

December 14, 1883 (5741), SELLON.—Claim 1: Wood or porous division, and elastic clamping frame. Claim 2: Distance pieces made to form clamps. Claim 3: Wood matting. Claim 4: Ditto with elastic connections. Claim 5: Porous tiles of clay and clamped together. Claim 6: Larger size negatives and combination with above.

April 10, 1884 (6228), SELLON.—Saddle-shaped electrodes, inverted cone-shaped, etc.

April 22, 1884 (6646), JOEL.—Claim 1: Alloy of lead and tin. Claim 2: Completely enveloping terminal plate. Claim 3: Electrodes in clamping frames with bolts retained under pressure. Claim 4: Separating division, lattice work, etc. Claim 5: Several means of clamping wood clamps, etc.

July 7, 1884 (9483), HOWARD.—Special holders for electrodes of wood cradles, dovetailed ends, and grooved wood, or perforated wood partitions.

September 2, 1884 (11876), HOWARD.—Dovetailed boxes or cells.

February 9, 1885 (1764), SELLON.—Combination of horizontal and vertical compound perforated and corrugated electrodes.

PRIOR PUBLICATIONS.

1831 to 1838, FARADAY (Experimental Researches in Electricity).—Describes secondary electrolytical action; solution of acetate of lead, producing peroxide of lead. Describes method of producing peroxide of lead. Coats electrode with paste of peroxide of lead, and also red lead to form secondary battery.

June 15, 1843, WHEATSTONE (Royal Society's Bakerian Lecture).—Describes formation of peroxide of lead from decomposing secondary action from a solution of acetate of lead.

1860 to 1879, PLANTE (Researches sur l'Electricity).—Making and describing secondary batteries.

SOME FACTS ABOUT POLYPHASE MOTORS.*

BY LOUIS BELL.

(Concluded from page 221.)

COMPARISON OF A POLYPHASE AND CONTINUOUS-CURRENT MOTOR.

Fig. 2 gives a striking comparison between the properties of the two classes of machines under consideration.

The polyphase motor selected for comparison is of 2 h.p. output, representing the average small motor to be found in central-station practice. This particular size weighs 218lb. complete, and runs at a speed of about 1,400 revolutions per minute on 50 cycles, loaded. It is relatively neither better nor worse than polyphase motors of other sizes, as may be seen by reference to the curves in my previous paper on this general topic. The power factor in this case rises quite sharply, reaching 86 per cent. at half load, and through most of the working range of the motor remains at or near 90 per cent., nearly 91 per cent. as a maximum. The efficiency has its maximum a little under full load of the motor, and reaches nearly 77 per cent., being 75 per cent. at full load. Both power factor and

*A paper read at the Philadelphia meeting of the American Institute of Electrical Engineers.

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efficiency hold high values from half load up, and do not fall off seriously until some distance below half load.

Contrast with Curves A and B belonging to the polyphase motor, Curves C and D; the former is the efficiency curve of a 2-h.p. 500-volt motor of one of the well-known American makes, and Curve D is a similar curve for 2-h.p. 110-volt motor of European manufacture. These are not selected curves, but were the two completest available. Both these curves, C and D, show remarkable similarity.

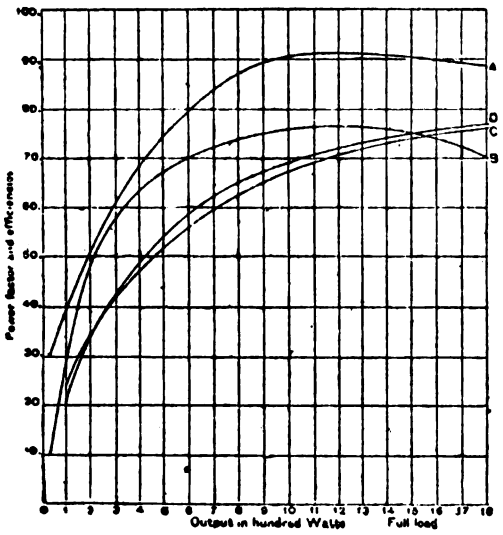


FIG. 2,

Neither of the motors sparked seriously at full load, the load limit being set rather by the heating. Both curves rise slowly, and attain their maximum values at some point beyond the available load of the machine. At full load the efficiency is substantially the same as that of the triphase motor. At low loads it is noticeably worse. I think C and D are fair average average machines. In tests of a wide variety of motors some higher and some lower efficiencies would be found. Such, too, would be the case in testing a variety of polyphase motors. In fact, the mate of the triphase motor shown, sent through the factory at the same time, showed about 1½ per cent. higher efficiency, but a complete test was not attainable, as the machine had to be immediately shipped. A comparison of these curves will render it evident that it is quite practicable to produce a polyphase

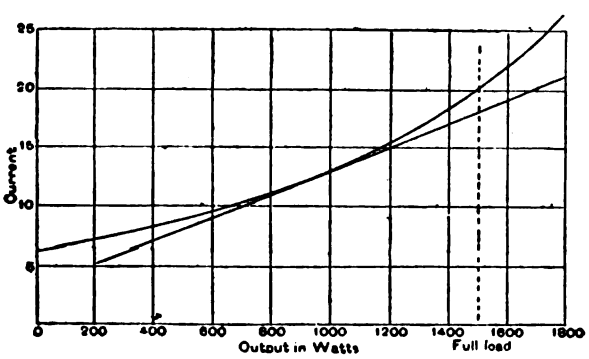


FIG. 3.

motor having an efficiency fully equal to that of direct-current motors of similar size, and I think the tendency will be towards better efficiency at moderate loads. It should be mentioned here that the 2-h.p. triphase motor was made of ordinary good armature iron.

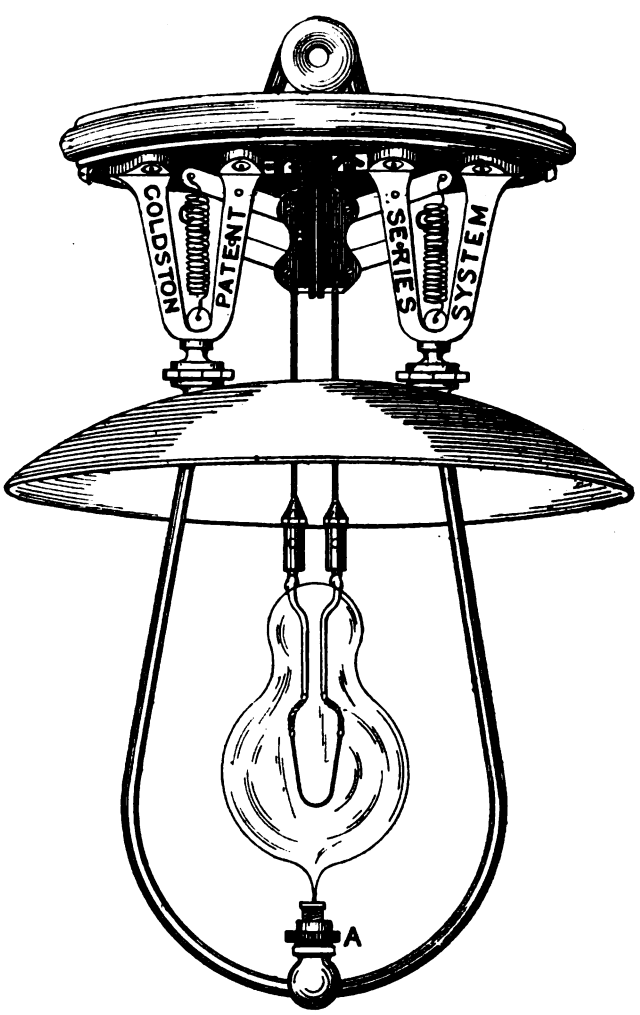
Finally, let me call sharp attention to Curve 3, which shows the effect of the power factor which, I regret to say, has been talked about not wisely but too well in most of the discussions pertaining to polyphase apparatus. Two curves in Fig. 3 show the total current in the line in the 2-h.p. triphase motor, and the 110-volt continuous-current motor above mentioned. The current curve of the continuous-current machine is nearly a straight line—that of the polyphase machine is almost tangent to it and slightly concave upward. A noticeable fact displayed is that throughout the ordinary working range of these two motors the currents were substantially equal, the existence of the power factor in the polyphase motor being only noticeable at very low loads and at overloads. This comparison should be a sufficient answer to the charges of excessive current that have so often been made against the polyphase machines. In a bad polyphase motor they would have foundation in fact. In a rather good one the net effect of the lagging current is trifling. It should further be noted that the current in this triphase motor at friction load is only about 30 per cent. of current at full load, and of this only 30 per cent. represents loss of energy. This is in marked contrast with the results obtained from a foreign triphase motor of similar size exhibited at the World's Fair, in which the no load current was nearly equal to that at full load, and the power factor at full load was barely over 50 per cent.

In this brief discussion of some of the properties of modern polyphase motors I have endeavoured to show how nearly they fulfil the conditions which may be regarded as desirable in electric motors in general. That they do so as well, if not better, than the continuous-current machines of similar capacity I believe that I have satisfactorily shown.

The demand which certainly is arising for polyphase motors for general power purposes based on their intrinsic merits indicates that the older type of machinery has found a dangerous rival, all questions of long-distance transmission aside.

THE "GOLDSTON" SYSTEM OF SERIES INCANDESCENT STREET-LIGHTING.

We called attention in our last issue to a want felt in street-lighting, and we have now to enter upon a description of how invention has attempted to supply that want



The results of any attempt at series incandescent lighting can only be obtained after trial, and we shall not therefore attempt to predict, except that if a really satisfactory system is found it has a good future before it. Mr. Goldston claims to have designed an apparatus which has

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been tried over a long period of time, though on a small scale, and has been found to be satisfactory. Our illustration is from the latest form of apparatus, a specimen of which was kindly placed at our service by the inventor. The reflector is insulated from the working parts. The action will be best seen by tracing the path of the current. Assume the apparatus in a normal condition. Assume the current to enter by the right-hand terminal, it goes through the flexible wire to the right-hand metal piece, B, through the continuing flexible wire to the lamp terminal, by the carbon filament to the left-hand flexible wire, contact-piece, and left-hand terminal. The bottom of the lamp bulb is continued as a glass rod, and the position of the bulb can be adjusted by means of the screw, A. For normal working it is adjusted so that the contact-pieces, B B, are separated by an air-space. Thus we have the force used in the adjustment opposed to the force exerted by the springs, C C, whichever act to bring the surfaces of B B into contact. The breaking of the bulb or the glass continuation allows the springs to act. B B immediately make good electrical contact, and continuity of circuit is preserved from terminal to terminal. If the carbon is ruptured it is found that an arc is formed, and a little melted metal from the action of the arc on the carbon connections drops upon the point where the glass continuation joins the bulb, and rupture takes place. In any case the arc which is set up travels up the stems, and in cracking the glass at the crown of the lamp, thus releasing the tension, the contact-makers instantly come together. When no automatic regulation is provided to compensate for any lamp being cut out, the apparatus is sent out with carbon faces on the contact-maker, a compensating resistance being thereby inserted simply and automatically. Everything seems exceedingly simple, and as trial has proved it satisfactory we may hope in the very near future of seeing a more extended use of series incandescent lighting.

THE PATHOLOGY AND TREATMENT OF ELECTRIC ACCIDENTS.*

BY W. S. HEDLEY, M.D. EDIN.

If the living body become the path of an electrical current of dangerous magnitude, what are the nature and sequence of the lesions that ensue ; and how may death occur ? Not on account of its connection with lightning stroke, nor because of a ghastly interest it may derive from the process of "electrocution," but because of those accidents that occasionally occur in connection with electric light circuits it is that this question becomes chiefly interesting. It has an obvious practical bearing on the proper treatment to be pursued in attempting the resuscitation of persons injured by such accidents—if, indeed, it be permissible to speak of electrocution as an accident—and to hint at the possibility of reanimation. One of the most useful contributions to a knowledge of this subject is a communication made by M. d'Arsonval in 1877 to the Société de Biologie ; and this has recently been followed up by interesting confirmatory evidence. It is considered that the alternating currents of commerce may cause death in either of two ways : (1) by actual lesion or destruction of tissue ; and (2) by arrest of respiration, producing asphyxia. In the former class death is actual, and nothing can restore animation ; in the latter (including electrocution) death may be, and at first often is, only apparent, recovery still being possible, and even probable, by a timely resort to artificial respiration. The following practical rule is therefore formulated : "Un foudroyé doit être traité comme un noyé." There is a limit, however, to this possibility of recovery. If the elevation of temperature produced by the passage of such currents exceed 45deg. death ensues, "as Claude Bernard has shown, by coagulation of the muscular fibres of the heart."† Should this point have been reached such cases pass into the first category of "mechanical destruction," and are not recoverable ; but in accidents of the kind under consideration the contact is generally of short duration, and the tetanic muscular contractions have not generally lasted long enough to induce the fatal elevation of temperature.‡

It is thus considered that in cases of accidental contact with electric light wires the condition is generally one of suspended animation—of only apparent death—and that by the timely use of artificial respiration real and actual death can often be averted. In attempting the restoration of persons thus injured those repeated rhythmical tractions on the tongue known as the "Laborde" method for the treatment of asphyxia are advocated. It is the procedure which its originator, in his communication to the Academy of Medicine, called "the physiological treatment of death," and its technique is thus described : "With the thumb and index finger, either bare or covered by a handkerchief, the tongue is seized by its anterior third, and powerful repeated rhythmical tractions and relaxations are carried out with a frequency of about 15 to 20 times a minute. In making these tractions it is important to feel that the dragging action affects the root of the tongue. If, in attempting to seize the tongue, it is found that the jaws are closed and the teeth clenched, open them by the finger, if possible, or use as a wedge a piece of wood or the handle of a pocket-knife, or anything of the kind that may be at hand."*

In illustration of the foregoing points an interesting case of recent occurrence is cited. Its details, as given by two electrical engineers who were eye-witnesses of the occurrence, and who assisted in the efforts at restoration, are as follows : It appears that with the voltmeter registering 4,500 volts and an ampere-meter marking 750 milliamperes an alternating current was accidentally short-circuited through the body of a man. The point of entrance was the hand, and that of emergence the buttock. The duration of contact was "certainly many minutes." More than half an hour elapsed before artificial respiration was commenced, and during that time the man showed no sign of life. Arm movements were then carried out, without apparent effect ; on practising the Laborde procedure, however, respiratory movements soon appeared, and in about two hours the man could speak. In the course of a few days he had quite recovered, excepting from the burns at the points of entry and exit. In such accidents the line of treatment to be pursued is sufficiently obvious. It is imperative that artificial respiration be promptly and patiently carried out. The pathology of the accident, however, seems by no means so simple. It is nearly a century and a half since Priestley, experimenting with Leyden jar discharges, showed that death might result from "electric shock" without structural lesion. Recent experiments, especially in electrocution, have abundantly demonstrated this. Such cases might perhaps come under d'Arsonval's second class, and it is allowable to speculate how far the result might have been averted by a timely resort to artificial respiration. How, then, in the absence of actual destruction of vital structures, may such accidents injure or kill ? What part do the lungs, heart, and nervous system respectively play in the morbid process ? How far is the process direct, or reflex, or inhibitory ? Stimuli applied through the vagus or "almost any afferent nerve" will, by reflex effects through the bulb, influence respiration, and it may probably be accepted that, if the stimulation be very strong, respiratory action may be arrested in inspiratory tetanus. So far as the heart is concerned, the inhibitory action of the vagus will come into play. Ziemssen showed in his "classic" experiments that tentanising induction currents applied to the heart of the dog produced those irregular, arhythmic, fibrillar contractions spoken of as "delirium cordis," "caused by some change in the muscular fibres themselves." Is this change a coagulation by the heat resulting from the tetanic muscular contractions ? The further experiments of Ziemssen with currents applied directly to the human heart with only pericardiam intervening, as well as the experiments of Ludwig and Hoffa, of Biedermann, MacWilliam, Herbert, and Dixon Mann, are familiar through the text-books of physiology. Such experiments may possibly serve as a guide to ordinary therapeutic work or as a starting point in the controversy as to the risks of vagus stimulation in such conditions as chloroform narcosis or other intoxications ; but they will not tell us how a modern industrial current may injure or kill. Further direct experimentation ought to be taken up from the point where the above-named investigators have left it. Cardiographic and respiratory tracings are wanted to show in sequence of time the nature and extent of the influence on circulation, respiration, and innervation of modern currents under various conditions of contact, strength, direction, and duration.

* The *Lancet*.

† According to Halliburton, *myosinigen* coagulates at 56deg.

‡ M. d'Arsonval points out that the elevation of the central temperature produced by the passage of these strong currents is not due to the "resistance of the body to the passing current, in conformity with the laws of Joule, but to the violent contractions throughout the whole of the muscular system, and also to the condition of asphyxia, as Dr. Brown-Séquard has shown."

* "If the case be one of drowning, at the beginning of the proceeding, whilst holding the tongue with one hand, pass the index finger of the other hand to the back of the fauces to induce vomiting, and clear the stomach as far as possible from water, food, etc."

Electric Deck Planers.—Messrs. Mavor and Coulson, of Glasgow, have just shipped one of Sutherland's electric deck planers to Messrs. Cramp, of Philidelphia. This is the second planer purchased by that firm.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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Vol. XIII. of new series of "THE ELECTRICAL ENGINEER" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

ELECTRICITY IN FACTORIES.

The recent meeting of the Iron and Steel Institute at Brussels directed attention once more to the value of electricity for power purposes. A brief description of the installation at the National Arms Factory at Herstal, near Liège, was given by Mr D. Selby-Bigge in his paper, an abstract of which appeared in our last issue. Great interest was shown in this description, and some members were heard to admit that they visited Belgium and the meeting solely for the purpose of visiting Herstal and examining the installation. Although the author summed up the advantages to be derived from electric driving, there was one of considerable importance which might have been made more prominent. We give Mr. D. Selby-Bigge's summary of advantages:

1. The concentration in one highly economical plant of the generation of power for the whole of the works, and great reduction in coal consumed per unit of work done.

2. Reduction in wages, owing to the very small number of officials required in connection with such a plant.

3. Transmission of the energy generated, with very trifling loss, to the different parts of the works.

4. Absence of main shafting, counter-shafting, pulleys, bearings, and belts, and heavy cost of up-keep in connection therewith.

5. Absence of long lengths of steam-pipes, and losses due to condensation.

6. Absence of scattered and separate boilers.

7. Absolute control over the economical running of the works owing to the self-indicating nature of electric motors, and the immediate detection of any undue losses which so often occur in mechanical forms of power transmission.

8. Great economy in work of an intermittent nature and varying loads, a direct proportion between the indicated horse-power of generating engine and work given out by motors being obtained.

9. Very small cost and size of foundations involved in works driven electrically.

10. Great facility for alterations and extensions, without any modification being necessary to the original plant.

It seems to us that more ought to be made of the point that with electric motors there is no loss due to the constant rotation of shafting, belts, and loose pulleys. The work demand is intermittent, but in an ordinary factory with a multiplicity of shops and tools, the shafting, belts, and loose pulleys are constantly running. It would not be difficult to ascertain the loss thereby occasioned. Indicator diagrams might be taken with all these running and no tools on, thus getting the constant demand on the engines not required in actuating the tools for doing work. The cost of driving a tool by electricity may at present and when taking the prices charged by supply companies seem and actually prove greater than the cost of steam for similar work, but the larger part of the cost of electricity stops as the tool stops; and when this is taken into consideration we fancy that the total annual cost of electric driving will, in the majority of cases, turn out to be less than that of steam driving.

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Many householders have to acknowledge that the "use only when required as light" has really diminished their light bills where electricity has replaced gas. The mistress and the maids switch on when required and switch off when not required, instead of lighting the gas in the early evening and leaving it burning till bedtime.

But besides the information given by Mr. Selby-Bigge, the many hundreds of engineers who visited the Cockerill Works at Seraing were somewhat astonished to see a sixty-ton travelling crane worked electrically. This is one of the largest, if not the largest, cranes so worked, and the ease with which it was manipulated, as well as the manner in which it did its work, caused such working to be looked upon with favour by many who had previously scoffed. There was a prevalent idea in many minds that with electricity stoppages and hitches of various kinds were constant, but these views have, we think, been almost entirely removed by actual examination. The value of this visit of the Iron and Steel Institute to Brussels upon the prospects of electrical development cannot be over-estimated. We have never been inclined to prophesy unless we know, but in this case we are certain that many prejudices have been overcome, many eyes enlightened, and that there will be less hesitation in future among the six hundred or so of the members who took part in these proceedings to test the value of electrical work in their own factories. After all, men are in some things very much like sheep, inclined to follow a leader. Individually they hesitate to take a new departure, and wait for some of their fellows to take the initiative. This is, however, but natural, for many new departures prove failures, and a return to the old paths is necessary; thus comes the inclination to let someone—not me—bear the racket of proving the new thing a success or a failure. "If it is a failure," says the individual, "I save my money. If it is a success, why I shall only be a short way behind." It is this feeling that keeps many men from going ahead, and while caution of a certain type may be commended, it is not so certain that caution of another type is advantageous. Were all men endowed with this spirit of following, there would be little progress, but the bolder spirits, and those who have more confidence in themselves, prefer to be in the first flight, well knowing that being first in the field never tells against them in business matters. It is always a gain, and the gain compensates the risk. Thus it is to be hoped that many who have held aloof will in the near future try the electrical distribution of power, and we are sure the trial, if made under due precautions, will prove satisfactory to all concerned.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

STREET-LIGHTING WITH INCANDESCENT LAMPS.

SIR,—Your article in your issue of the 24th points out that "the real solution of the problem seems to turn upon the introduction of a satisfactory method of lighting incandescent lamps in series," and that the difficulties of placing street lamps on the ordinary low-pressure mains that serve for house-lighting, etc., seems to point to a series system "as being the most likely to give satisfaction with economy." You add that, "after all, it only means the devising of a reliable and efficient cut-out for incandescent lamps—automatic in action, cheap, and simple to construct."

May I draw the attention of your readers to the fact that all the desiderata you mention already exist in Mr. Goldston's system of series incandescent lighting for public streets, of which I enclose you the printed description (with a drawing) which can be applied at this moment in any system of distribution, either alternating or continuous, which employs a current of 750 volts and upwards.

This has already been brought by me to the notice of all the municipal engineers interested in electric lighting; and as the time arrives for them to take up the question, I hope they will put themselves in communication with me.—Yours, etc., C. E. WEBBER.

London, E.C., August, 27, 1894.

[A description of this lamp mentioned is given in another column.—ED. *E.E.*]

AGEING AND MATURING BRANDY BY OZONE.

SIR,—I do not know what is the Brandy Distillers Association to whom you refer in your last issue, but it strikes me that its process for ageing brandy by ozone is extremely slow.

If maturing and improving brandies takes 18 months, the only conclusion to be arrived at is that the apparatus used are very imperfect, and produce a very poor quantity of ozone.

With a medium-sized apparatus a cask of wine or spirit can be ozonised within from four to six hours, according to the quality of the liquid, and after some weeks' rest—say three months—connoisseurs will declare that the ozone will have given a few years to the wine or spirits.

Any person who may desire to ascertain the accuracy of my statement has simply to send a small or large cask of new port wine or brandy or whisky to my works, 7, Letchford-buildings, Bethnal Green, E., where, in his presence, the wine or spirits will be ozonised and the vessels sealed, and two or three months after the liquids will be tasted and a decision given.

Not only is the expense in ageing and improving wines and whiskies or brandies trifling, but this maturing and refining of alcoholic liquids is rapid, and thus realises a great economy based on the quick turnover and on the saving of the loss by interest on capital and of the shrinkage, which always takes place by evaporation.

If ozone is applied to wines and spirits, there must be no question of waiting 18 months for the results. Eighteen weeks is already too much. E. ANDREOLI.

London, August 25, 1894.

PERSONAL.

Sir,—A circular letter, written by a gentleman with whom I was for some years connected, has been sent round which so evidently refers to myself that I feel bound to take notice of it, and should be glad if you will allow me to correct, through your columns, inferences made therein.

When I left that gentleman he was aware that I intended starting in business for myself, and also that I intended issuing a register. These things were not done without his knowledge, and as, by his statement, he found it necessary to part with me, he did so quite knowing what I was about to do, and our parting was on the most friendly terms, and as he expressed a wish that we should have business transactions together, some apparatus which were his property were put in my register, so that if he could not dispose of them I might be able to do so for him. As regards the mention of his name, I do not consider that there could be the least objection to my stating that I had left that gentleman, and it was only in this way that the name was mentioned. As regards the alteration of address, when I first commenced, and before I had taken a City

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office, I had sent out notices from my country address, and the attention was called in my register to the change to the City address. As the letter was so evidently issued for the purpose of injuring me, I am bound, though with very much regret, to correct statements made with this palpable intention.—Yours, etc., G. E. PIGGOTT.

110, Cannon-street, E.C., August 28.

LOWRIE'S INTRAPOSED SYSTEM.

SIR,—My opinion of Mr. Lowrie's compound intraposed automatic system was, as mentioned, based upon a description contained in your journal of the 27th ult. As Mr. Lowrie says that his switch works all right, I must conclude that the description was not a correct abstract from the specification. If so, I hope Mr. Lowrie will correct this abstract, the more so because the point mentioned in my letter was not the only one which seemed to show a want of knowledge of the working of a transformer. I had good reason for believing that Mr. Lowrie's system was one of the numerous inventions which are patented before thorough experiments are made, as it has been pointed out on several occasions in the *Electrical Review* that the system had not yet been subjected to a practical test. I am glad to learn that I have been under a misapprehension in this respect. I am afraid I have been somewhat misled by the name of the system; as a rule the value of a patent is inversely proportional to the square of the length of its name.—Yours, etc., S. A. FABER.

August 27, 1894.

CITY AND GUILDS OF LONDON INSTITUTE.

We have received from Messrs. Whittaker and Co., the publishers, a copy (price 10d.) of the programme of technological examinations, etc., for the session 1894-5. It may interest many of our younger readers to know exactly what the examination demands, and, while not seeking to lay too much stress upon the value of examinations, we must point out that in combination with practical work they may be enormously beneficial. The ability to answer examination questions proves a man to have a specific as well as a general knowledge of his subject. We have often said the average Englishman is neither a reader nor a student. He ought to be both. Hitherto he has thought it a grand thing to be as good as anybody else. In the struggle for existence this will not do. To succeed you must aim to be better in something than your competitors, and having achieved that distinction, you are taken from the ruck and stand upon a pedestal whereon there is not such fierce competition. Here is the syllabus for "Electric Lighting and Power Transmission":—

With the view of encouraging artisans to take a complete course of instruction in this subject, an elementary examination will be held preliminary to that in the ordinary grade. No certificates will be given to cadidates on the results of this preliminary examination, but their successes will be notified to the centre at which they were examined. Candidates may take the ordinary grade without having passed the preliminary, or both examinations may be taken in the same year. Those who pass the preliminary examination as well as the examination in the ordinary grade (whether in the same year or in a previous year) will not be required to produce a Science and Art Department's certificate in the subject of electricity and magnetism before they are eligible for the full technological certificate. In the preliminary examination no questions of a mathematical nature will be set, nor any involving calculations beyond the ordinary rules of arithmetic as applied to such matters as Ohm's law; nor will any questions be asked concerning the chemical applications of electric currents.

The preliminary examination will be held on Wednesday, May 1, from 7 to 10.

In the ordinary grade questions will be set that presuppose an acquaintance with elementary algebra, including quadratic equations, and a knowledge of the simple trigonometrical quantities, sine, cosine, etc. The candidate must be able to plot values in the form of curves. He is strongly recommended to learn the use of the slide-rule, and should bring one to the examination, or he may use in calculation a table of four-figure logarithms. Greater accuracy in working out examples than can be obtained by the use of the slide rule is not required. In marking the answers the examiners will take note not only of the correctness of the results, but also of the methods used. Simple common-sense methods, in which the general accuracy of the work can be tested step by step, are to be preferred to the use of long and complicated formulæ. Candidates are expected to be able to make simple hand sketches showing sizes of parts.

The examination in the ordinary grade will be held on Monday, May 6, from seven to ten.

In the honours grade there are three sections corresponding to the three main branches of the electrical engineering industry. The candidate must elect for himself in which of the three sections he desires to be examined. The examination will be confined solely to the single section he selects, and any questions may be asked on the subjects contained in this section, such as can be answered by a practical electrical engineer who has devoted himself specially to these subjects. In the honours grade the candidate may during the examination use an electrical engineering pocket-book; but if he avails himself of this, he must state the title of the book on his answer paper, and in his answers give references to the pages of the book he has consulted.

The examination in the honours grade will be held on Monday, May 6, from seven to ten.

I. Syllabus.—The preliminary examination will include questions founded on the following subjects:

1. General notions about electromotive force, current, resistance, and the principles of electric circuits, simple and branching. The voltage required to produce any required current in a wire of given resistance.

2. The construction and action of electric bells; the arrangements of battery cells and of circuit for bells.

3. General descriptive knowledge of magnets and electromagnets. Best methods of winding electromagnet coils for various services.

4. Simple principles and use of electric measuring instruments: ampere-meters, voltmeters, delicate mirror galvanometers, resistance coils.

5. The induction of currents by motion of magnets. Notions about magnetic lines of force. Magneto-generators for electric bells. Simple descriptive knowledge of the common sorts of dynamos and alternators.

6. The induction of currents by action of currents in neighbouring circuits. The effect of iron cores. Simple descriptive knowledge of induction coils and of transformers for alternate currents.

7. Simple principles of electric motors and of electromagnetic mechanism. The magnetic drag on wires carrying currents.

8. Elementary descriptive knowledge about incandescent lamps and arc lamps, and their arrangement in parallel and in series. The necessary parts of arc lamps, and their action.

9. The relations between mass, weight, and force. Distinction between work and power. Relations between heat and work. Relation between the watt, the kilowatt, and the horse-power. Wattmeters.

ORDINARY GRADE.

In addition to the foregoing, candidates for the ordinary grade certificate are expected to be acquainted with the following matters, except the parts contained in brackets [ ].

1. Comparison between the British units of mechanical measurement, and the international units based on the centimetre and the gramme.

2. The laws of Ohm and of Faraday respecting steady currents. [Laws of Helmholtz and of Maxwell respecting sudden and periodic currents.]

3. Electric measuring instruments for the laboratory, and the manner of using them. Wheatstone's bridge. Standards of resistance, electromotive force, and capacity.

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4. Practical ampere-meters, voltmeters, and wattmeters. Electro-dynamo-meters, current balances, electrostatic voltmeters, hot-wire instruments.

5. Magnetic properties of materials, magnetising force, induction and permeability. Hysteresis. [Methods to determine these quantities.]

6. The solenoid and its properties. The electromagnet [and its adaptations to electro-mechanical devices].

7. Mechanical strength and electric properties of materials. Conductivity of metals and alloys, and its change with temperature. Mechanical qualities and resistance of insulating materials, and the influence of temperature. [Testing of insulation resistance. Ohm meters.]

8. Condensers. Work stored in a condenser. [Dielectric strength of insulating materials and its relation to mechanical strength, incombustibility, and specific inductive capacity.]

9. Fundamental points of magneto-electric induction. Self and mutual induction. [Induction balances. Standards of self-induction. Secohm-meters.]

10. Outline of theory of continuous-current dynamos and motors. Characteristic curves.

11. The magnetic circuit as applied to dynamo machines. Types of field magnets and armatures, considered magnetically.

12. The winding of field magnets and armatures.

13. The mechanical features of dynamos and motors as regards strength of parts, heating, durability, ease of repair, construction of brushes, commutators, terminals, etc.

14. Motor generators, fundamental rules as to winding, speed, and output.

15. The electrical and mechanical efficiency of dynamos and motors. [Methods of determining efficiency.]

16. The construction [and theory] of alternators and transformers. [Alternate-current motors.]

17. [The efficiency of alternate-current apparatus.]

18. The transmission of power by direct currents over moderate distances.

19. Practical method of arranging lamps and circuits.

20. Incandescent lamps and arc lamps, watts per candle. [Photometry, illumination of rooms and open spaces.]

21. Secondary batteries, construction, use and theory.

22. Distribution of electrical energy from central stations direct and transformer systems, continuous and alternating currents, two-wire and multiple-wire mains.

[23. Central stations. Load diagrams. Conduits.]

HONOURS GRADE.

Candidates for Honours must have previously passed in the ordinary grade.

Candidates will be examined in one of the following sections:

Section I.—Electrical instruments and regulating appliances; their construction, use, etc.; or

Section II.—Dynamos, motors, accumulators, and transformers; their construction, use, etc; or

Section III.—Light and power distribution, mains, and central stations.

The candidate for the Honours Grade Examination must elect in which of the three sections he desires to be examined. The examination will be confined solely to the single section he selects, and any questions may be asked on the subjects contained in this section, such as can be answered by a practical electrical engineer who has devoted himself specially to these subjects.

SECTION I.—ELECTRICAL INSTRUMENTS, ETC.

More difficult questions will be set in subjects 1 to 8 inclusive, including the subjects contained in brackets, and in addition, a knowledge will be required of: Galvanometers, sensitive, aperiodic, astatic, differential, ballistic. The use of shunts, the calibration of instruments. Measurement of very large and very small resistances. Switchboards; safety devices; automatic regulators. Portable instruments for electric and magnetic measurements and photometry.

SECTION II.—DYNAMOS, ETC.

More difficult questions will be set in subjects 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 19, 20, including those in brackets, and in addition a knowledge will be required of; the designing of dynamos for arc and incandescent lighting, of alternators and transformers; predetermination of characteristics; armature reaction; causes of heating and sparking of machines; parallel working of alternators; the construction of motors for special purposes and gearing of same.

SECTION III.—ELECTRIC LIGHT AND POWER.

More difficult questions will be set in subjects 4, 9, 12, 13, 14, 17, 18, 19, 20, 21, including those in brackets, and in addition a knowledge will be required of electric transmission and distribution of power by continuous and alternating currents; electric railways and tramways; private electric light installations; the electrical equipment of central stations, including arrangement of dynamos, batteries, switchboard, and regulating appliances; overhead and underground mains; safety devices, testing devices, fire office rules; size of the feeders and mains in the two and three wire systems; use of sub-stations.

II. Full Technological Certificate.—A provisional certificate will be granted on the results of the above examination. For the full technological certificate in the ordinary grade the candidate who is not otherwise qualified (see above and rules 41-2) will also be required to have passed the Science and Art Department's examination in the elementary stage at least, and for the full certificate in the honours grade in the advanced stage at least, in two of the following science subjects: II., machine construction and drawing; V., mathematics; VI., theoretical mechanics; VII., applied mechanics; VIII., sound, light, and heat; IX., magnetism and electricity.

In connection with these examinations, it has been decided during the winter season to give a series of articles or lectures for the benefit of students who are unable to attend classes.

ELECTRIC CONDUCTORS FOR COAL MINES.

In the "Foreign Abstracts" of the Institution of Civil Engineers, a paper is given by Mr. J. Libert on this subject. The author states that until recently, safety lamps, using vegetable oil, were required by law to be used in all Belgian mines, and by implication electric lighting was forbidden. Lately this restriction has been removed, and it has become important to consider what kind of conductors afford the greatest degree of safety against the ignition of fire-damp, this being very common in Belgian mines. The principal danger to be guarded against is the production of sparks in case of any accident, from falling stone or otherwise, happening to the cable. The attempts that have so far been made to avoid this danger have all proceeded on the lines of dividing the current into two parts, a main and a secondary current, whose conductors are in the same envelope. These conductors are so made that in case of a rupture of the cable, one must break before the other. The first effect of the accident, then, is to throw a sudden increase of current on the line which remains unbroken, at any rate for a short while, and this increase of current is made either to interrupt or short-circuit the current outside the mine, so that the subsequent breakage of the other conductor can do no harm. In the first safety cable of this kind—viz., Atkinson's—the conductor for the auxiliary current is formed of a spiral of wires which will stretch to a great extent without breaking. A fusible plug interposed in this auxiliary circuit cuts off the current whenever the breakage of the main conductor has thrown extra current into the auxiliary circuit. The "Charleton" safety cable has the auxiliary conductor so stretched that it will break before the principal conductor, and its breakage will interrupt by electromagnetic action the current. Another cable, which it is the principal object of the paper to describe, has been invented by Mr. Nolet. It is in sections, so that any section can, if necessary, be detached for repairs. The sections are coupled by sleeves, the principal and auxiliary conductor having each its own sleeve. These sleeves slide freely on the conductors, and are very different in length, so that any accident tending to break the cable will first interrupt the auxiliary current, and this interruption, by electromagnetic appliances, will

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interrupt the main current outside the mine, where any spark would be harmless. The auxiliary conductor is a wire, and the main conductor a tube surrounding it, insulated outside and in. The auxiliary current travels in the opposite sense to that of the main current. Any other accident, such as crushing or cutting of the cable, so as to produce a contact of the principal and auxiliary conductors would equally interrupt the current before over-heating or sparking could occur. By putting in an earth connection at the middle of the auxiliary conductor, the apparatus will serve to detect any serious leakage in the main conductor.

PRACTICAL NOTES ON DYNAMO CALCULATION.*

IX.

BY ALFRED E. WIENER.

(Continued from page 157.)

By comparing the values of J found from (49) with the average given in the following Table XXXI. the rise of the armature temperature can be approximately determined, and thus a measure for the electrical quality of the armature be gained. The quality of the proportion between the armature winding and the dimensions of the core is indicated by the amount of increase of the armature temperature. If the latter is too high, it can be concluded that the winding is proportioned excessively, and either should be reduced or divided over a larger armature surface.

TABLE XXXI.—Rise of Armature Temperature Corresponding to Various Circumferential Current Densities.

Circumferential current density.	Rise of armature temperature in deg. C. High-speed (belt-driven) dynamos.	Slow-speed (direct-driven) dynamos.
50 to 100	15 to 25	10 to 20
100 ,, 200	20 ,, 35	15 ,, 25
200 ,, 300	30 ,, 50	20 ,, 35
300 ,, 400	40 ,, 60	25 ,, 40
400 ,, 500	50 ,, 70	30 ,, 45
500 ,, 600	60 ,, 80	35 ,, 50
600 ,, 700	70 ,, 90	40 ,, 60
700 ,, 800	80 ,,100	50 ,, 70

The difference in the temperature rise at same circumferential current density for high-speed and low-speed dynamos (columns 2 and 3 respectively of the above table) is due to the fact that, other conditions being equal, in a slow-speed machine less energy is absorbed by hysteresis and eddy currents; that consequently less total heat is generated in the armature, and, therefore, more cooling surface is available for the radiation of every degree of heat generated.

20. *Load Limit and Maximum Safe Output of Armatures.*—From Table XXXI. also follows that, according to the temperature increase desired, the load carried by an armature varies between 50 and 800 amperes per inch of circumference, or between about 150 and 2,500 amperes per inch of armature diameter. As a limiting value for safe working, Esson† gives 1,000 amperes per inch diameter for ring armatures, and 1,500 amperes for drums. Kapp‡ allows 2,000 amperes diametral current density for diameters over 12in. as a safe load.

Taking 1,900 amperes per inch diameter (= 600 amperes per inch circumference) as the average limiting value of the armature load, corresponding to a temperature rise of about 70deg. to 80deg. C. (see Table XXXI.), we have

$$K \times \frac{C}{2P} = 1{,}900 \times d_a \quad . \quad . \quad . \quad (50)$$

and since for the output of a dynamo we can write (see Part II., chap. 1)

$$W = E \times C = \frac{K \times \Phi \times N}{P \times 10^8 \times 60} \times C \quad . \quad . \quad (51)$$

in which

W = the output of dynamo in watts;
E = total E.M.F. generated in armature in volts;
C = total current ,, ,, ,, amperes;
K = number of armature conductors;
Φ = number of useful lines of force;
N = speed in revolutions per minute;
P = half number of parallel armature circuits (number of pairs of poles).

We obtain for the limit of the output by inserting (50) into (51):

$$W = \frac{1{,}900 \times d_a \times \Phi \times N}{10^8 \times 30} = \frac{63 \times d_a \times \Phi \times N}{10^8} \quad (52)$$

But the useful flux, Φ, is the product of gap area and field density, or

$$\Phi = \frac{d_a \times \pi}{2} \times \beta' \times l_a \times \mathfrak{B},$$

and consequently (52) becomes

$$W = \frac{63 \times d_a \times \frac{d_a \times \pi}{2} \times \beta' \times l_a \times \mathfrak{B} \times N}{10^8}$$

$$= d_a^2 \times l_a \times \beta' \mathfrak{B} \times N \times 10^{-6} \quad . \quad (53)$$

W = maximal safe output of armature, in watts;
d_a = diameter of armature core, in inches;
l_a = length ,, ,, ,,
β' = percentage of useful gap circumference; to be taken somewhat higher than percentage of polar arc to allow for circumferential spread of the lines of force (see Table XXXII.);
$\mathfrak{B}$ = Field density, in lines of force per square inch;
N = Speed in revs. per minute.

Average values for β' taken from practice are given in the following table:

TABLE XXXII.—Percentage of Effective Gap Circumference for Various Ratios of Polar Arc.

Percentage of polar arc, β.	Percentage of effective gap circumference, β'. 2 poles.	4 to 6 poles.	8 to 12 poles.	14 to 30 poles.
1·00	1·00	1·00	1·00	1·00
·95	·98	·97	·965	·96
·90	·96	·94	·93	·92
·85	·94	·905	·89	·88
·80	·91	·87	·85	·84
·75	·88	·835	·815	·80
·70	·85	·80	·78	·76
·65	·82	·765	·74	·72
·60	·78	·73	·70	·68
·55	·74	·69	.665	·64
·50	·70	·65	·625	·60

* From the *Electrical World* (New York).
† Esson, *Journal* Inst. Elec. Eng., vol. xx.. p. 142 (1890.)
‡ Kapp, "S. P. Thompson's Dynamo Electric Machinery," fourth edition, p. 439.

REPORT ON DRY CELLS.

THE E.C.C. AND OBACH CELLS.

In our issue of August 3, we referred to the report prepared by Prof. Andrew Jamieson, M.I.C.E, on dry cells of the Obach and E.C.C. types, and promised to again refer to the subject on a future occasion. We now take the opportunity of dealing with the matter. There were two series of tests—these being taken by Messrs. David A. Ramsey, John Burns, and James Macgregor.

The first series of tests were made with a No. 2 E.C.C. cell weighing 2lb. 2oz., and of the following dimensions, 16·5cm. by 6·5cm. diameter; and with a No. B Obach cell weighing 2lb. 10oz. and 15·6cm. by 6·5cm. in diameter. The tests were taken in order to determine (1) potential current, the variation of the potential difference at the terminals of each cell due to the variation of the current strength in its external circuit; (2) potential time, fall of potential while on closed circuit and maintaining approximately the same current throughout the whole test; (3) total output in ampere-hours, discharging through a constant resistance until practically exhausted.

Two galvanometers were used—one of very high resistance as a voltmeter, and the other of very low resistance as an ammeter. The high-resistance astatic mirror galvanometer of 26,000 ohms (which was used as the voltmeter) had in circuit with it a resistance of 100,000 ohms, so that the total resistance was about 126,000 ohms. It was so controlled that a new Latimer Clark's standard cell of 1·454 volts at 15deg. C. produced a deflection of 300 scale divisions. Consequently, one scale division = $\frac{1}{3}\cdot\frac{1}{4}\frac{1}{5}^4$ or ·0048 volt. The low-resistance mirror galvanometer was under strong magnetic control and shunted by a short thick copper wire. It was then carefully calibrated for milliamperes by the college Kelvin balance. Paraffin blocks with mercury-cups were used as switches, and the connections were made by stout copper wires.

The total output in the case of the Obach cell was 17·4 ampere-hours, and with the E.C.C. No. 2 cell 15·1 ampere-hours, being an excess of Obach over E.C.C. of 2·3 ampere-hours.

The second series of tests is quoted from the report as follows:

A new pair of cells was used for this series of tests—namely, an Obach A and an E.C.C. No. 1.

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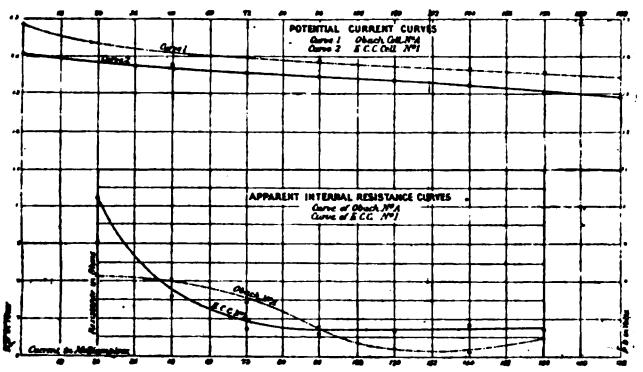
TABLE I.—Weights and Dimensions.

	Weight.	Dimensions.
Obach A	4lb. 6oz.	7¼" × 3⅛" diameter.
E.C.C. No. 1..	3lb. 9oz.	7¼" × 3⅛" diameter.

The tests taken were as follows: (1) potential current; (2) internal resistance; (3) total output in ampere-hours and watt-hours; (4) recuperativity; (4A) potential time; (5) behaviour as storage cells; (5A) power time or output in watt-hours.

Test 1: Potential Current.—The connections were the same as before. The test was conducted as follows: (1) the E.M.F. of each cell was taken; (2) currents of certain values were obtained from each cell alternately for five minutes; (3) the potential difference and current at the end of each period of five minutes was noted; (4) at the end of each five minutes the current was stopped, and readings taken of E.M.F. every five seconds until it became steady. By plotting the curve backwards, the value of the E.M.F. at the end of the five minutes was ascertained.



SHEET I.

Table II. shows a few of the results (see "Potential Current," Curves 1 and 2 on Sheet I.):

TABLE II.

Current in amperes	Obach A.			E.C.C. No. 1.		
	E.M.F. in volts.	P.D. in volts.	E.M.F. at end of each five minutes.	E.M.F. in volts.	P.D. in volts.	E.M.F. at end of each five minutes.
0·000	1·488	—	—	1·401	—	—
0·024	—	1·430	1·440	—	1·372	1·392
0·048	1·430	1·410	1·432	1·392	1·372	1·387
0·072	1·420	1·392	1·412	1·372	1·358	1·368
0·096	1·420	1·382	1·392	1·372	1·344	1·358
0·120	1·416	1·368	1·372	1·368	1 329	1·344
0·144	1·401	1·368	1·372	1·368	1 320	1·344
0·168	1·392	1·358	1·372	1·359	1 305	1·329
0·192	1·392	1·344	1·368	1·344	1 296	1·320
0·216	1·372	1·344	1·368	—	—	—

Test 2: Internal Resistance as calculated from the results of Test 1, given in Table II. The potential difference at the end of each period of five minutes was deducted from the total E.M.F. at the end of each period. This gives the voltage absorbed inside the cell. Then this internal voltage or fall of potential inside the cell, divided by the current at the time, gives the apparent internal resistance of the cell. The following table shows the results (see Sheet I. for curves):

TABLE III.

E.M.F. absorbed (volts).		Current (amperes).	Resistance of cell (ohms).	
Obach A.	E.C.C. 1.	Obach and E.C.C.	Obach A.	E.C.C. 1.
·010	·020	·024	·416	·833
·020	·015	·048	·416	·312
·020	·010	·072	·281	·138
·010	·014	·096	·104	·145
·004	·015	·120	·033	·125
·004	·024	·144	·027	·166
·014	·024	·168	·083	·142
·024	·024	·192	·125	·125
·024	—	·216	·111	—

Test 3: Total Output.—The cells used in the last test—viz., an Obach A and an E.C.C. No. 1—were connected up with a constant resistance of about 10 ohms. A reading of the E.M.F. was taken at the beginning. Then readings of current and potential difference were taken every 10 minutes for two hours, and less frequently afterwards. Voltameters were also placed in circuit to find the total ampere-hours.

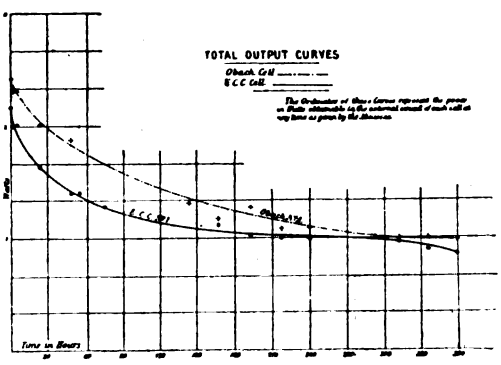
The gain of the Obach's plate = 40·557 grammes.
" " E.C.C.'s " = 35·264 "

Weight of copper deposited in one hour by one ampere = 1·177 grammes, therefore the total number of ampere-hours from
Obach A. ..... = 34·4 ampere-hours.
E.C.C. No. 1 ..... = 29·9 "

Table IV. shows a few of the results (see Sheet II. for curves).

TABLE IV.

Time.	Obach A.			E.C.C. No. 1.		
	P.D. in volts.	Current in amperes.	Watts.	P.D. in volts.	Current in amperes.	Watts.
Minutes.						
0	1·488	·162	·241	1·464	·148	·216
10	1·440	·162	233	1·416	·146	·206
20	1·440	·162	·233	1·372	·145	·199
30	1·416	·162	·229	1·372	·145	·199
60	1·416	·162	229	1·348	·146	·199
90	1·416	·165	·233	1 348	·147	·200
120	1·416	·170	·234	1·344	·150	·202
Hours.						
4½	1 392	·172	·236	1 344	.152	·201
23½	1·296	·161	·206	1·195	·138	·164
47½	1·272	·157	·188	1·104	·127	·140
74	1·200	·156	·133	1·046	·124	·129
240	0 902	·122	·109	0 902	·110	·099
336	0·902	·114	·099	0·902	·108	·090
360	0·864	·112	·094	0 888	·106	·088



SHEET II.

TABLE V.—Showing E.M.F., P.D., Resistance, and Output.

Cell.	E.M.F. in volts.	Potential difference in volts.		Resistance in ohms.		Output.	
		Initial.	Final.	Int.	Ext.	Amp. hours.	Watt hours.
				Approx.	Approx.		
Obach A. ...	1·488	1 440	0·864	·30	10	34 4	50·2
E.C.C. No. 1	1·464	1 372	0·888	·62	10	29 9	34·4

Test 4: Recuperativity.—This test was carried out with the same cells as in the last test—viz., Obach A and E.C.C. No. 1. They were short-circuited for 120 hours, so as to be practically exhausted. The same galvanometer was employed as a voltmeter, and readings of the potential difference were taken every five minutes for an hour, and at longer intervals thereafter. Table VI gives a few of the results* (see Sheet III. for curves):

* Note of Messrs. Siemens Bros. and Co., Limited, London, June 2, 1894.—Referring to Prof. Jamieson's Test 4 on recuperativity, and the corresponding curves on Sheet III., it might seem at first glance that the recuperation of the "E.C.C." cell, shown in the above Table VI. as 1·056 volts, was superior to that of the "Obach" cell, which reached a voltage of only ·782. A closer investigation of this statement, although correct in itself, shows that the "Obach" cell had when this test began an internal resistance of only ·3 ohm, whereas that of the "E.C.C." had already attained more than double that amount—viz., ·62 ohm. The output of current during the short-circuiting for 120 hours must therefore have been considerably greater for the "Obach" cell, by reason of its lower resistance, than in the "E.C.C." cell. In consequence of this, the test of recuperativity showed after 10 minutes a voltage of ·288 for the Obach, and ·576 for the E.C.C., resulting after 24 hours' recuperation in a net increase of ·494 volt in favour of the Obach, and ·480 volt in favour of the E.C.C. This is a result most favourable for the Obach cell, the more so when we consider that it was doubly as much exhausted when the experiment began as its competing E.C.C. cell. According to our own experiments, we are in a position to say that had a longer time been allowed for recovery, say some days, instead of one day only, our cell would invariably reach by recuperation a final E.M.F. of 1·2 to 1·3 volts. This maximum is more rapidly reached by the smaller than by the larger sizes, since it depends almost entirely on the rapidity of permeation of the depolariser by atmospheric oxygen.—Approved by Prof. Jamieson.

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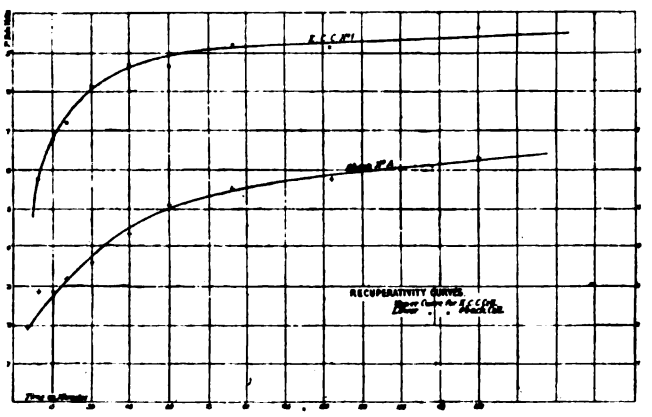
TABLE VI.

Time.	P.D. Obach A.	P.D. E.C.C. No. 1	Time.	P.D. Obach A.	P.D. E.C.C. No. 1
Minutes.	Volt.	Volt.	Minutes.	Volt.	Volt.
5	·192	—	50	·480	.864
10	·288	·576	55	·480	·864
15	·288	·672	60	·504	·864
20	·312	·720	65	·528	·880
25	·336	·768	85	·552	·912
30	·360	·816	125	·576	·912
			Hours.		
35	·384	·816	3	·624	·960
40	·432	·864	24	·782*	1·056*
45	·432	·864	—	—	—



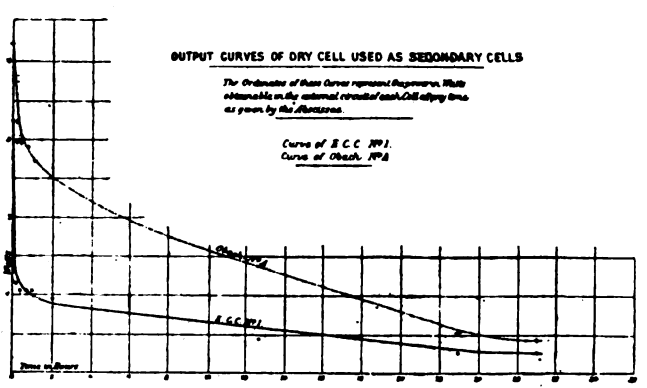
SHEET III.

Test 4a: Potential Time.—This is the same as Test 3. Both cells were coupled up through a constant resistance of five ohms, and the fall of voltage was noted for about an hour after the current started.

TABLE VII.

Time.	Obach A. (P.D.)	E.C.C. 1. (P.D.)	Time.	Obach A. (P.D.)	E C.C. 1. (P.D.)
Minutes.	Volt.	Volt.	Minutes.	Volt.	Volt.
0	·888	1·094	30	·528	·624
5	·576	·648	35	·528	·624
10	·555	·648	40	·513	·614
15	·537	·648	45	·504	·600
20	·528	·633	50	·480	·600
25	·528	·624	55	·480	·600

Test 5: Behaviour as Storage Cells.—The above cells were then short-circuited for a considerable time until the voltage had fallen to ·048 volt in the case of the Obach, and ·168 volt in the case of the E.C.C. They were then connected up in series and charged with a current of about two amperes from the storage cells in the laboratory. The current was kept on for seven hours—*i.e.*, until 14 ampere-hours had been given to them. The E.M.F.'s, when disconnected, were: Obach = 1·464 volts; and E.C.C. = 1·296 volts.



SHEET IV.

Test 5a: Power Time.—(See Sheet IV. for curves) The cells were then discharged through a constant resistance of five ohms, and the potential difference was observed every four minutes, as follows in Table VIII. The output in watts was derived from the product of the respective potential differences and their corresponding calculated currents; or from $P.D.^2 \div R$, where R = 5 ohms external resistance.

Remarks.—Since these results have been obtained under exactly the same conditions for each cell, they form a very fair comparison of their general efficiency. They demonstrate in most cases the superiority of the Obach cell. This may be accounted for by its greater weight*, as it is 8oz. heavier than the E.C.C., but it is very little greater in bulk, and is quite as convenient to handle. When a large current is taken, a viscous sort of fluid begins to ooze from the Obach cell.† This may prove troublesome unless it is noticed. It may be said, however, that with the moderate currents used in these tests no trouble was experienced until they were short-circuited, when, of course, the current was only limited by the internal resistance of the cell.

TABLE VIII.

Time.	Obach A.		E.C.C. No. 1.	
	P.D. in volts.	Corresponding current in amperes or P.D. ÷ R.	P.D. in volts.	Corresponding current in amperes or P.D. ÷ R.
Minutes.				
0	1·464	1·464/5 = ·292	1·296	1·296/5 = ·259
4	1·296	·259	·816	·163
8	1·272	·254	·768	·153
12	1·248	·249	·768	·153
16	1·248	·249	·768	·153
20	1·248	·249	·744	·148
24	1·248	·249	·744	·148
32	1·224	·244	·744	·148
40	1·200	·240	·744	·148
48	1·200	·240	·744	·148
60	1·186	·237	·744	·148
120	1·152	·230	·720	·144
Hours.				
23	·528	·105	·384	·076
27	·480	·096	·384	·076

Bell Ringing Test (taken by John Burns, March and April, 1894).—In addition to these tests, two cells (one Obach and one E.C.C.) were tried in order to ascertain which of them would ring an electric bell for the longer time. The two cells were alternately placed in circuit with a trembling bell for six minutes at a time by means of a clock and mercury contacts. Each cell had alternately six minutes' work of ringing the bell and six minutes' rest. After the clock had gone 1,552 hours 30 minutes, the E.C.C. cell failed to ring the bell. It had consequently done 776 hours 15 minutes' work with a corresponding time of rest. The Obach cell continued to ring the same bell, under identically the same conditions, for 1,700 hours 30 minutes from the commencement, or 850 hours 15 minutes' of work, with a corresponding number of hours' rest. Thus the Obach cell rang the bell for 74 hours longer than the E.C.C. cell.

ELECTRICAL STANDARDS.

NEW DENOMINATIONS.

An Order by the Queen in Council specifying and describing the new standards of electrical measurements for use in trade was published in the *London Gazette* last Friday. The Order is as follows:

Whereas by the Weights and Measures Act, 1889, it is among other things enacted that the Board of Trade shall from time to time cause such new denominations of standards for the measurement of electricity as appear to them to be required for use in trade to be made and duly verified.

And whereas it has been made to appear to the Board of Trade that new denominations of standards are required for use in trade based upon the following units of electrical measurement—viz.:

1. The ohm, which has the value 10^9 in terms of the centimetre and the second of time, and is represented by the resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice 14·4521 grammes in mass of a constant cross-sectional area and of a length of 106·3 centimetres.

2. The ampere, which has the value $\frac{1}{10}$ in terms of the centimetre, the gramme, and the second of time, and which is represented by the unvarying electric current which when passed through a solution of nitrate of silver in water in accordance with the specification appended hereto, and marked A, deposits silver at the rate of 0·001118 of a gramme per second.

3. The volt, which has the value 10^8 in terms of the centimetre, the gramme, and the second of time, being the electrical pressure that if steadily applied to a conductor whose resistance is one ohm will produce a current of one ampere, and which is represented by ·6974 ($\frac{1000}{1434}$) of the electrical pressure at a temperature of

* As regards the somewhat greater weight of our cell in comparison with the E.C.C., this is chiefly due to the use of thicker zinc for our cells. Prof. Jamieson, in his former report, called attention to the circumstance that the E.C.C. zincs were too thin for practical purposes; the heavier zinc is therefore rather an advantage than otherwise.—S. B. and Co.

† With our earlier make of these cells, which were the sort supplied to Prof. Jamieson, a viscous liquid occasionally oozed from the cell; we have, however, since then entirely overcome this defect by some slight alterations in the construction of the cell.—S. B. and Co.

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15deg. C. between the poles of the voltaic cell known as Clark's cell set up in accordance with the specification appended hereto, and marked B.

And whereas they have caused the said new denominations of standards to be made and duly verified.

Now, therefore, her Majesty, by virtue of the power vested in her by the said Act, by and with the advice of her Privy Council, is pleased to approve the several denominations of standards set forth in the schedule hereto as new denominations of standards for electrical measurement. C. L. PEEL.

SCHEDULE.

I. *Standard of Electrical Resistance.*—A standard of electrical resistance denominated one ohm being the resistance between the copper terminals of the instrument marked "Board of Trade Ohm Standard Verified 1894" to the passage of an unvarying electrical current, when the coil of insulated wire forming part of the aforesaid instrument and connected to the aforesaid terminals is in all parts at a temperature of 15·4 C.

II. *Standard of Electrical Current.*—A standard of electrical current denominated one ampere being the current which is passing in and through the coils of wire forming part of the instrument marked "Board of Trade Ampere Standard Verified 1894," when, on reversing the current in the fixed coils, the change in the forces acting upon the suspended coil in its sighted position is exactly balanced by the force exerted by gravity in Westminster upon the iridio-platinum weight marked A, and forming part of the said instrument.

III. *Standard of Electrical Pressure.*—A standard of electrical pressure denominated one volt being one-hundredth part of the pressure which, when applied between the terminals forming part of the instrument marked "Board of Trade Volt Standard Verified 1894," causes that rotation of the suspended portion of the instrument which is exactly measured by the coincidence of the sighting wire with the image of the fiducial mark A before and after application of the pressure, and with that of the fiducial mark B during the application of the pressure, these images being produced by the suspended mirror and observed by means of the eyepiece.

In the use of the above standards the limits of accuracy attainable are as follows:

For the ohm, within one-hundredth part of 1 per cent.
For the ampere, within one-tenth part of 1 per cent.
For the volt, within one-tenth part of 1 per cent.

The coils and instruments referred to in this schedule are deposited at the Board of Trade Standardising Laboratory, 8, Richmond-terrace, Whitehall, London.

SPECIFICATIONS referred to in the foregoing Order in Council.

SPECIFICATION A.

In the following specification the term silver voltameter means the arrangement of apparatus by means of which an electric current is passed through a solution of nitrate of silver in water. The silver voltameter measures the total electrical quantity which has passed during the time of the experiment, and by noting this time the time average of the current, or if the current has been kept constant the current itself, can be deduced.

In employing the silver voltameter to measure currents of about one ampere the following arrangements should be adopted: The cathode on which the silver is to be deposited should take the form of a platinum bowl not less than 10 centimetres in diameter, and from four to five centimetres in depth.

The anode should be a plate of pure silver some 30 square centimetres in area and two or three millimetres in thickness.

This is supported horizontally in the liquid near the top of the solution by a platinum wire passed through holes in the plate at opposite corners. To prevent the disintegrated silver which is formed on the anode from falling on to the cathode, the anode should be wrapped round with pure filter paper, secured at the back with sealing-wax.

The liquid should consist of a neutral solution of pure silver nitrate, containing about 15 parts by weight of the nitrate to 85 parts of water.

The resistance of the voltameter changes somewhat as the current passes. To prevent these changes having too great an effect on the current, some resistance besides that of the voltameter should be inserted in the circuit. The total metallic resistance of the circuit should not be less than 10 ohms.

Method of Making a Measurement.

The platinum bowl is washed with nitric acid and distilled water, dried by heat, and then left to cool in a desiccator. When thoroughly dry it is weighed carefully.

It is nearly filled with the solution, and connected to the rest of the circuit by being placed on a clean copper support to which a binding screw is attached. This copper support must be insulated.

The anode is then immersed in the solution so as to be well covered by it, and supported in that position; the connections to the rest of the circuit are made.

Contact is made at the key, noting the time of contact. The current is allowed to pass for not less than half-an-hour, and the time at which contact is broken is observed. Care must be taken that the clock used is keeping correct time during this interval.

The solution is now removed from the bowl, and the deposit is washed with distilled water and left to soak for at least six hours. It is then rinsed successively with distilled water and absolute alcohol, and dried in a hot-air bath at a temperature of about 160deg. C. After cooling in a desiccator it is weighed again. The gain in weight gives the silver deposited.

To find the current in amperes, this weight, expressed in grammes, must be divided by the number of seconds during which the current has been passed, and by 0·001118.

The result will be the time average of the current, if during the interval the current has varied.

In determining by this method the constant of an instrument the current should be kept as nearly constant as possible, and the readings of the instrument observed at frequent intervals of time. These observations give a curve from which the reading corresponding to the mean current (time average of the current) can be found. The current, as calculated by the voltameter, corresponds to this reading.

SPECIFICATION B.

ON THE PREPARATION OF THE CLARK CELL.

Definition of the Cell.

The cell consists of zinc or an amalgam of zinc with mercury and of mercury in a neutral saturated solution of zinc sulphate and mercurous sulphate in water, prepared with mercurous sulphate in excess.

Preparation of the Materials.

1. *The Mercury.*—To secure purity it should be first treated with acid in the usual manner, and subsequently distilled *in vacuo*.

2. *The Zinc.*—Take a portion of a rod of pure redistilled zinc, solder to one end a piece of copper wire, clean the whole with glass-paper or a steel burnisher, carefully removing any loose pieces of the zinc. Just before making-up the cell dip the zinc into dilute sulphuric acid, wash with distilled water, and dry with a clean cloth or filter paper.

3. *The Mercurous Sulphate.*—Take mercurous sulphate, purchased as pure, mix with it a small quantity of pure mercury, and wash the whole thoroughly with cold distilled water by agitation in a bottle; drain off the water, and repeat the process at least twice. After the last washing, drain off as much of the water as possible.

4. *The Zinc Sulphate Solution.*—Prepare a neutral saturated solution of pure ("pure recrystalised") zinc sulphate by mixing in a flask distilled water with nearly twice its weight of crystals of pure zinc sulphate, and adding zinc oxide in the proportion of about 2 per cent. by weight of the zinc sulphate crystals to neutralise any free acid. The crystals should be dissolved with the aid of gentle heat, but the temperature to which the solution is raised should not exceed 30deg. C. Mercurous sulphate treated as described in 3 should be added in the proportion of about 12 per cent. by weight of the zinc sulphate crystals to neutralise any free zinc oxide remaining, and the solution filtered, while still warm, into a stock bottle. Crystals should form as it cools.

5. *The Mercurous Sulphate and Zinc Sulphate Paste.*—Mix the washed mercurous sulphate with the zinc sulphate solution, adding sufficient crystals of zinc sulphate from the stock bottle to ensure saturation, and a small quantity of pure mercury. Shake these up well together to form a paste of the consistence of cream. Heat the paste, but not above a temperature of 30deg. C. Keep the paste for an hour at this temperature, agitating it from time to time, then allow it to cool; continue to shake it occasionally while it is cooling. Crystals of zinc sulphate should then be distinctly visible, and should be distributed throughout the mass; if this is not the case, add more crystals from the stock bottle, and repeat the whole process.

This method ensures the formation of a saturated solution of zinc and mercurous sulphates in water.

To set up the Cell.

The cell may conveniently be set up in a small test tube of about two centimetres diameter, and four or five centimetres deep. Place the mercury in the bottom of this tube, filling it to a depth of, say, ·5 centimetre. Cut a cork about ·5 centimetre thick to fit the tube; at one side of the cork bore a hole through which the zinc rod can pass tightly; at the other side bore another hole for the glass tube which covers the platinum wire; at the edge of the cork cut a nick through which the air can pass when the cork is pushed into the tube. Wash the cork thoroughly with warm water, and leave it to soak in water for some hours before use. Pass the zinc rod about one centimetre through the cork.

Contact is made with the mercury by means of a platinum wire about No. 22 gauge. This is protected from contact with the other materials of the cell by being sealed into a glass tube. The ends of the wire project from the ends of the tube; one end forms the terminal, the other end and a portion of the glass tube dip into the mercury.

Clean the glass tube and platinum wire carefully, then heat the exposed end of the platinum red hot, and insert it in the mercury in the test tube, taking care that the whole of the exposed platinum is covered.

Shake up the paste and introduce it without contact with the upper part of the walls of the test tube, filling the tube above the mercury to a depth of rather more than one centimetre.

Then insert the cork and zinc rod, passing the glass tube through the hole prepared for it. Push the cork gently down until its lower surface is nearly in contact with the liquid. The air will thus be nearly all expelled, and the cell should be left in this condition for at least 24 hours before sealing, which should be done as follows.

Melt some marine glue until it is fluid enough to pour by its own weight, and pour it into the test tube above the cork, using sufficient to cover completely the zinc and soldering. The glass tube containing the platinum wire should project some way above the top of the marine glue.

The cell may be sealed in a more permanent manner by coating

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the marine glue, when it is set, with a solution of sodium silicate, and leaving it to harden.

The cell thus set up may be mounted in any desirable manner. It is convenient to arrange the mounting so that the cell may be immersed in a water-bath up to the level of, say, the upper surface of the cork. Its temperature can then be determined more accurately than is possible when the cell is in air.

In using the cell sudden variations of temperatures should as far as possible be avoided.

The form of the vessel containing the cell may be varied. In the H form, the zinc is replaced by an amalgam of 10 parts by weight of zinc to 90 of mercury. The other materials should be prepared as already described. Contact is made with the amalgam in one leg of the cell, and with the mercury in the other, by means of platinum wires sealed through the glass.

MR. MOLESBY'S MYSTERIOUS MOTOR.

The inauguration of the new electricity works at Garnesdon* was not a huge success, unless viewed in the light of a farce or from the local gas company's point of view. Never, surely, since the days of Eve had a chairman's good lady pressed an inaugurative electric button to such little useful purpose. True it is that certain effects were produced—to wit, irritating smiles on the faces of the guests, anguished disappointment in the hearts of the board of directors and the permanent officials, and wild and weird blasphemy from the lips of the working staff behind the scenes when they heard the "fizz-z-zpit" of the main fuse, realised the unaccountable clogging of a turbine, and became aware of the fact that the exciter in use had developed a short-circuit in its armature windings.

However, the chairman stuck to his guns, and explained that the contractors for the plant had so much delayed its delivery that the staff had had to work day and night on its erection sooner than postpone the date of the inaugural ceremony. This unavoidable haste, he assured his audience, was the cause of the breakdowns, which would never occur in actual work. The explanation was received hopefully by the guests.

The Convivial Gathering.

At the next time of asking the station was successfully illuminated, and the current was in the mains ready for use. Then followed a tour of inspection through the machine-room and an adjournment for dinner at The King's Head, after which toasts and speechmaking of the mutually appreciative order, so necessary to the success of such functions, took place. It was a dinner worthy of the name, and the ladies and other respectable people having departed early, the meeting resolved itself into a committee of ways and means of liquor-judging, and was finally thrown out at closing time. It is sad to record that the old gas lamp-posts having been pulled down and taken away, and the new electric lamps standards being fewer in number and placed very inconveniently in the centre of the roadway, the facilities for reaching home were reduced to a minimum, with direful consequences to the appearance and apparel of the more enthusiastic of the diners whose homeward ways lay through muddy roads.

A few days afterwards the engineer Holloway and the canvasser Barker were talking shop at the electricity works.

"You would hardly credit the amount of harm those breakdowns have done," Barker was saying. "Before the opening I couldn't get applications down fast enough, and now I have to fight for them; and the people who haven't had the wiremen in yet want to back out of their agreements."

"Don't you fret," said Holloway, "when we've run for a few months without anything going wrong, you'll find they'll flock after you again."

"Well, I hope so. I've perjured my soul quite enough with regard to the future infallibility of things here. And worst of all, I find that old Molesby, of Berkley-street, is going to put down a private plant solely on account of the mess made at the opening."

"Private grandmother," sneered Holloway; "why the man won't want 25 lights in the whole show. Wait till he finds out what it will cost him to instal, not to mention work it. Ho! ho! ho!"

"Well, I'll just go round and worry the beggar again. He may have got an estimate in by now which has opened his eyes," and Barker went out with a canvasser's firm belief in the omnipotency of the human tongue. He went straight to Berkley-street and called at the house. "Mr. Molesby was engaged in the coal-cellar," the servant said, "but would Mr. Barker come inside and wait?" So Barker sat down in an easy-chair in the front room and prepared for action. That is to say, he cleared his throat, and ascertained that his necktie had not crawled up the back of his head—which property of disregarding the laws of gravity and respectability is peculiar to neckties, and part of the system of inanimate cussedness which exists to try the patience of and torment human kind in general. Barker thought the coal-cellar a strange place for a man to pass his time in, even after making due allowance for Mr. Molesby's eccentricity, which was as notorious as his grasping meanness. The fact of his going in for such a comparative luxury as the electric light could only be accounted for by reason of the former peculiarity.

A Fruitless Journey.

Presently the object of the visit entered, dressed as the eye of man had probably never before seen him, for he was a neat man notwithstanding his oddness—a disreputable suit of clothes embellished with a boot-blacking apron, and the whole covered with clay, mortar, and dust; and if an unbiassed observer had had to judge of his occupation by the state of his hands, the resulting opinion would have probably been "mudpie-making."

"Good afternoon," said the canvasser, blandly; "I have called from the electric light company to see if you have decided to let us supply you with electric light, the light of the future, Mr. Molesby."

"I'm very sorry you've given yourself that trouble," said Mr Molesby; "but I'm just now engaged upon making ready foundations for my own electric light plant. You did not know, maybe, that I was in the electrical line myself a few years back, and I found out a better way of getting the light than by paying eightpence a unit and risking all manner of breakdowns at your works yonder."

"There'll be no more breakdowns now," Barker explained, "and I hope you know what your plant will cost—boiler, steam-engine——"

"I'm using no engine," interposed Mr. Molesby, quietly.

"Gas-engine, then, I suppose?"

"Nor gas-engine either. It's nothing more nor less than an engine of my own invention, that only needs half an hour's attention a day, and starts itself as soon as a switch is turned on. Now that's all I'm going to tell you till I've perfected the thing, and then you can come to me for your light of the future and I'll let you have it for a penny a unit delivered anywhere. Good afternoon, sir," and Mr. Molesby brusquely disappeared whence he came.

"The man's stark, staring, damp mad," said Barker to himself on his way back to the works. And Holloway, the engineer, said something similar when he heard of this invention which seemed destined to revolutionise electricity supply. They two and Lavington, the electrician, sat down in the nearest chairs, which happened to be at The King's Head, and made exceeding merry over it—which was only right and proper under the circumstances.

The Work of the Motor.

Nevertheless, when in a month's time the Molesby domicile was found to be illuminated throughout by the electric light, their mocking grew less, the more especially when they found that not only had Mr. Molesby wired the house throughout with his own hands, but that nothing of the nature of an ordinary engine could be seen or heard. His chimneys vented forth but an ordinary amount of smoke, and neither knocking nor vibration was perceptible from the outside of the house. Many were the solutions suggested by the three people most interested in the matter—Holloway, the engineer; Barker, the canvasser; and Lavington, the electrician—but none seemed to fill the bill. Holloway pinned his faith on a water motor, and went straightway to the waterworks to investigate, but the officials there declared, after examining into the case on his kindly information, that they were satisfied only an ordinary amount of water was used by the Molesby household. Lavington said it was a windmill concealed upon the roof, which stored up energy by means of springs, accumulators, or compressed air, but a close examination of the roof from a neighbouring house-top did not add strength to that supposition; and Barker's idea, founded upon Mr. Molesby's traditional absence from the bosom of his family during a period of three calendar years, was that he worked a treadmill dynamo for half an hour a day and stored the energy. This, indeed, seemed the only plausible reason, considering the mystery that Mr. Molesby was making of his invention, for the idea that "a broken-down old fakir," as Barker politely expressed himself, was capable of doing anything of a revolutionarily scientific nature was too absurd for anyone's credulity. And as he had distinctly said that it was an engine of some description, primary batteries seemed out of the question. It was very provoking not to be able to get to the bottom of the mystery. Mr. Molesby could be absolutely sphinx-like when he chose, and his putty-faced wife and putty-faced children knew and revered him as the god of their destiny, if not as a husband and father. Without a doubt, if Mr. Molesby had let his family into the secret of the motor, wild horses could not drag it out of them. The rest of the household consisted of the governess and the servant, and all seemed equally inscrutable subjects.

The Three were having a shoppy conversation one night, when the eternal topic of Molesby and his motor came up for discussion. Holloway was a bit mad on the subject at the time.

* See "How Garnesdon Got Electricity," *Electrical Engineer*, May 11, 1894.

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"The beggar came in here this morning," he exclaimed, "with an infernal cheeky grin on his face, and wanted me to lend him a file to shape his brushes up with—— No, Lavington, I did not tell him to go there—didn't feel rude enough at the time, but I informed him that we never lent our tools out, and what do you think he said then?"

"Well," was the chorus.

"Said he was sorry to find such a lack of professional courtesy in the provinces, and that he was afraid he might not be able to give us help with his machines when ours next broke down. Professional courtesy, eh?"

"Look here," said Lavington; "I don't know how you fellows feel, but I can't stick it any longer. Let's lure the old sinner in here and play Spanish Inquisition on him from the 'bus bars till he tells."

"Won't do," said Holloway. "Not going to make a charnel house of my nice clean station. Any other suggestions? Well, why doesn't Barker get round the governess? Nice girl enough, and trust a woman to find out anything if Barker wanted her to."

"Capital," said that portion of the audience whose name was not Barker. "I second that."

"But how am I to do it?" said Barker, appealingly. "I don't know the girl a bit." There seemed some hidden joke in this, for the Three smiled audibly for some time, and the council ended after the final carrying of the resolution.

The Governess Questioned Without Result.

In the course of a few days the Three met again to report progress. In the interim Barker, in some mysterious way known only to electric light canvassers, had become acquainted with the Molesby governess.

"She says," he continued, after mentioning his success, "that Molesby keeps his machinery, whatever it is, in the cellar; that it came one day in a big box, and that no one in the house, except the ruler thereof, knows anything at all about it. Mr. Molesby keeps the keys to the cellar, which has been fitted with a special lock; has blocked up the pavement grating, and is never seen to take anything in or out. Spends about half an hour daily in there, and never seems fatigued in the least when he emerges. That's all I can get out of the pretty governess."

"We are not much wiser, then," said Holloway; "it seems to bar the treadmill theory, and I suppose she hasn't heard any gearing rattle suggestive of windmills?"

"No; she says everything inside is as quiet as the grave, which makes things more bewildering."

"Can't you induce her to get the keys and go inside and find out?" suggested Lavington, whose valuable advice was usually founded on first thoughts.

"That would be a first-class idea," said Barker, "if old Molesby was not regarded quite so much in the light of an ogre by his household. No, I'm afraid the Bluebeard dodge won't answer. We shall have to wait till he has perfected the thing, if he ever does."

"Wait be hanged!" said Lavington. "I know a plan worth two of that! Let us hire a basement as near as possible to Molesby's cellar and burrow our way into the elucidation." This seemed the only satisfactory plan at the time, but when the actual hiring was attempted the thing fell through, for the very simple reason that nowhere near was there a basement to be had for love or even a reasonable amount of money. There seemed nothing for it but to watch and pray.

A Hauling-in Dodge.

Meanwhile, the successful working of the station had averted the incipient panic among would-be consumers; applications for light flowed in freely again, and a new transformer sub-station became a necessity in the Upper Town. In due course the feeder was drawn into one of the ducts of the Johnstone conduit from the works to the new sub-station, and only in Berkley-street did any hitch occur in the operation. What the hitch was due to no one could at the time make out, but the fact remained that for a long time seven men could not pull through an 80 yards' length of $^{7}/_{18}$'s concentric. There seemed to be an obstacle about half-way between the road boxes that no amount of pulling could overcome, and the foreman of the work went to the central station to get permission to take up the road to find the obstacle. When he came back with the requisite instructions, he found old Molesby critically eyeing the hauling-out rope. Molesby went to meet him in a singularly polite manner and said:

"I see that you are having a difficulty with your cable. Can I, as an old electrician, render you any help with it?"

The foreman, with a certain amount of respect for the man who had invented a new engine, explained that the cable had stuck in the conduit.

"Ah! I often had that trouble when I was in the trade," said Molesby; and there's only one thing to be done when that's the case."

The foreman enquired the remedy.

"If you'll let me direct your men," said Mr. Molesby, "I'll very soon have your cable through."

The foreman was willing, and instructed the men to obey Mr. Molesby, who made them coil up about 10 yards of rope by the road box, and to catch hold each man of the remainder. This done, and a chafing mat put over the edge of the box, Mr. Molesby started the men off at a run. The spare rope between them and the box was soon trailing down the street, and then, instead of the violent jerk or the breaking of the rope that the most optimistic among them expected, the rope gradually tightened, and its regular rate of transit through the box showed that the cable was coming through as it should do, and very soon the length was in place. The foreman expressed his gratitude to Mr. Molesby, who said deprecatively that it was a trick he had learnt in America, and was called "bust the rope or bring the cable," for which information the foreman was truly thankful, and went to examine the cable end, which showed several deep indentations, as if made by ineffectual pulls against the obstacle, whatever it was.

Mr. Molesby had now begun to be regarded as a trade competitor by the electricity company on account of his supplying current in the neighbourhood of his house at the low rental of 5s. per annum per 8-c.p. lamp installed. Most of the houses near him availed themselves of the cheapness, and Molesby had a switchboard fitted up in his back kitchen, from which ran separate cables through the back gardens to his clients' lamps. Never was there such a well-lit block of houses. If Goethe had only died in that block, he would have had to compose different last words. The pity of it was that the lamps were not everlasting, otherwise it would have been quite unnecessary to put up switches at all. And yet Molesby seemed quite happy, explaining to everybody that his motor approached so nearly to perpetual motion as to enable him to do this profitably. When he had made it quite perfect, he said, he would reduce the price to half-a-crown a year. Whereat his fame grew and spread abroad, and at a Board meeting of the G. and D. E. S. Company, Limited, it was seriously proposed to open negotiations with him for the sale of his motor, but when the inventor was approached on the subject he refused to entertain any proposals till the final improvements and patenting had been executed. So the Board said unpleasant things about him.

A Tricky Wireman Arrives on the Scene.

And it came to pass that a wireman in search of work arrived in Garnesdon from America, and business being brisk just then he was engaged as foreman by the firm who had the contract for wiring the Town Hall. This man, Bernard, quickly became acquainted with the staff at the electricity works, and was in great request as a narrator of traveller's tales and moral stories. He, too, became interested in the Molesby motor, but being governed by an unbridled curiosity, and unhampered by a too fastidious conscience, his determination to elucidate the mystery seemed to stand more chance of realisation than was the case with his slightly more scrupulous acquaintances. To this end he booked a seat in a pew just in front of Molesby's, and became a devoted attendant at the little Wesleyan chapel in which Mr. Molesby spent a certain percentage of his wet Sunday mornings. Bernard's idea was that an acquaintanceship formed through a religious body would be more likely to lead to a productive result than an introduction by any other means, and, generally speaking, perhaps he was right. However, after a quarter's trial nothing came of it; the Molesbys kept to themselves in and out of church, and so the time spent by Bernard at services, prayer meetings, and congregational tea fights was only wasted, not to mention the pew rent at 5s. 6d. per quarter.

"However," said Bernard to himself, philosophically, "a good thing takes trouble to get all the world over"; and he was not dismayed, but redoubled his exertions. He took a room as near Mr. Molesby as possible, and prevailed on his landlady to apply for light from the Molesby factory. This she did on finding that she had only to pay the annual price per lamp, the installation being fitted up by Mr. Molesby personally on an easily removable system, so that, as he explained, he might take away the fittings if ever the light was required to be discontinued. The backyards of that block were quite picturesquely festooned with cables to the different customers, and the electricity company felt acutely over the matter, and wrote distracted letters to the Board of Trade, who, however, could do nothing while the cables were on private property. During the installation of Bernard's lodgings he did his best to ingratiate himself with Mr. Molesby, who, unfortunately, evinced a decided distate for him, the more especially when he discovered his calling; and the wiring was finally completed without any advance in Bernard's object—in fact, retrogression—as Molesby seemed perfectly aware that Bernard had an ulterior object to his friendly advances.

Testing His Suspicions.

When the light was switched on Bernard unlaid the strands of his lamp leads and placed a galvanometer between them, the absence of a pronounced deflection showing that the current was of an alternating character. This seemed strange, as for the

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compact area which Mr. Molesby supplied a continuous current would have been so much more efficient. A faint suspicion dawned upon Bernard, which seemed rather improbable, but which nevertheless stuck in his mind.

The Three had not worried much over the motor subject since the ineffectual transaction with the Molesby governess, but curiosity still mixed with professional jealousy in their breasts, and when the next day Bernard came into the station and began the conversation with a reference to Mr. Molesby, their tongues wagged as vigorously on the subject as of yore, and the old conjectures were again brought under view to seek to explain the mystery. Conversation eventually turned to general subjects, and Bernard took it upon himself to criticise the sub-station transformer method that was in use at Garnesdon.

"And if you really had to feed those things up with coal, as every other less fortunately situated works has to do, you would soon find," he concluded, "what it costs to provide for the maximum load with only one transformer, instead of banking some or regulating the windings."

Holloway confessed, in reply, that there was a huge difference between the output as recorded at the station and the actual commercial output as evidenced by the consumers' meters; that the mains had been tested and found of reasonable insulation resistance, and therefore there seemed nothing to do but to put the blame on to the transformer.

Bernard suggested that the iron conduit might have something to do with the deficiency, by exerting a choking effect upon the current; but Holloway explained that as the positive and negative mains were always placed in the same ducts, the loss from that cause must be too minute to thoroughly explain the difference. Then the conversation turned to the doings of the local cricket club, at which Bernard scoffed and made mockery.

"Cricket, fishing, and going to sleep," he said scornfully. "If you want an exciting game, a game to make your toe-nails arise and stand on end, you must go to a baseball match in the States. No flies on them there! Every man with both feet on springs, and the crowd—my aunt, don't they whisper when a base is stolen?"

"It's much the same kind of thing at a representative cricket match," said Barker, patriotically.

"Much the same! Wait till you've seen the wicket-keeper padded and armoured and masked from head to feet; wait till you've had the top of your head screamed off by the johnnie behind you, then you may begin to say the game's exciting; but that only begins the fun in baseball. Bah! eleven men lounge around a five-acre field and two men take it in turn to let the ball hit their bats occasionally; that's your high-class cricket."

A Manœuvre at the Station.

So it ended with Bernard getting slung out of the station for high treason and blasphemy, and he went home meditating on the link in his chain of evidence which the abnormal transformer loss furnished. "Now, I only want one more proof, and then, Mr. Molesby, we shall begin to take an interest in each other, and my friends of the electricity company may become a little more polite." He thought the matter over during the next day or two, when one evening the plan matured. He charged his landlady to watch the electric light in her sitting-room during his absence, and she being of a rare and obliging variety sat down with her knitting and promised not to fall asleep till he came back. Then he went off to the electricity station with a fell purpose in his mind.

"Hullo! what's brought you here?" politely asked the engineer. "Rather expected you would be dreaming of baseball matches by now."

"Oh, I got sick of reading at home, and I just looked in to see if you had had any breakdowns lately. I haven't felt at all well the last day or two."

"Poor beggar, did the chucking out affect his nerves, or is he sighing for his beloved roast peanuts and iced drinks?" queried Lavington.

"Not much; beer is good enough for me. How filthy hot this place is. Open the door for goodness' sake," and as his friends moved away towards the door Bernard fell forward, clutching one of the switches *en route* to the ground, and the switch being of the knife order opened and let him down to the ground with a jerk. Instantly Holloway rushed to the switchboard and replaced it, watching the voltmeter attached anxiously the while. Lavington had more humanely gone to the assistance of the prostrate Bernard, whom he found in a perfectly rigid condition, features contracted, and a froth at the mouth. He turned him over and unfastened his collar, which proceeding apparently relieved the sufferer, whose breathing grew less stertorious.

"Rummy go, this," observed Lavington; "didn't know the beggar was subject to fits. What had we better do?"

"Oh, sling a bucket of water over him," said Holloway, in not the sweetest of tempers, after the treatment of his beloved machinery.

"Well, old chap," said Lavington, soothingly, "feel better?"

Bernard heaved a sigh of great volume and intensity, and struggled gamely to open his eyes.

"Have a glass of whisky?" suggested Holloway, who was of an intensely practical nature.

The patient feebly nodded his head in the vertical plane of approval, and straightway a glass of neat spirits was put in front of him, which appeared to have the desired effect. "It's very kind of you fellows to look after me like this," he muttered; "I thought I had left those attacks in America. Haven't had one for years."

"Well, when you are going to have another one," said Holloway, who half relented his brutality, "kindly keep away from our switchboard. You opened No. 3 transformer at nearly full load, and the Lord only knows what the customers will say about it to-morrow."

Proof of the Swindle.

Bernard expressed his sorrow for the accident, and asked for a cab to be sent for to take him home. He entered the vehicle like a partially resuscitated corpse, but the ride evidently did him good, for he was a very different being when he alighted, and, after paying the jarvey, hurried into the house to his landlady's sitting-room.

"How's the light been, Mrs. Vernon?"

"It went very dull a short time ago, and I thought it was going out; but it has been just as usual otherwise. However did you think it might go dim to-day. It never does so usually."

"Ah!" said Bernard, knowingly, "I saw Mr. Molesby very tight this morning, and I thought something would happen. I'll just go round to him and give him a piece of my mind. We pay for light, not flashes—eh, Mrs. Vernon?"

It was a delightful walk to the Molesby's—at least, under the circumstances; and all traces of the fit had vanished. Bernard's frame of mind was as it should be with a man when he elucidates a mystery that has puzzled wiser men than he, and doubly so when there is money to be had from the elucidation. For above all things Bernard was practically minded; to him honour and fame were good and to be sought for, but he recognised that while they pandered only to the immediate vanity of the soul, they were even as serviettes and menu cards to a starving man without the golden aid that sustains life and give pleasure to the grosser flesh. So he strolled along gaily, making mental calculations as to how much his discovery was worth intrinsically.

Bearding the Lion.

Mr. Molesby was in, and seemed considerably astonished to see who his visitor was. His face paled visibly when Bernard asked for 10 minutes' private converse with him, but he led the way to his smoke-room, and, without offering a chair, waited frowningly while Bernard inspected the room as if fearful of eavesdroppers.

"Mr. Molesby," said Bernard, impressively, helping himself to a chair, "I have long suspected your electric engine to be an erring miracle, and to-day I had the pleasure of discovering what it really consists of. That being the case, I am hardly sure if it is not my duty to inform the electric light company as to its mode of construction. Can you give me any reason why I should not do so at once?"

Mr. Molesby's face had been slowly growing longer till, discovering his jaw to be reposing on his necktie, he regained his composure with a visible muscular effort, and retorted, angrily: "I don't in the least understand what you mean. Leave my house at once!"

Bernard smiled the smile of he who bluffeth on jacks and queens, and stepped towards the door. "I'll go," he said; "but I shall be back in a few minutes with some of the central-station people, and——" pausing and whispering, "with a pick and shovel."

He was already through the door when Mr. Molesby called him back. "Wait a minute," he exclaimed; "just sit down again and tell me what you mean." Bernard glanced back. Mr. Molesby's eyes were very widely opened and his expression lividly entreating; so Bernard returned, flung himself on to the sofa, and meditated.

"Well!" said Mr. Molesby, a trifle impatiently."

"I think you know what I mean," said Bernard, slowly; "your new motor is all rot, and the current you are selling to the neighbourhood is obtained from the mains that run past your house. Do you want it any plainer than that, or shall I prove my theory?"

Mr. Molesby was quite collected by now; a quickly-realised calamity is painless to some people, and it seemed then that strong measures would not answer with Bernard. "And supposing this be true," he said, "what does it matter to you? Don't you get your light cheaper than if the company supplied it?"

"Very much so; but the point is that I am the only person that knows your secret, and if you care to make it worth my while it can go no farther. If you don't, why I should think the electricity people would be very generous to anyone who could give them a clue to the loss on their mains."

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"Oh, so they have noticed a loss," said Mr. Molesby, coolly; "I didn't think they would bother about taking measurements when they get their power from turbines. Well, now," he continued, in a much more genial tone, "will you please tell me how you discovered my little secret."

Bernard was nothing loth. "You see," he remarked, "I used to be mains superintendent to an American company, who laid the same kind of conduit they use here. Well, the thing is easily taken to pieces, as you know, and one day a man's house was found to be illuminated whose name was not down on the company's books, and as he didn't have sense enough to brag about a wonderful engine, and light up half the town with it, the company got suspicious, had the pavement up in front of his house, and, sure enough, there were the service wires running into his basements, just as yours are at this moment. And to think that I was ever tenderfoot enough to swallow your motor yarn after that experience! Thinking of that the other day gave me my first clue, and afterwards it was enough to substantiate the thing. Weren't you nervous about being found out? Heavy imprisonment, I should say!"

The Lion Springs.

"Oh, I reckoned that up before I took the risk on," said Mr. Molesby. "I don't see how the law can touch me, except for damage to conduit and cable, since electricity has no visible existence, and beyond that I have been careful to put my own wires into the houses in quite a temporary fashion, so that if the company did find out, I fancy they would prefer to come to an arrangement with me to leave the fittings in and supply my customers than to prosecute, in which case my fittings would come out quick, and few of my present clients would care to go to the expense of rewiring. And, you know, whatever the efficiency of their mains is at present, it matters little with their turbines whether they run at full, half, or quarter load, so that they are not really losing anything. Do you see, Mr. Christopher Columbus?"

"I see," said Bernard. "And now about my little remuneration?"

"What do you want?"

"Half shares."

"You can go straight to the devil or to the company when you like," said Mr. Molesby, sweetly, "but you won't get a penny out of me; and as my household has seen you here it might pan out to a pretty clear case of attempted blackmail, and you wouldn't get much out of the company then."

Bernard was thunderstruck. Truly, Molesby had the pluck of the cornered rat as well as the wisdom of the fox.

A Dishonest Partnership.

With a slight smile at Bernard's blank expression, Mr. Molesby continued: "But I'll tell you what I'll do. I'll make you a present of one of my motors, and you can go into another part of the town and start a branch business."

Bernard did not know whether to laugh at this proposal, to look blue, or to become savage. Therefore he said, "Well, I'm blowed," in a tone of deep conviction.

"I have been thinking of making extensions," Mr. Molesby went on, but could trust nobody to help me, and now that a bountiful Providence has sent you to my aid I think I can see my way clear. There's a little tumbledown cottage we could rent in Church-road, and do even a better business with than I am doing here. Now, come; you would have your house rent free, and nothing to do but spend half an hour a day in a snug little cellar to satisfy a curious world that there is really something in the place, and I'll give you 75 per cent. of the profits."

Bernard thought it over. It seemed easy enough; it was an experience that did not come across one every day, and would be a good tale to recount in after life. The risk was as much to Mr. Molesby as to himself, and Molesby was not the kind of man wilfully to put his precious skin in danger, added to which it seemed the only way by which anything might be made out of his discovery, so Bernard decided to accept the offer and risk.

"What do you reckon I should make over the swindle?" he enquired first.

"If I guarantee you £100 a year, paid quarterly, will that suit you?" queried Molesby.

"I am with you on those terms," said Bernard, and then the ice fairly broken they sat down to make a night of it, and to drink success to the Molesby motor.

It was a very pleasant evening. Bernard related the awakening of his suspicions after testing the lamp leads, and how the discussion at the electricity station on the loss in the mains added to their probability, which suspicions were finally confirmed on finding that the light flickered at his lodgings at the time when he opened the transformer switch at the electricity company's station. Mr. Molesby, however, was apprehensive lest any of his customers had compared notes with the company's customers concerning the flicker, in which case the motor theory would receive a rude shock.

Then Mr. Molesby recounted on his side the invention of his motor; how the inventive idea originated by watching the laying of the conduit, and observing how easily the cable inside could be reached by knocking the wedges out. How, when the work of laying was completed, he excavated the roof of his cellar till he came to the conduit, when, after taking the bottom length off, the service connections to the low-tension cables was an easy job during the period of light load. Then he successfully lit his house, and finding his motor tale gaining credence he proceeded further into the business and lit his neighbours' houses at the expense of the electricity company, and to his own monetary advantage.

This recital of ascendant villainy, and perhaps Molesby's '93 vintage, inflamed Bernard's longing to be in the swim and to taste the joys of unholy success.

"And only once have I been anywhere near discovery," continued Mr. Molesby, triumphantly, "and that was when the company started their extensions and commenced drawing in a new feeder past this house. Of course the thing stuck when it came to the yawning cavity over my cellar, and I believe they would have had the street up if I had been 10 minutes later. As it was I saw the crowd of men by the corner road box just in time to go down to the cellar, clear the cable, and rush out to the gang and show them an 'American' way of drawing cable through a tight place, which of course was only an excuse to get them to give another pull. A most obliging foreman it was; another man would have told me to go to blazes."

It was getting late, so after a few parting drinks, and final arrangements about their new partnership, the precious twain parted.

During the following morning both Holloway and Lavington dropped in at the Town Hall to enquire after Bernard's health. Bernard felt small compunction in seeing them, being naturally highly gifted with hypocrisy. A less highly-gifted man might have been inconvenienced in the conscience department, but Bernard prided himself upon being broad minded, therefore his moral nature was flexible and capable of standing worse strains than this.

Advancing the Swindle.

At the end of the week operations commenced at the new house. Mr. Molesby had been to London in the interim and arranged for a new switchboard to be sent down, together with the requisite cable and switches, all enclosed in a box to be marked "Machinery—With Care." Thus on its delivery it got about the neighbourhood that a new Molesby motor was going to begin operations, and he had small difficulty in persuading people in the vicinity to take the light at the Molesby tariff.

So far Bernard had shrunk from letting his intimacy with Mr. Molesby be known. He wished to put off the day upon which he felt sure he should lose the esteem of his friends at the electricity works, and though he guessed he should gain their envy, as well as the admiration of others who would not be in trade rivalry with him, yet he preferred the facts of the new partnership to become public property at the last possible moment.

It had been arranged that Bernard should make the connections necessary to the successful working of the "motor" at the dead of night, when fewest lights would be on. Mr. Molesby had been working away at the "foundations" arrayed in his boot-blacking apron and disreputable clothes, and one morning Bernard got a note from him saying that all was prepared, and arranging for the final connections that same night. Bernard got his jointer's tools ready, and about midnight went to the house. Mr. Molesby let him in gently, and they both went downstairs as if the house was full of detectives. Arrived in the cellar, Bernard saw that the roof had been torn away for several feet before the conduit had been located at the extreme end of the cellar, and there it hung suspended, black and mysterious.

The two men took their coats off and proceeded to knock out the necessary wedges at the ends of the bottom half, and then, putty only holding the framework together, the piece was soon dislodged and lowered to the ground, exposing five cables.

"Now," said Mr. Molesby, mopping his face with a none too clean handkerchief, "the two cables in the duct nearest the house are the distributors, the ones on the other side nearest the road are the arc light cables, and the middle one is the feeder. Don't touch either of the latter more than you can help—the best of rubber is not more than human; and would you like any gloves to do the jointing?"

The Mysterious Motor Jibs.

"No, thanks," said Bernard; "there'll be no current worth mentioning till morning." And, pulling the meat-safe forward to act as a platform, he commenced hacking away at the insulation with his stripping tool. "These are blooming little cables," he continued; "I shouldn't think the authorities calculated on getting much custom out of this neighbourhood."

"Ah! we'll show them," said Mr. Molesby, exultantly, holding the lamp near the better to compare the cables. "Why, the arc cables are bigger than them."

Bernard gave a violent wrench with his tool, when suddenly

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there was a spark, a gasping yell, and he fell back against Mr. Molesby and the lamp, knocking the latter to the ground and descending upon its flaming fragments with a crash. Mr. Molesby jumped back astounded, and before he could recover his self-possession, Bernard's body was enveloped in flames, upon which he gazed helplessly for some little time. Then the stench of the burning clothing and a still more ghastly perfume drove him into a more humane frame of mind, and he rushed into the kitchen and proceeded to fill a bucket of water at the tap. This operation took quite a minute and a half, which seemed little shorter than three weeks to Mr. Molesby, who was tormented by a feeling of utter helplessness.

During the waiting interval the events of Mr. Molesby's none too virtuous life forced themselves upon him, and the smell of sizzling flesh was borne in unto his nostrils and did not assist his mind to calmness or coherency. At last the bucket was full, and, strong with the desire to help his friend, Mr. Molesby hurried into the cellar and poured the water upon a smouldering heap that had once been a human body, causing a dense smoke, the odour of which exceeded in subtlety the odour of merely burnt clothes by many degrees. Then, his duty to his partner accomplished, Mr. Molesby sat down to consider affairs.

Plainly this was a case for a clear head. Mr. Molesby's mind grasped the superficial facts that a death had occurred by burning, the result of falling on the top of a smashed lamp, and it certainly seemed strange to him that the fall should have been so heavy as to obliviate the agony of the flames, but beyond that he could only see that what had happened would destroy his business if ever the facts became known, and would also put him in a very suspicious position. Then, since Bernard had given him to understand that no one knew of his partnership, or of his intention to visit the house, the most obvious course of common-sense procedure seemed to him to be to get all traces of the occurrence removed as quickly as possible, and trust to luck, as was his custom, to protect the innocent.

And Kills Both Partners.

That being decided upon, and the spade and pick being handy from the "foundation" work, Mr. Molesby opened the back windows and proceeded to dig a grave in the cellar, which grave he mentally decided should be deep enough to prevent any traces of the incident from becoming known accidentally. It was hard work, and the harder since he had to work silently in the confined space of the cellar. At last he could stoop no longer, and crawled out of the hole to the cooler and less effluvient kitchen.

"Phew!" he muttered, as he blew his nose lustily; "I must get old Cherry Blossom out of smelling reach before morning."

But he could not sit still long, he was too excited to rest utterly, and his back was feeling too brokeny to resume his labours in the grave, so he took his candle back again, and standing on the meat-safe, commenced cutting away at the insulation where the late Bernard had left off, intensely anxious that the job should be finished and all traces removed before the morning. Then another strange thing occurred. A tiny spark between the cable and the knife, a veiled scream, and with a thud Mr. Molesby fell upon what remained of his partner's physical self. And that was all that happened in the cellar that night.

The next day it began to be wondered where the foreman of the Town Hall wiring job was; Mr. Molesby's wife also grew anxious concerning her lord. However, the mystery was cleared up before night. The open windows at the back of the fateful house, and a certain pungent odour, rousing the curiosity of a neighbouring household, the police were communicated with, and then a discovery was made that supplied even Garnesdon with gossip for many months after. The facts soon got round to the electrical works, and an official order to examine Mr. Molesby's premises resulted in the complete elucidation of the motor mystery.

To the Benefit of the Supply Company.

At the inquest, it transpired that the deceased had evidently mistaken the arc light circuit for the distribution mains, and this mistake arose from the fact that in that particular street the arc lamps were suspended from wall brackets, instead of from posts in the roadway, and so the arc cables were placed in the ducts nearest the houses, which special arrangement was, of course, beyond Mr. Molesby's knowledge.

Among the people who mourned Mr. Molesby's death were his customers, who were threatened with disconnection from the "motor" if they did not care to pay the company's charges, and Mrs. Molesby was advised by her lawyer to make a claim for the fittings belonging to her late husband in their houses. But the result of these claims only served to prove the contention that people once having used electric light would be very loth to part with it, and before the end of the year the Garnesdon and District Electricity Supply Company, Limited, had reason to bless the misguided genius of Mr. Molesby for being the means of adding to their load diagram, and eventually to their dividends, by means of his once-time mysterious motor.

ELECTRIC LIGHTING AT ABERGAVENNY.

The report has been issued by Mr. E Manville on the introduction of the electric light into Abergavenny, he having been engaged to advise the Commissioners on the subject. He is of opinion that the undertaking would prove profitable, and in support of that opinion refers to the success which has attended similar undertakings in the hands of certain large municipalities, which he mentions, and makes special allusion to Bradford. He advises that 8d. per unit should be charged at first, and points out that, judging from past experience, the Commissioners will be at no risk of making a loss prejudicial to the gas undertaking should they decide on the erection of an electricity supply station in conjunction with it.

The course to be taken in applying for a license or provisional order is then described, and the report continues: "In your case the first or whole area will be the town of Abergavenny, and for the second area, or compulsory streets, I would advise that you put forward the following: Brecon-road, Frogmore-street, High-street, Cross-street to the Swan Hotel, and Lion-street. Before dealing with the cost of carrying out the scheme I am putting before you, I would wish to describe the systems that are generally in use for the distribution of electrical energy. There are, generally speaking, three systems at present in use by which electricity may be distributed from a generating station to those spots where the energy will be utilised by consumers: first, the high-tension alternating-current transformer system; second, the high-tension continuous-current transformer system; third, the low-tension continuous-current direct system. Each of these systems has its own particular advantages under given circumstances, and each of them is better adapted for particular localities according to the particular characteristics of the particular districts to be served, and each of these three systems may again be modified to make them more particularly suitable for a given locality. The third, or low-tension continuous current direct system, is best adapted for districts in which the lighting is likely to be very concentrated, in which there are no gaps between the streets where electricity would be required, and in which the furthest distance the supply will be required to extend from the distributing point is not likely to be very great. This system is also well adapted for a supply of electrical energy for motive power purposes. I think you will see clearly that this latter system—the low-tension continuous-current direct system—is the one best adapted for supplying the demand in Abergavenny. From a distribution point near the Town Hall, the main street in which the supply mains would first be laid extends only slightly over a quarter of a mile on each side of this point, and the streets off the main street also extend to but a short distance from the distribution point, and even these streets still further afield are no great distance from the same point, and I am of opinion that the demand for electric light that might ever exist in Abergavenny can be best met by the adoption of this system.

"I now come to an important subject in connection with the scheme—viz., the method by which the power for generating the electricity should be produced. It was pointed out to me by some of your committee that there were various streams of water in the neighbourhood from which they thought sufficient power might be obtained. I examined these streams, and I feel sure that none of them are of sufficient size, or have a sufficiently certain supply of water, to make them suitable for the economical production of the power required, this being in the first instance, in the scheme I am laying before you, from 75 to 100 effective horse-power. The choice, therefore, falls between the use of coal, of gas as at present supplied in the town, or water gas; and I am of opinion that water gas will be the most suitable method of producing this power. A steam-engine plant would require separate attendance, which would not allow of its being worked as economically as gas might be produced. The gas production for the town being already overloaded, it would not be possible to produce further for use in gas-engines from this source.

"The gas generating plant would be best situated at the gas-works and the generating station at the Baker-street site. On the basis that if you carry this project into effect you will decide in favour of so locating the plant, the following is a description of the machinery included in the following estimates. At the gasworks will be placed a Dowson generator, producing water gas with anthracite coal. The gas from this generator will be contained in a gasholder capable of holding 10,000 cubic feet, and the generator will be sufficiently large to produce all the gas required by one of the gas-engines when developing its full power of 100 h.p., requiring only the addition of a small steam jet from the existing boiler at the gasworks. It is my proposition that during the times of heavy load—*i.e.*, in the winter from four o'clock in the afternoon to, say, nine at night—that the gas generator should be kept at full work, thus supplying all the gas required without drawing upon the 10,000 cubic feet contained by the gasholder. For the remainder of the evening, from nine to 12 o'clock, when the load on the gas-engine will have very much decreased, the gas generator can be stopped altogether, and the gas contained in the gasholder will contain a sufficient supply to run the gas-engine for this length of time. From midnight until four o'clock the following afternoon the gas-engines will not be run at all, the set of electric accumulators provided for in the hereafter appended estimates being sufficient to maintain the 35 public lamps during the remainder of the night, and any small demand there may be for private lamps during that time or during the following day. In the summer the same cycle of operations will be observed, excepting that as the heavy load time will be much shorter than in the winter, the gas

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generator will be at work for a shorter proportion of time. When the demand for electric light increases so that it is found desirable to put down a third gas-engine, when two would be working at maximum power through the hours of heavy load, it will only be necessary to add the second gas generator at the gasworks with its subsidiary apparatus. From the gasholder to the generating station in Baker-street will be laid a 9in. cast-iron gas-main. The generating station in Baker-street will consist of an oblong brick building, say, 40ft. by 80ft. In this generating station will be placed, in the first instance, two gas-engines, each capable of indicating 100 h.p., and two electric generators of the same size. Only one gas-engine and one generator will be required for the maximum number of lamps provided for in the estimates hereafter appended, the other being completely spare; and when a third gas-engine and generator is added on the extension of the system, there will still be only one set completely spare, whilst the output of the station will be double. In the generating station will also be provided a set of accumulators of sufficient size to run the 35 public lamps from the time that the gas-engines are stopped until dawn, and to supply any likely demand for private lighting during this time and during the hours of daylight." The report then gives in detail an estimate of the cost of outlay, maintenance, and revenue. The cost of providing plant is estimated at £8,168. 17s. 6d.; the annual revenue is estimated at £1,105, and the cost of working and maintenance at £871. 8s., leaving an annual profit of £233. 12s. This would provide for 2,000 8-c.p. lamps at 8d. per unit, and 35 public lamps at £3 each, and allow £400 for depreciation."

ELECTRIC LIGHTING AT MONMOUTH.

In our last issue we referred to the adoption by the Monmouth Town Council of the combined scheme prepared by Messrs. Bramwell and Harris for electric lighting and sewage disposal at Monmouth. A few extracts from the report presented by Messrs. Bramwell and Harris will be of interest:

The carrying out of the sewage scheme alone will involve an original expenditure of £12,000, and will involve an annual expenditure equal to a rate of 1s. in the £ sterling, and we propose now to consider whether the addition of a scheme for the supply of electrical energy, if carried out on the lines of utilising the water power at the Old Forge Mill, will enable you in the near future, when the whole product of the electric generating station is absorbed, to reduce the amount of the rate from the 1s.; or, to put it another way, whether the receipts to be derived from the sale of electrical energy will not be so much that when they are set against the annual expenditure, including every item for the two combined schemes, they will reduce the £900 per annum (which is the cost of working the sewage scheme alone), and will thereby reduce the 1s. rate.

Having heard the result of private enquiries, and having ourselves made enquiries, so far as it was possible, we are of opinion that, providing it could be done at a reasonable cost, your Council would be perfectly justified in establishing a station capable of supplying at one time current for 1,000 lamps each of 16 c.p. installed, or, stated in the general way in which electric light is now estimated, 2,000 lamps of 8 c.p. each installed. More especially would this be true if there were included in this amount of light, the light necessary for street-lighting, replacing therefore the existing gas lamps by the superior electric light, and crediting the revenue of the electric light station with the present annual cost of the gas lamps.

Under the above circumstances we have examined the district with the object of ascertaining whether it was possible to, in any way, utilise some of the large amount of power running to waste in the rivers passing through your town. Practically, the only suitable place which is available for obtaining water power in or near the centre of the town is the present disused Old Forge Mill on the Osbaston-road. We have already pointed out that this is close to both the suggested sites for the sewage disposal. We are informed, as the result of enquiries that have been made, that the owner of the property is prepared to lease the water power here to the Corporation, and also to lease sufficient land for the erection of an electric generating station. There is ample water power for a reasonably large station, larger than it is probable you will require for a considerable number of years to come. To utilise some of this water power we should propose to place at the Old Forge Mill three turbines, each being capable of giving, say, 35 i.h.p. These together, when working at their maximum, would generate electrical energy sufficient for, say, 1,700 8-c.p. lamps, or their equivalent, alight at one time, equal therefore to something like 2,500 8-c.p. lamps installed. We should suggest that there should be four alternating-current dynamos (one being stand-by), each capable of absorbing the power developed by one turbine; there should also be three steam-engines, each of similar power to the turbines, and the machinery should be so arranged that either the turbines or the steam-engines, or both, should be capable of driving three alternating-current dynamos working to a pressure of 2,500 volts. From this station we would lay (so far as is possible in the same trench as the pumping main for the sewage) an electric light and power main to the sewage pumping station, would there connect it to three alternating-current motors, one for each set of pumps, to be used for pumping the sewage. In the sewage pumping station the high-tension current, brought there by this electric main, would be transformed to low-tension current of 100 volts pressure, and from the transformers to be placed in this station, and in, say, two other suitable places, the electrical energy would be carried by distributing mains to every part of the town where demand for current arises. From this distributing main the street lights would also be lit. The attendant in the sewage station would control the lighting by means of the transformers and apparatus placed in that station, and would also superintend the working of the sewage pumps and of the water pump hereafter referred to.

Our estimate of the first cost of this work, allowing a small sum for the purchase of the land for the sewage and electricity transformer station, amount to £5,600. We estimate the annual cost of working this installation, allowing a sum of £50 per annum as rental for the land and water power at the Old Forge Mill, and allowing for every other possible item, including repayment of capital and interest on loan, at 5 per cent. on the cost, all as in the sewage scheme, at the sum of £700 per annum. There is a further source of income which has been suggested, by which we think your Council ought to benefit, and that is the present cost of pumping the water for the cattle market and for flushing sewers, etc. This work could easily be done by the attendants at the sewage pumping station, which is close to the river—the water being taken from the river. The cost of the machinery for doing this, driven either electrically or by a gas engine, would be extremely small, and is included in our estimates.

Experience shows that from each 8-c.p. lamp installed a revenue is derived equal to, say, 7s. per annum. In many cases this is exceeded, but the average receipt of 7s. per annum per 8 c.p. lamp may be assumed to be accurate for the purpose of this report. At this rate, when 2,500 lamps, each of 8 c.p., or their equivalent, are installed, a gross revenue will be derived from the electrical generating station of £875 per annum. To this may be added the sum of £50 a year to be saved from the pumping of water for use in the cattle market, and for use in flushing the sewers; and in considering the combined schemes there should also be added the cost of pumping the sewage, because this will form a revenue for the electric generating station, we estimate this cost as £150 per annum. The total annual income to be derived from the combined schemes therefore appears to be £1,075. The working cost of the schemes amount, as already stated, for the sewage scheme to £900 per annum, and for the electric lighting scheme to £700 per annum, deducting the £1,075 of income to be derived from the combined schemes, there is a balance left of £525 per annum, which will have to be found from the rates. This would involve a rate equal to, say, 7d. in the £, or, in other words, your Corporation would, by expending the larger sum of, say, £17,600 for the combined schemes, be able to carry out, and to carry on, the whole of the work with a rate of 7d. in the £ sterling, instead of a rate of 1s. in the £ sterling, which would be required if the sewage scheme alone, costing £12,000, is carried out. The above is based upon an estimated output from the electric generating station equal to 2,500 lamps of 8 c.p. each installed. When this output is exceeded the income will be correspondingly increased, while there will be but less proportionate increase in the expenditure—that is to say, the suggested rate of 7d. in the £ sterling will be still further reduced.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Widnes.—The Corporation desire by September 4 tenders for the supply of a steel Lancashire boiler. Specifications and other particulars may be obtained from Mr. Isaac Carr, A.M.I.C E., Gasworks, Widnes. Tenders are to be delivered to Mr. H. S. Oppenheim, town clerk, Town Hall, Widnes.

Cheltenham.—The Corporation invite tenders by September 8 for junction-boxes, covers, and other castings. Specifications, forms, and conditions of tender may be had on application to the borough surveyor, Municipal Offices, Cheltenham. Tenders to be sent in to Mr. E. T. Brydges, town clerk, Municipal Offices, Cheltenham.

West Bridgford (Notts.).—The Local Board require by September 3 tenders for supplying and fixing a new boiler at the pumping station, West Bridgford. Particulars can be obtained on application to the Board's surveyor, Mr. T. C. Gray, Stratford-road, West Bridgford. Tenders are to be sent to Mr. Arthur T. Ashwell, clerk, St. Peter's Church-walk, Nottingham.

Edinburgh.—The Corporation invite tenders for the following work in connection with the electric lighting of the city: Contract No. 18.—supply of arc lamp-posts. Copies of the specification and drawings can be obtained from the Resident Electrical Engineer, Dewar place, Edinburgh. Complete full-size detail drawings can be inspected, and all information will be supplied at the office of the Consulting Electrical Engineer, 14, Old Queen-street, Westminster, S.W.. or at the office of the Resident Electrical Engineer, Dewar-place, Edinburgh. Copies of the specification may be obtained on sending a deposit of £1. 1s. Tenders are to be directed to Mr. Wm. Skinner, W.S., town clerk, by September 17.

RESULTS OF TENDERS.

Southampton—The Harbour Board have accepted the tender of Messrs. Crompton and Co., at £789, for the electric lighting of the Town Quay.

Edinburgh.—The Electric Lighting Sub-Committee of the Edinburgh Town Council have accepted tenders of Messrs. Ferranti, Limited, for steam-engines, alternators, switchboard,

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and rectifiers, and of the India Rubber, Gutta Percha, and Telegraph Works for insulated cable, amounting to between £4,000 and £5,000.

BUSINESS NOTES.

Dunblane.—The Police Commission will apply for a provisional order themselves.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,545.

Denbigh.—The Town Council are investigating methods of lighting the town by electricity.

Plant for Sale.—Our advertisement columns contain particulars of various kinds of plant for disposal.

Sunderland Exhibition.—The electric lighting of this exhibition will be carried out by Messrs. Ernest Scott and Mountain.

Electric Bells.—Messrs. Julius Sax and Co. have been asked to give a price for fixing electric bells at the Strand Union casual wards.

Manchester.—New Inland Revenue offices are being built in Deansgate. It is probable that they will be lighted throughout by electricity.

Pupils.—The Electrical Power Storage Company, of 4, Great Winchester-street, E.C, have a vacancy for one or two premium pupils or improvers.

Wellingborough.—Arrangements have been made for the installation of the electric light throughout the extensive sidings on the Midland Railway at Wellingborough.

Rochdale.—The whole of Duckworth's Hotel is now lighted electrically. The installation comprises a Crompton dynamo driven by a 12-h.p. Stockport gas-engine.

Cardiff.—The stores known as the Hayes Market, belonging to Messrs. David Rees and Co., are to be reopened to-day. They have been lighted throughout electrically.

Exploitation, Limited.—This Company has been registered with a capital of £1,250 to carry on business as mechanical, civil, electrical, hydraulic, and general engineers.

Blackburn.—A new church, to be called St. Silas, is to be built here. Although the usual gas fittings are to be put in, it is not unlikely that the electric light will be introduced.

Southall.—The opinion has been expressed at a meeting of the Southall-Norwood Local Board that the district has not yet reached a stage at which the electric light can be introduced.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending 26th inst. amounted to £1,094, as compared with £778 in the corresponding week of last year.

Leeds.—The Leeds Corporation Lamp Committee have appointed a sub-committee to consider a proposal made by the House-to-House Electricity Company to illuminate certain public thoroughfares.

Stalybridge.—Messrs. Parker and White have purchased the works of Messrs. Millburn, Sons, and Co., Limited, Stalybridge, and will start business there as ironfounders and electrical engineers.

Leeds Tramways.—The Corporation Tramways Committee left Leeds on Wednesday morning on a visit to the Isle of Man, for the purpose of inspecting the electric tramway from Douglas to Laxey.

Margate.—Letters have been received from two companies, who give notice of their intended applications to Parliament for provisional orders empowering them to supply electric light to this borough.

Saycoe Electrical Syndicate, Limited.—This Company has been registered, with a capital of £10,000 in £1 shares, to acquire and turn to account certain patents relating to improvements in primary batteries.

Kendal.—Tenders have this week been invited for the placing of telephonic communication between the gas company's offices, Parkside-road, and borough treasurer's office, 69, Highgate, for the Kendal Urban Sanitary Authority.

Elmore Copper.—The name of Elmore's Patent Copper Depositing Company, Limited, has been placed on the list of contractors to the War Department as a result of tests made upon Elmore copper, which has been approved by the Government.

Bristol.—The Electrical Committee met at the Council House on Friday, Mr. George Pearson being in the chair. The committee decided to alter the position of one arc lamp in College-green, and to erect two additional lamps, one on each side of the Queen's statue.

Dissolution of Partnership.—The partnership heretofore subsisting between Mr. Sydney Cummins Smith and Mr. William Habgood, carrying on business as electrical engineers, at Great Missenden, in the county of Buckingham, under the style of Habgood and Smith, has been dissolved.

Nottingham.—The central station is now rapidly approaching completion. The boiler-house, engine-room, and battery-room are all practically finished, and as the whole of the necessary machinery has also been laid down, there is every probability of the station being started at an early date.

Glasgow.—Plans have been prepared by Messrs. Bruce and Hay, 261, West George-street, Glasgow, for extensions of the warehouse of Messrs. Copland and Lye, Sauchiehall-street. It will be lighted electrically, and be provided with electric lifts.

City and South London Railway.—The receipts of the Company for the week ended August 26 were £878, against £719 for the corresponding week of 1893, or an increase of £159. The total receipts for the current period of the present half-year amount to £6,942, as against £6,647 in the corresponding period of 1893.

Portsmouth.—The Portsmouth Town Council have decided to apply to the Local Government Board for sanction to the borrowing of £1,265 for the purpose of extending their electricity distribution system. On the 1st inst. there were, exclusive of the public lighting, 3,517 16-c.p. lamps connected with the mains.

Taunton.—The globes of the arc lamps having been damaged by catapults, the Council have decided to offer a reward of £1, to be paid to the person giving information on the conviction of any person damaging the globes or plant. The electric lighting station, machinery, and plant have been insured in the Atlas Insurance Office for £6,000 at 4s. per cent.

Johnson and Phillips.—This firm inform us that they are at present very busy with numerous large orders in their cable department, especially in their indiarubber shops, manufacturing house-wiring cables and wires. Very few of the latter are now used, the majority of engineers specifying that only stranded conductors may be employed on the works.

Wolverhampton.—On Tuesday a meeting of the shareholders in the Wolverhampton Gas Company was held, at which Mr. J. Annan, the engineer, referring to the introduction of the electric light into the town by the Corporation, said it would not be a great disadvantage to the company, as alterations and improvements were being effected at the gasworks which would enable the company to hold their own.

Bath.—Alderman Sturges has reported to the Town Council that the Lighting Committee, having considered the further correspondence from the electric light company with regard to their application for a provisional order, were still of opinion that it should be resisted. He was in favour of the Corporation having a free hand at the end of the present license of seven years. The recommendation was adopted.

Aberdeen.—It has been reported to the Education Committee of Robert Gordon's College that the new installation of electric light from the city mains for the college and the school of art was expected to be completed in about a week. The contracts accepted for the work were £200 less than the estimate. In view of the circumstance that the installation was entirely new, the committee agreed that there should be a formal inauguration. The date has yet to be fixed.

Hertford.—The Lighting Committee of the Hertford Corporation have drawn up a report recommending to the Corporation that the proposed electric lighting scheme be carried out as speedily as possible; that the engineer be instructed, with the assistance of the borough surveyor, to prepare the detailed plans for carrying out the scheme and the requisite forms of tender; and that application be made to the Local Government Board for their sanction to a loan of £6,000 for carrying out the scheme.

New Installations.—Messrs. Rashleigh Phipps and Co., of 102, Oxford-street, have recently fitted up a large number of installations for Colonel Edis, the well-known architect of Fitzroy-square, and they have now been entrusted with the lighting of his house throughout. This firm have also received a contract for the whole of the fittings for the new Conservative Club in Glasgow. This club is a very large one, and the building is second to none in Glasgow. The Hon. Percy Allsopp, of Park-street, has also entrusted the lighting of his house to this firm.

Akroydon.—It is now several years since Mr. Milner, of the Woodside Mills, first introduced the electric light into Elland. His example has been followed by one or two manufacturers, and now Messrs. James Dyson and Co., of the Atlas Soap Works, are putting down an installation. A dynamo, made by Mr. J. A. Edmundson, Bradford, runs at 1,000 revolutions per minute, and has an output of 135 volts and 67 amperes. This will feed, perhaps, 60 lamps in the works varying in power from 16 to 25 candles, and 70 other lamps at the new house which Mr. Sam Dyson, Parkfield, has built in Victoria-street.

Crompton and Co., Limited.—An extraordinary general meeting of the shareholders was held on Wednesday, when Mr. R. E. Crompton, who presided, moved the confirmation of a resolution passed on the 13th inst., to the effect that the capital of the Company be reduced from £300,000 to £280,000 by cancelling paid-up capital which has been lost, or is unrepresented by available assets, to the extent of £20,000; and by cancelling 4,000 ordinary fully-paid-up shares of the Company, numbered 2,785 to 6,784 inclusive, which have been issued. The Chairman said the objects of the resolution were fully explained at the previous meeting. The resolution was adopted.

Belfast.—Mr. Greenhill has stated at a meeting of the Harbour Board that it was a matter of interest for the public to know that the Great Northern Railway had arranged for an installation of the electric light for the inspection of cattle after sunset during the winter months. This arrangement would enable dealers to send down their cattle by later trains. He trusted that the other railway companies having termini in Belfast would follow the example of the Great Northern, with the result that there would be a general improvement in the cattle traffic of the port. Mr. Davidson said the new light would be a decided advantage, as the steamers in future were to start an hour later from Belfast.

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Londonderry.—A special meeting of the Corporation has been held, at which a report was read from Mr. Christie, the resident electrical engineer. The report contained a list of occasions on which the electric cable had fused and been cut and repaired. The breaks were in all parts of the system. Councillor Turner was proceeding to question Mr. Christie, when the Mayor asked the Council, in the interests of the citizens and the Corporation, to reserve any observations on the subject until they had before them a report on the cables from Mr. Blake, the electrical engineer under whom the works were constructed. Mr. Blake said he had only returned to town, and had not had time to draw up a report. He admitted that these breaks constituted a serious feature, and would require to be put right.

Penzance.—The Town Council have been discussing the question of the lighting of the public lamps. Mr. Ludlow read the report of the Lighting Committee, showing the expenditure was £12. 9s. 7d. during the past five weeks. The committee recommended the acceptance of the gas company's tender, subject to the third clause being modified to the extent that the Corporation pay for opening and closing trenches for gas mains when used for supplying gas to public lamps only. Mr. Ludlow said the tender of 3s. 8d. was the same as before, but this clause, requiring the Council to open and close all trenches of present and future lamps, was the thin end of the wedge to get the electric light in. They were obliged to accept the tender as they were quite in the hands of the company. That really brought up the price. The report was adopted.

Ilkley.—An enquiry was held at Ilkley by Mr. F. H. Tulloch, Local Government Inspector, into an application by the Ilkley Local Board for sanction to borrow £2,600 for additions and alterations to the gasworks. Mr. Gaunt objected to the loan on the ground that the Local Board had already expended too much in the purchase of gasworks, and that a debt was likely to be created which he considered objectionable and unnecessary. Instead of spending so much on gas, he contended that the Board ought to have endeavoured to supply the electric light. The electric light was wanted in Ilkley, and it was very likely they would get it, but if the Local Board had gone in for electric light first, they could have bought the gasworks at a far less sum than they had paid. A note was taken of the objection, and the inspector viewed the works.

Colchester.—The Lighting Committee of the Town Council have, before deciding as to the establishment of the needful works for lighting a portion of the borough by electricity, issued a circular to the inhabitants of the district proposed to be lighted—viz., High-street, Head-street, North-hill, Crouch-street, St. John's-street, Queen's-street, part of Culver-street, St. Nicholas-street, St. Botolph-street, Long Wyre-street, and Short Wyre-street—with the view to ascertaining the extent to which such inhabitants are desirous of availing themselves of the electric light. The committee, after giving particulars in reference to the estimated cost of the light and fittings, distinctly state that the income to be derived from the works, if established, should be sufficient to render the undertaking self-supporting, in order that no charge may be made upon the rates.

Whitechapel.—An important report has been submitted to the Whitechapel District Board of Works by the committee of that body having charge of the scheme for the electric lighting of the district, for which powers were obtained some two or three years ago under a provisional order of the Board of Trade. The Streets Committee have been at work, with the assistance of Prof. Robinson, but have not come to any decision, and have submitted a detailed account of their labours for the opinion of the whole Board. The first scheme for lighting the prescribed area was estimated to cost £52,300; three alternative schemes were afterwards submitted, the total capital outlay being respectively £72,250, £74,750, and £84,250. In each case proportionate incomes are estimated to be received from supplying private consumers, but whether those amounts will be realised or the total expenditure exceeded are matters for consideration. The great feature in the local proposal, and it is one on which any scheme decided upon will be acceptable, is that the Whitechapel destructor premises can be used as a station, and the present waste heat of the furnaces utilised for generating purposes. The Board's consideration of the matter has been adjourned until October.

Bromsgrove.—In our last issue we referred to the position of the subject of the electric light here, and mentioned that a public meeting was to be held on Thursday evening last week. At this meeting there was a large attendance. Mr. D. Laing presided, and explained that the meeting was called to consider the application of Messrs. Hemming and Co., Birmingham, to the Local Board for permission to lay down electrical plant in the town. Mr. Bown said he was willing to move a resolution expressing the meeting's approval of granting the application, subject to such regulations as the Local Board thought it necessary to impose. Some of the working-men in the meeting expressed dissent at any restrictions being imposed, and Mr. Bown pointed out the necessity for regulations to preserve the streets and the other property of the Board. He went on to say that if Messrs. Hemming meant business he was sure the meeting would be unanimous in saying, "Come and welcome." A good deal of sympathy had been expressed with the gas company in this matter, but no one had expressed sympathy for the poor sellers of lamps and petroleum, and it was adding insult to injury to ask him to move such a resolution, for he might lose the sale of so many barrels of petroleum; but he did not care for that. He moved, "That in the opinion of this meeting it is desirable that the request of Messrs. Hemming be complied with, subject to any conditions which it may be necessary to impose." Mr. Wright, secretary of the company, being called upon, explained that the company could proceed by applying at once to Parliament for a provisional order, or they could apply to the Board of Trade for a license, and in the latter case it was necessary first to obtain the consent of the Local Board. In reply to the question whether the company meant business, he said they would not proceed to lay down their plant immediately the consent of the Local Board was obtained, but would proceed to ascertain what amount of support it was probable they would receive from the town. The Rev. E. Pine Hall seconded the motion, which was carried unanimously.

The Newcastle Tramways.—The Newcastle Tramways Committee have met to consider the resolution come to at a meeting of the Council—namely, that the Tramways Committee should prepare a scheme for the working of Westgate-hill, Arthur's-hill, and Stanhope street district with cable trams. Mr. Eustace Smith met the committee, and a conference was held as to the new company, of which he is a promoter, taking up the section alluded to. Mr. Smith stated that it would be almost impossible to work so short a section profitably, as it would only be equivalent to four miles, and it would entail the putting up of an engine-house near the workhouse. If the cable trams were extended over the city, such engine would be of no use, as they would really require two engine-houses somewhere in the centre of the town to work the two sections. Thus the cost involved in building the new engine-house, etc., would be lost. From the experience gained in Edinburgh it was ascertained that the cost of working a tramcar for a short distance of four miles was at the rate of 10d. per mile; for six miles, 9d.; and for 12 miles, 7½d. per mile; or a difference of £7,000 in the revenue. The committee, however, requested Mr. Smith to entertain the scheme as agreed upon by the Corporation, and to state upon what terms his firm could work it, and if they could not see their way to take it over on certain terms, to say what they would be prepared to offer for the section alluded to and a further extended portion in the city. A letter was read to the committee from Messrs. Leadbitter and Harvey, on behalf of gentlemen interested in electricity, whereby they suggested to run a line from the central station to a point opposite the church in Church-street, Walker. They undertook to work such line by the conduit system to the Walker New-road, and from there down to the terminus at the Walker Church. They proposed to have overhead wires on poles to be placed on one side of the road, but in no case were the wires to cross the road. The committee decided that the matter should stand over pending the decision on Mr. Smith's proposal.

Edinburgh.—The Cleaning and Lighting Committee of the Town Council, on a statement from proprietors and tenants in the district, recommended that George-street, Charlotte-square, and St. Andrew-square, and the streets leading from these to Princes-street, should be lighted by electricity. Bailie Steel proposed that the recommendation be not agreed to. He suggested that they should pause until they saw the result of the installation already sanctioned. Treasurer M'Crae seconded. If they agreed to this proposal, there was no street in the city that could be excluded from the electric lighting scheme. They had again and again increased their public electric scheme, and the question was where they were to stop. Bailie Gulland proposed the adoption of the committee's recommendation. He maintained that fairplay to the business community in George-street and the adjoining streets demanded that these streets should be lit with electricity. Mr. Mortimer seconded Bailie Gulland's motion. George-street, he said, was at present one of the worst lit streets in the city. Mr. Mackenzie pointed out that, altogether apart from the question of electric lighting, the Corporation must lay their minds to improving the public lighting of the streets. At present they spent 1¼ cubic feet per hour on their street lamps. In the large English towns they consumed about 5 cubic feet per hour. Manchester, with double the population of Edinburgh, spent four times as much as Edinburgh on public lighting. He did not believe there would be a deficit on the electric lighting scheme. Manchester had set up an installation at a cost of £127,000, and in the very first year the deficit was only £238 after paying all expenses. After some further discussion, the Lord Provost, in supporting the amendment, pointed out that they would be introducing a novel principle if they lighted the streets here proposed, and a principle which would bring a great deal of trouble upon their heads. The committee had recommended the lighting of people and not of property, but here they were going upon the principle of lighting property and not people. Once they did that they would have people from all parts complaining that their property was not lighted. On a division, Bailie Steel's motion was carried by 14 votes to 12 given to Bailie Gulland's.

Salisbury.—The Town Council, acting as the Urban Sanitary Authority, recently held a meeting for the purpose of receiving the minutes of a committee meeting of the Authority, and to consider the draft form of license which the Salisbury Electric Light and Supply Company, Limited, sought to obtain from the Board of Trade. The town clerk reported that at the committee meeting a copy of the draft form of license was considered, and that a resolution was passed requesting Mr. Hammond to insert therein such conditions and modifications as he might deem expedient, with a view to the same being considered at that special meeting. The Council decided that Mr. Gramshaw, representing the company, should be admitted, but that the draft form of license, as amended by Mr. Hammond, should be read before he was invited into the room. The draft of the license (which, it was stated, would absolutely expire at the end of seven years, or would

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certainly be revoked by the Board of Trade on the issue of a provisional order which was to be applied for) was then read. This was discussed, and Mr. Gramshaw was then called into the room, and the alterations in the draft form of license suggested by Mr. Hammond were communicated to him. The only objection raised by Mr. Gramshaw had reference to the proposed purchase clause, which he contended was unnecessary. He remarked that the license was simply, so to speak, a permission given on the part of the Board of Trade to save time, whereas the provisional order was really the legal engagement, and under this the Authority would have a greater *locus standi*. The Authority would have plenty of time to discuss the question of purchase when the provisional order was applied for, and he would see that a clause was inserted in the order; but if they were to decide on such an insertion now in the form of license it would create a precedent for the provisional order which would not be fair to the company, which was in its infancy, and had not yet made any contract. It was not fair to the company either to ask them to insert in the license something which was not usually inserted in such cases. The company could not accept the proposal, but if the Authority insisted on the insertion of the clause, they would go to the Board of Trade and lay the facts before them, as he had laid them before the Council. Mr. Pyesmith moved that the license should be drafted without any reference to a purchase clause, and that both the Corporation and the Authority should be left entirely free to deal therewith when the same came up for discussion in the provisional order. Alderman Brown seconded the motion, which was agreed to. It was understood that the provisional order would be applied for in the parliamentary session of 1895. The Mayor moved, and Mr. Scamell seconded, that Mr. Hammond should be empowered, on behalf of the Sanitary Authority, to lodge the draft license with the Board of Trade, subject to such alterations therein as had been approved by the Council. This motion having been carried, the proceedings terminated.

PROVISIONAL PATENTS, 1894.

AUGUST 20.

15789. **Improvements in thermo-dynamic motors.** Francis William Crossley and James Atkinson, Openshaw, Manchester.

15825. **Improvements in constructing electric cartridges for fog signalling on railways.** Herbert Brocklehurst and Henry Constien, 24, Cheyne-court, Chelsea, London.

15843. **An improved telegraphic apparatus for transmitting domestic orders or other signals.** Louis Boudet and Pierre Lacombe, 18, Buckingham-street, Strand, London.

15858. **Improvements in permanent ways for electric railway and tramway vehicles.** Jean Claret and Olivier Wuilleumier, 47, Lincoln's-inn-fields, London.

AUGUST 21.

15899. **An improvement in copper castings for electrical purposes.** Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Eugene Obach, Germany.)

15900. **Improved means for preventing variations in the regulation of shunt arc lamps for alternating currents.** Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Messrs. Siemens and Halske, Germany.) (Complete specification.)

15920. **Improvements in and connected with primary batteries.** George Herbert Reid, 55, Chancery-lane, London.

15921. **Improvements in the electrical propulsion of boats and vessels.** Anthony George New and Arthur James Mayne, 55, Chancery-lane, London.

AUGUST 22.

15985. **Improvements in or connected with electric arc lamps.** William Hopkin Akester and Henry Herbert Price, 57, Chancery-lane, London.

16002. **Improvements in apparatus for refining metal by electrolysis.** Henry Alonzo House, Henry Alonzo House, jun., and Robert Rintoul Symon, 115, Cannon-street, London. (Complete specification.)

AUGUST 23.

16097. **Improvements in and relating to electric high and low tension fuse heads for use in blasting.** Tom Malson, 54, Fleet-street, London.

16100. **Improvements in apparatus for use in the electrolysis of alkaline chlorides and other alkaline salts.** Henry Auer and Ferdinand Hurter, 47, Lincoln's-inn-fields, London.

16105. **Improvements connected with the electrical deposition of zinc and other metals.** Richard Heathfield and William Stepney Rawson, 1, Leadenhall-street, London.

AUGUST 24.

16106. **Improvements in galvanometers.** Arthur Ford-Lloyd, 5, Hunter-street, London.

16112. **An adjustable electric contact specially designed for safe and strong-room doors.** Frederic Charles Geary, Church Gresley, Burton-on-Trent.

16131. **Improvements in electric signs and advertisements.** William David Hawksey and Ivie Mackie Lamb, 70, Market-street, Manchester.

16145. **Improvements in electrolytic processes and apparatus.** Cornelius Hessel, 21, St. Julian's-road, Kilburn, London.

16156. **Improvements in and relating to electric winding engines, locomotives, and other electric motors, chiefly designed for use in mines.** Bruno Lebrun, 45, Southampton-buildings, Chancery-lane, London.

16162. **Improvements in accumulators or secondary batteries.** Moricz Engel, 28, Southampton-buildings, Chancery-lane, London.

16163. **Electrical apparatus for controlling the motion of cranes, travellers and other similar apparatus.** John August Essberger and Alexius Wilhelm Geyer, both of the firm Union Electricitäts-Gesellschaft, 28, Southampton-buildings, Chancery-lane, London.

16191. **Improvements in or relating to electric bells and other sounding or indicating devices.** Samuel Quincey, Philip Benns, and Henry Belham, 46, Lincoln's-inn-fields, London.

16192. **Improvements in or relating to electric bells and other sounding or indicating devices.** Samuel Quincey, 46, Lincoln's-inn-fields, London.

AUGUST 25.

16243. **Improvements in the electric propulsion of cars.** Archibald H. Brintnell, 4, South-street, Finsbury, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1893.

16467. **Working electric tramways.** Anderson.

15217. **Electric cables.** Dymond. (Thompson.)

15231. **Electric arc lamps.** Boult. (Bureau.)

15486. **Electric switch.** Mann and Hopwood.

18602. **Telephone switchboards.** Abel. (Société Générale des Téléphones Reseaux Téléphoniques et Construction electriques.)

18690. **Conduits for electric conductors.** Picking.

1894.

8761. **Electric fire-alarms.** Archibald and Tarry.

12875. **Alternating-current meter.** Kelley and Stanley.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	5	5½-5¾
Bournemouth Electric Company	—	—
Brighton and Hove Company Original	100	210-215
—— "A" Ordinary	—	162-166
Brush Company, Ordinary	3	2¾-3
—— Nom. Cum., 6 per cent. Pref.	2	2½-2¾
—— 4½ Debenture Stock	100	110-113
Charing Cross and Strand	5	4½-5½
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	12½-13½
—— 6 per cent. Cumulative Pref.	10	14-14½
—— 5 per cent. Debenture Stock	115	128-131
City and South London Railway, Consolidated Ordinary	100	36-38
—— Debenture Stock	100	121-123
—— 5 per cent. Pref. Shares	10	12½-13½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¾-2½
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	95-100
Electric Construction, Limited	2	1-1¼
—— 6 per cent. Debentures	—	87-92
—— 7 per cent. Cumulative Pref.	2	1½-2
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1-1⅛
Elmore's French Company	2	⅛-¼
Elmore's Wire Company	2	1-1⅛
Fowler-Waring Cables	5	⅛-¼
W. T. Henley's Telegraph Works, Ordinary	10	⅞-1
House-to-House Company, Ordinary	5	1-1⅛
—— 7 per cent. Preference	5	5½-5¾
India Rubber and Gutta Percha Works	10	23-24
—— 4½ per cent. Debentures	100	103-105
International Okonite, Ordinary	—	—
Kensington and Knightsbridge	5	4¾-5½
—— 6 per cent. Pref.	—	6¼-6¾
Liverpool Electric Supply, Ordinary	5	6¼-6¾
—— Pref.	—	—
Liverpool Overhead Railway	10	7 13/16-7 15/16
—— Pref.	10	12½-13
—— 4 per cent. Mortgage Debentures of £100	100	111-113
London Electric	5	¾-1⅛
Metropolitan Electric Supply	10	8¼-8½
—— 5 per cent. Reg. Debentures, 1-10,000 in Bonds of £10, £20, and £40	—	—
National Telephone, Ordinary	5	4¾-5
—— 6 per cent. Cum. First Pref.	10	14-15
—— 6 per cent. Cum. Second Pref.	10	13½-14½
—— 5 per cent. Nom. Cum. Third Pref.	5	5¼-5¾
—— 4½ per cent. Deb. Stock	—	108-111
Notting Hill Company	10	4½-5¼
Oriental and Electric Company, £1 shares	1	1-1⅛
—— £5 Shares	—	6¼-7
—— £4½ shares	—	5¾-6
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7-7½
—— 7 per cent. Pref.	5	8¼-8½
Swan United	—	—
Telegraph Construction and Maintenance	12	40-42
—— 5 per cent. Bonds	100	102-105
Westminster Electric Supply, Ordinary	5	6¼-6¾
Yorkshire House-to-House	4½	4¼-4¾

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NOTES.

Madras.—The locomotive department of the Madras Railway is building 50 cars for the Madras Electric Tramways.

Football by Electric Light.—A football match has been played at Rochester at night, with the aid of the electric light, before 3,000 people.

Mysore.—It is stated that preparations are being made to light by electricity the whole of his Highness the Maharajah's banqueting hall at Mysore.

Brussels Tramways.—A Brussels paper states that three accidents have recently taken place in connection with the working of the electric tramways in this city.

Personal.—Prof. Helmholtz celebrated his seventy-third birthday on the 31st ult. He is now much better, and it is hoped that his complete recovery will soon take place.

French Contemporaries.—The cessation in the publication of *La Lumière Electrique*, which has recently taken place, has also abruptly terminated the existence of *Electricité*.

Electric Cooking.—A food and cookery exhibition has been opened at the Exhibition Hall, Rusholme-road, Manchester, at which daily demonstrations are given of cooking by electricity.

Mediterranean Trip.—The "Electra," with Sir John Pender and his party, including Lord Wolseley, Sir Evelyn Wood, Lord Portsmouth, and others, on board, left Athens on Monday *vid* the Canal of Corinth, for Genoa.

Telegraphic Nomenclature.—The ninth edition of the "Nomenclature Officielle des Bureaux Télégraphiques," published by the Bureau International des Administrations Télégraphiques, of Berne, will be issued in a few days.

Telephony in Belgium.—According to the *Etoile Belge*, Belgian-Dutch communications have been going on by which a telephone line will be established between Brussels and Antwerp and Amsterdam and Rotterdam.

Electric Traction Systems.—Mr. J. M. Nicol, of Plymouth, has contributed an article on electric traction to the *Western Morning News*, in which he has dealt more especially with the Pollak and Binswanger closed-conduit system.

Institution of Engineers and Shipbuilders.—We have received Part 9 of Vol. X. of the *Transactions* of the North-East Coast Institution of Engineers and Shipbuilders. It contains the constitution, by-laws, and list of officers and members.

Hampstead.—The date for the public starting of the supply of electric light at Hampstead has been fixed for October 1. The North-Western Hospital of the Metropolitan Asylums Board will, it is said, be the largest private consumer.

Hospital-Lighting.—The new hospital at Birmingham, which will be inspected by the Duke of York to-morrow (Saturday), is lighted throughout by electricity. In addition to this, two fans driven by electric motors have been installed for ventilating purposes.

Paris-Madrid Telephony.—Paris and Madrid will shortly be telephonically connected. On the Spanish side the line extends from Madrid to Saragossa, and on the French side from Paris to Tarbes. The section between Tarbes and Saragossa has still to be connected.

Electric Traction in Italy.—An application has been made by Mr. Guiseppe Ferrando to the Mayor of Palermo for a concession for the construction of four tram lines in that town to be worked by electric cars. It is proposed to erect the power station in the Piazza Ucciardone.

Royal Photographic Society of Great Britain. A soiree of this society will be held on Saturday evening, 22nd inst., in the gallery of the Royal Society of Painters in Water-Colours, 5A, Pall-mall East. The thirty-ninth annual exhibition of the society will open on the 24th inst., and will be continued until November 14.

Electro-Harmonic Society.—The concerts of the Electro-Harmonic Society this season will be six in number, and will take place on the evenings of the following dates: September 28, smoking concert; October 26, smoking concert; November 30, ladies' night; January 25, 1895, smoking concert; February 22, ladies' night; and on March 29, smoking concert.

Electric Traction on Railways.—Mr. A. B. Kitching, the chairman of the Mersey Railway Company, at the half-yearly meeting of the company held on Thursday last week, stated that the directors had made enquiries as to the practicability of working the railway by electricity, and these enquiries were still going on. As far as they had gone, the information was rather encouraging.

Going Up.—Business seems to be improving in the electrical industries, if Stock Exchange quotations are any indication. During the past week there has been (as will be seen from our companies' stock and share list) a rise in the shares of the Brush Company, Indiarubber Company, Henley's Works, some Elmore companies, some supply companies, and the National Telephone Company.

Lightships and the Electric Cable.—A petition has been forwarded by Mr. E. J. Hobbs to the member for Thanet, expressing satisfaction with the great success of the cable connection between the North Sands Head and Kentish Knock light-vessels and the shore, and asking Parliament to sanction the connection of the remaining 240 lightships round the coast, and especially the East Goodwin light-vessel.

New Electric Launch.—A demonstration of the capabilities of the electric launch "Velvoca" will be given on Monday next by the Battery and Motor Company, of St. Margaret's Offices, 53, Victoria-street, S.W. The launch will start from Petersham Island, Richmond, at 3 p.m. The current is obtained from 48 Velvo-carbon primary batteries, each of which, we are informed, weighs 30lb. The output is said to be 60 amperes for 10 hours.

University College, London.—The lectures and practical work in the engineering and chemical laboratories at University College, London, will commence on 2nd proximo. The courses, as will be seen by our advertisement columns, are in civil, mechanical, and electrical engineering, graphics, and architecture. Copy of prospectus may be obtained of Mr. J. M. Horsburgh, M.A., secretary, University College, Gower-street, W.C.

Gas and Electricity.—That the competition of the electric light is bringing down the price of gas is being shown in different parts of the country. Two or three weeks ago we noted this fact in connection with Hanley, and now the Croydon Commercial Gas Company have decided to reduce the price "in view of the possible advent of the electric light." Gas companies, it would appear, are beginning to feel the shoe pinch more keenly than ever.

Gross Exaggeration.—"I do not think," says the Scotch correspondent of the *Journal of Gas Lighting*, "the citizens of Edinburgh realise that electric lighting will cost them about £50 per lamp per annum, or, if they did, I am persuaded they would not go in for so extensive a scheme." Our office boy says that he intends to proceed to Scotland

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to learn the gentle art of exaggeration from the correspondent in question. Will our contemporary oblige us with his address?

Electrical Machinery.—We have received from Messrs. Ernest Scott and Mountain, Limited, Close Works, Newcastle, their new catalogue of electrical plant and machinery—a well-printed and well-illustrated book. The sections respectively deal with general particulars of lighting, Tyne dynamos for all purposes, transmission of power, motive-power plant, arc lamps, electrical accessories, electric light fittings, bells, telephones, domestic apparatus, and engineering specialities, and machinery. There is a good selection of dynamos, and the motor plants include various pumps for mining purposes, winding and haulage plant, electric cranes, lifts, wharf capstans, launches, mining drills, coal-cutters, fans, and blowers.

Launches on the Thames.—Mr. Fras. F. Ommanney has sought the columns of the *Standard* to ventilate a complaint concerning the danger caused to small boats by large launches on the upper reaches of the Thames, with special reference to recent fatal accidents. He suggests, with a view to prevent such accidents, "the following further restrictions for the consideration of the powers that be: (1) no vessels propelled by steam, oil, or electricity to exceed 40ft. by 7ft.; (2) no such vessel to travel at a greater speed than 'slow'; (3) at locks, launches to wait until after pleasure boats have gone through, and not to approach within a hundred yards of lock gates except by permission of authorised lock-keeper; (4) all pleasure craft to carry lights after dusk."

A Gassy Contemporary.—Our contemporary the *Journal of Gas Lighting* prints an editorial on "Petroleum or Gas for the People." Of course the conclusion of the article is that efforts should be made by "those who are responsible for the popularisation of gas to persevere in their endeavours to facilitate the employment of this means of lighting where it is most likely to do most good." Why not take it to Africa then, dear *Journal*—there "it is most likely to do most good" among the niggers. Gas and petroleum are about in the same boat as regards safety (?), but the nose of the former is gradually being put out, and in this case, as also when American papers refer to it as the *London Journal*, the *Journal* does not like it. The decrying of the use of oil lamps by a gas journal is simply paradoxical.

State Telephony.—In an article published in the *Elektrotechnische Zeitschrift* of August 16, Mr. J. Baumann discusses the question of telephony, and points out that the working and management of telephone systems are in the possession of the Governments of Germany, Belgium, France, Austria-Hungary, Luxembourg, Switzerland, Roumania, and Bulgaria. In Sweden both the Government and a private company operate telephone exchanges, the extent of the services being practically equal. This fact, the author suggests, shows that it is only a question of time when the whole of the European countries will be placed in communication with each other by means of State telephone networks, similarly to the telegraph systems. The author then passes on to consider the question of telephone rentals.

New Steamer.—A new steamer, named the "Duke of York," and intended for service between Richmond and Hampton Court, was launched on Saturday from the yard of the Thames Electric and Steam Launch Company, Eel Pie Island, Twickenham. The steamer has been designed by Mr. W. S. Sargeant. It affords accommodation for 300 passengers, and is said to be the largest launch on the Thames above Richmond Lock. Her length from stem to taffrail is 80ft., with beam 14ft., depth 7ft., and draught about 3ft. 6in. The main saloon is artistically decorated, and down the centre of the skylight are ornamental lacquered brass electroliers fitted with incandescent lamps. The vessel is propelled by a single screw, having three blades of Bull's metal supplied by the Phosphor Bronze Company. The motive power is provided by a pair of compound surface-condensing engines of the marine type.

Electric Lighting in Germany.—Although the Chemnitz central station has not been long in operation, the demand has been such that steps are being taken to extend it next spring. A second feeder is being laid down, the first supplying 7,000 incandescent lamps, 225 arc lamps, and 30 h.p. for electromotors. The electric light is being introduced into Geringswalde and Bruck-on-the-Maine. The Municipality of Landstuhl have decided to take current from Messrs. Bumb and Herrle, a local engineering firm. The town will lay its own cables. The Cologne Municipality have decided to light the High-street and the district surrounding the cathedral electrically from the municipal central electric light station. Some of the lamps supplied by the Helios Company for this purpose are already in use. They are hung from steel wires stretched across the streets, which are narrow. The Municipality of Mannheim have issued circulars to ascertain the probable demand for current.

A Simplon Electric Railway.—The project of piercing the Simplon from the Swiss to the Italian side has now made another step forward. When the scheme of constructing the tunnel was approved by the Swiss Confederation and the Italian Government, a committee of three eminent engineers was appointed to examine the mountain and report upon the best means of constructing the new line. Sir Douglas Fox was asked to form one of the committee, and he undertook the task in conjunction with Messrs. Wagner and Colombo, the former a famous Austrian engineer, and the latter of equal rank in his profession in Italy. These gentlemen have now concluded their labours, and although their report has not yet been formally presented to the Italian and Swiss Governments, its tenor has been made public. Sir Douglas Fox deals specially with the question of the ventilation of the proposed tunnel, and recommends that electricity should be used entirely for traction purposes. If electric traction is used, there will be no special ventilating machinery required.

Electric Lighting in Australia.—According to the *Melbourne Age*, the second reading of an Electric Lighting Bill was moved in the Legislative Assembly on July 17. Mr. Wynne, who moved the second reading, said the time had arrived when some system should be introduced for the regulation of the supply of electricity. This Bill was very similar to the one introduced by the president. It was necessary for the interests and the safety of the public that control should be provided for regulating the operations of companies and their dealings with municipalities in the supply of electric light. Arrangements were made by which local councils could either construct the works or let that power to a company. A council would be empowered to strike a special rate. Companies would be required to supply information of their profits and of the manner in which they had dealt with the concession. Right of purchase by the municipal councils was provided for. There was a limitation of profits to 10 per cent. dividends, and the consumers were given the benefit of a reduced rate, as the dividends might be increased in proportion to a specified rate of reduction in the price of electricity. The discussion was adjourned.

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Polarisation of a Thin Metal Partition in a Voltameter.—Mr. J. Daniel, in the *Phil. Mag.*, mentions that when a thin metal partition is introduced between the poles of a voltameter, gases are evolved at its surface, but if the thickness of the partition is below a certain limit, the current passes without evolution of gas and without evident polarisation. The author finds that the "critical thickness"—that is, the least thickness of partition through which the current passes without polarisation—is 0·00009mm. for gold, 0·00015mm. for platinum, and 0·0005mm. for aluminium, with a small current and a good conducting electrolyte. The "upper critical limit"—that is, the smallest thickness for which the polarisation is the same as for very thick plates—is about 0·004mm. under the above conditions. Between the critical limits the polarisation increases with the thickness. Special experiments indicated that in the case of copper sulphate solution the passage of the current was not accompanied by the passage of copper ions through the gold-leaf partition, but rather that the copper sulphate itself diffused bodily through the membrane.

Gas and Electricity in Berlin.—A report issued by the Aeltesten der Kaufmannschaft über die Handels und Industrie Verhältnisse, of Berlin, deals with the question of the influence of the introduction of the electric light on the consumption of gas. It appears that the adoption of electric lighting is having a considerable effect in Berlin in spite of the hopes which were entertained of the increased use of gas for heating and cooking purposes. For many years the consumption of gas rose annually by from 4 per cent. to over 6 per cent. each year, and even in 1892 the increase amounted to about 3,250,000 cubic metres, or about 3¼ per cent. compared with 1891. Last year, however, the consumption fell by nearly 1,000,000 cubic metres. Private gas consumers used 1,750,000 cubic metres less. This is attributed to the unfavourable condition of business, to the competition of the electric light, and to the economy of the Auer incandescent gas lamp. More use is being made of gas for heating, cooking, and motive-power purposes. Electricity has made great headway during the past year not only as regards the current taken from the central station of the Berliner Elektricitätswerke, but in private installations. The latter have decreased in number from 301 to 280, but the number of lights thus supplied has risen by 6 arc and 14,406 incandescent lamps, so that at the close of the year there were 3,869 arc lamps and 69,632 incandescent lamps connected with private installations. The Berliner Elektricitätswerke at the end of the past year supplied 4,931 arc lamps, 102,705 incandescent lamps, and 322 motors. The total increase in electric lamps during the past year was 19·96 per cent.

Internal Arc Lighting.—In discussing the subject of lighting rooms by means of arc lamps, Mr. F. Nerz in the *Elektrotechnische Zeitschrift* of August 30 dismisses as being out of the question dwelling-rooms where two or three gas or petroleum lamps are in use. When, however, the demand for light is greater than this, he states that arc lamps can be employed with advantage, and, although no saving may be effected, more light and a more even illumination are obtained than is the case with incandescent lamps, gas, or petroleum. In order to impart a warm tone to small arc lamps of from two to four amperes for internal illumination, we must take care first of all that the quantity of light directly beaming forth is diminished as much as practicable, but that the distributed light is increased. This may be accomplished (1) by increasing the obscuration of the surrounding globe of the lamp, (2) by augmenting the diameter of the same, and (3) by the addition of means for a further distribution of light. The author states that when properly applied the increase in the obscuration of the globe does not bring about those disadvantages generally imagined. Let us take the ordinary globe, and by giving it a thicker coating we shall considerably diminish its transparency, and at the same time increase the distributing effect. If we measure the lighting power in the room without and with a globe, we find in the latter case an important diminution in the value for the zone of highest intensity, and an increase in all other points of the room. Let us insert between the source of light and the globe a light-distributing means. The Schuckert Company, according to Mr. Uppenborn's proposals, place in their lamps for internal illumination a small glass cone arranged at the point of illumination, and this gives a good effect. The author then goes on to deal with other forms of lamps in which improvements have been introduced for the purpose of increasing the distributing effect.

The Latest Dalzielite Story.—Some of the items of news transmitted to this country by Dalziel's Agency are truly remarkable. One of the latest efforts of their Paris correspondent is the following: "A series of very wonderful experiments, which have just been concluded by Dr. Luys, whose observations and discoveries in connection with magnetism and electricity made a profound impression upon the scientific world some time ago, has led to a remarkable result. The latest discovery establishes the fact that cerebral activity can be transferred to a crown of magnetised iron, in which the activity can be retained and subsequently passed on to a second person. Incredible as this may seem, Dr. Luys has proved its possibility by the experiments just referred to. He placed the crown, which in reality is only a circular band of magnetised iron, on the head of a female patient suffering from melancholia, with a mania for self-destruction, and with such success was the experiment attended that within a fortnight the patient could be allowed to go free without danger, the crown having absorbed all her marked tendencies. About two weeks afterwards he put the same crown, which meanwhile had been carefully kept free from contact with anything else, on the head of a male patient suffering from hysteria, complicated by frequent recurrent lethargy. The patient was then hypnotised, and immediately comported himself after the manner of the woman who had previously worn the crown. Indeed, he practically assumed her personality, and spoke of himself as a woman, and uttered exactly the same complaints as she had done. Similar phenomena, it is reported, have been observed in the case of every patient experimented upon. Another experiment showed that the crown retained the impression acquired until it was made red-hot." It is not likely that anyone would care to have the cerebral activity of this enterprising reporter transferred to him.

Electric Travelling Cranes.—In our last issue some particulars were given of the great 60-ton overhead crane at the Seraing works of the John Cockerill Company; and we then expressed doubts as to whether this was not the largest of its kind as yet built. A correspondent calls our attention to the appliances of this type furnished by a single firm in the United States, though none of the cranes mentioned is larger than, or even so large as, the Belgian giant. The following are the particulars furnished to us: "The Morgan Engineering Company, of Alliance, Ohio, has an order from the Carnegie Steel Company for three of its patent electric overhead travelling charging cranes, for charging and drawing ingots in the vertical heating furnaces at the Edgar Thomson Steelworks. About a year ago the Morgan Company erected a crane of

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a similar character at these works. This has been so satisfactory that the firm has determined to change its horizontal heating furnaces to those of the vertical type, and is putting in these three additional charging cranes to handle the entire product of the blooming mill in connection with the rail mills. A 10-ton crane of 60ft. span is also being built for the foundry of this company, making in all 22 Morgan electric cranes in the plant. Two overhead travelling charging cranes, similar to those building for the Carnegie Company, have been ordered by the Ohio Steel Company in addition to a crane of 15 tons capacity, 75ft. span, recently placed, and among other recent orders are a five-ton, 50ft. span, and a three-ton locomotive type crane (both operated by electric motors) for the American Machine Company, Pawtucket; one of 20 tons, 70ft. span, and one of 40 tons, 40ft. span, for Mackintosh, Hemphill, and Co., Pittsburg, making in all seven travelling cranes furnished by that company. Two specially constructed patent travelling cranes for handling blooms in and out of horizontal heating furnaces are being erected for Jones and Laughlins, Pittsburg, in addition to two electric travelling tables for serving their blooming mill. Two travelling tables, operated by electric power, for the blooming mill of the Cambria Iron Company, Johnstown, Pa., will soon be shipped. Recent shipments include a travelling crane of 30 tons capacity, 75ft. span, fitted with double trolleys, to the American Steel Foundry Company, St. Louis; one 20-ton crane supplied with a patent auxiliary hoist, to the United Verde Copper Company, Granite Station, Arizona; one 25-ton, 55ft. span, travelling crane to the Johnson Company, Johnstown, Pa., this being the second furnished the company. It is stated that the Morgan Engineering Company makes applications of electric motors to more machinery of this class than any other similar concern."

The Pacific Cable Question.—In another column we reproduce from the *Times* an article on this subject. In a leading article discussing the matter that paper says: "It has been already shown that, as a matter of fact, the construction of the cable is likely to cost considerably less than the establishment of the new line of steamers which is regarded as being well within the limits of private enterprise. Possibly the tenders for which the Canadian Government has called will establish this fact still more clearly, and, if no other end were served, this alone would be a useful result. But the question opens wider issues. The field of the Pacific is growing daily more important. The Canadian and Australasian colonies have realised this fact, and they are naturally desirous that the ports which belong to them upon its shores should play a leading part in the development of the commercial future. They see also that, as foreign influence increases upon an ocean which separates them from one another, it will become necessary for them to develop their means of inter-communication. The nation which lays the first Pacific cable and puts the first good line of steamships on the Pacific Ocean may reasonably expect to hold a commanding position on its waters, and in the efforts which the British colonies are making to secure this position for Great Britain they are simply obeying the dictates of their own advantage. This is the form of self-interest upon which the principle of Imperial unity is based. It is perhaps both just and wise to leave the initiative in this matter to the communities which are most immediately concerned; but in estimating the advantages of cheaper submarine telegraphy which must inevitably result from the successful establishment of a Pacific cable, especially if it be established under Government control, we should be less than just if we were to underestimate the benefits to be derived by British trade. Nor ought we to permit ourselves to forget that in every political advantage which results from the strengthening of British ties and the development of communication throughout the Empire, a large share must of necessity be ours. For these reasons we are disposed to urge that, when the time is ripe for action, the proposals which have the most practical merit to recommend them may be entertained with an open mind. The possession of one line of cable would not necessarily commit the Government to the wider scheme of the purchase of the whole existing system. On the contrary, the experience of owning one alone for a term of years might possibly be of great value in determining opinion upon the general policy to be hereafter adopted; and, unless the estimates of experts are very widely mistaken, there should be little difficulty in disposing of the line to a private company, if, on the termination of the experiment, such a course were deemed to be desirable."

The Incandescent Lamp in the Future.—This subject is discussed in *L'Industrie Electrique* of August 25 by M. G. Claude, with special reference to the recent communication made by M. Larnaude to the Société Internationale des Electriciens on the subject of incandescent lamps. The writer points out theoretically that for a given temperature the quantity and quality of luminous radiations emitted by a body of determined dimensions depend essentially upon the nature of this body. One has to take as a luminous source a body of which the coefficient of emission is as high as possible. On the other hand, in proportion as we rise in the temperature scale, the proportion of the luminous radiation to the total radiation rapidly increases, as shown by M. Larnaude. Thus from two identical sources, of which one is at a temperature only a little higher than the other, the luminous efficiency of the latter is much superior. It is then necessary to raise the emissive body to as high a temperature as possible. Passing from this standpoint, the writer suggests that it is possible in future that we may be able to utilise for filaments bodies that are not now usable, and which will withstand higher temperatures, as shown by the experiments of M. Moissan. From an industrial point of view, M. Claude asks the reason why central stations use potentials of at most 120 volts, or 240 volts when recourse is had to the three-wire system? Why employ such low voltages, when the immediate result of this fact is to require a system of mains of enormous section and of considerable expense? The writer answers his own questions by stating that the reason lies simply in the fact that the existing incandescent lamp does not allow of our working otherwise, because the carbon being relatively very conductive the filaments that can be obtained for lamps of low luminous intensity would be unable to bear differences of potential exceeding from 100 to 120 volts, unless they are too fragile. Thus there have been made lamps of 16 c.p., and even 10 c.p., with a single filament working at the extreme limit of 200 volts, but these lamps are not practical. It is true that we could without inconvenience in the majority of cases branch the lamps two in series, but this method is generally repudiated. It might be difficult to believe that such a slight cause could bring about this result, but nevertheless that is the exact truth. The actual conditions of manufacturing incandescent lamps are the sole reason of the limitation of lighting distribution. But, M. Claude continues, suppose, on the other hand, that among the new compounds brought to light by M. Moissan there are some, or even only one, which has combined with extreme refractory properties a conductivity two or three times less than that of carbon. Suppose from now it is allowable to obtain practical solid filaments working under 300 or 400 volts, so also from now would the electric lighting industry be

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revolutionised. The efficiency of the incandescent lamp being raised to much more satisfactory values, central stations would cease to be trammelled by the necessity of laying mains for such a low pressure as at present used, and only have to concern themselves about voltage from the point of view of public safety. It will be from this direction, M. Claude concludes, that progress will be effected in the manufacture of incandescent electric lamps.

Electric Conductors in France.—The French *Journal Officiel* recently reproduced the text of the Bill presented to the Chamber of Deputies by M. Georges Berger in reference to electric conductors in France. It appears that existing legislation in regard to telegraph and telephone lines and electric conductors is contained in enactments of December 27, 1851, July 28, 1885, and May 15, 1888. The scheme submitted by M. Berger has for its object the modernising of this legislation and rendering it more liberal by taking account of the experience gained by the State and by private individuals in the employment of electrical energy. The law of 1851 concerns the monopoly and policy of telegraph lines. The Bill only aims at Article 2 and the clause V. of that law, taking from it its penalties and the forms in which contraventions will be set forth and repressed. The law of 1885 relates to the maintenance and working of telegraph and telegraph lines. It has a special object which is foreign to the question of electric conductors, and the Bill will not alter that law. On the other hand, and this is the main point dealing with the liberty which will be granted to the private use of electricity, the Bill in its last article intends to repeal the decree of May 15, 1888, relating to electric conductors in so far as concerns the previous declaration of their establishment, the general rules on their working, and administrative surveillance. However, the Commission has embodied in the text of Article 2 of the Bill that there must be discussed certain arrangements of the suppressed decree which determine the procedure to be followed by private persons required to ask authority to erect electric conductors. The first article of the Bill states that, apart from public ways, electric conductors not intended for the transmission of signals and speech can be established without authority or declaration. The second clause gives in its first paragraph particulars of the necessary reserves in view of the protection of telephone and telegraph wires, which are generally placed in public thoroughfares, against the inconvenience and trouble that might be caused in their working by the too close proximity of electric conductors, by induction, or by short-circuits. The zone of 10 metres—say 33ft.—which the law will compel to be provided in a horizontal plane from each side of a telegraph or telephone line is strictly necessary to avoid the latter difficulties. The electric conductors referred to are those which serve for the transmission of electrical energy for purposes other than for telephonic and telegraphic purposes. Dealing with the question of conductors for electric tramways, the report states that the Commission have interviewed on the subject the Director-General of Posts and Telegraphs, representing the State and the president of the syndicate of electrical industries, on behalf of the electrical trades. As a result of their deliberations the Commission suggest the introduction in the Bill of a new clause concerning the formation in connection with the Ministry of Commerce, Industry, Post, and Telegraphs of a committee constituted half by professional representatives of the French electrical industries and half by officials of the Post and Telegraph Department, and of members of the scientific world. The electricity committee is to be permanent, and is to investigate all administrative arrangements to be adopted as general regulations, or for each particular case in view of the establishment and working of electric conductors and the conditions of their surveillance.

German Electrical Trade.—In the *Bericht der Aeltesten der Kaufmannschaft über Handel und Industrie von Berlin im Jahre* 1893, Messrs. Siemens and Halske and the Allgemeine Elektricitäts-Gesellschaft give lengthy reports on the condition of the German electrical trade last year. The former state that, as in preceding years, the extension of central electric light stations has been greatly handicapped by the present system of contracting, and by inviting tenders for concessions. As regards the technical part of the industry, the various systems of continuous current, alternating current, and polyphase current have made pretty equal progress. The opposition between rival systems is now less keen than it used to be. Although the establishment of a large central station is now by experience as readily determined as that of the erection of a gasworks or the construction of waterworks, it is really surprising what delays occur and what difficulties are raised before matters are finally decided. During the past year the polyphase system has come into greater use in places where the extent of the district to be lighted is large, as, for instance, in Dresden and Chemnitz. It was feared at one time that the Auer incandescent gas lamp might seriously compete with the electric light, but this has not been the case, but it has had the effect of doing good by helping to show people the advantages of better modes of illumination. The use of current for the transmission of power has extended, and its advantages have been demonstrated in various industries, it being possible to supply the most scattered works with power from one point, and allowing of lighter buildings, the abolition of the belt-holes (which are dangerous in case of fire), of more space in the workshops, etc. Excellent results have been obtained in spinning and weaving mills. Hitherto the most progress has been made in connection with large works, but headway is being made in connection with small industries. The more current which central stations can supply for power purposes the greater is the economy with which they can be worked. Many electric tramways have been opened, but operations in this direction are hindered by the shortness of the concessions granted, which makes the financing of the undertakings difficult; while, on the other hand, objections are raised by the public to the overhead trolley system. As regard prices, the cost of finished raw materials has fallen, but in no proportion to the fall in the finished articles. The Allgemeine Elektricitäts-Gesellschaft report that they were well employed, and that electricity has advanced not only for lighting but for power purposes, especially in the mining, textile, and sugar industries. It is now obvious that electricity is no longer looked upon as an industry of luxury. Small industries are now taking up more power, and in Berlin there were connected with the central station on January 1 last 336 motors of 1,086 h.p., against 150 motors of 520 h.p. a year earlier. The company completed a considerable number of electric tramways during the year, and have many others in progress. The overhead system has proved economical, but one or two scientific bodies are opposed to them. Advances have always been made in connection with steam railway lines, where electricity is being used for lighting railway stations, works, and for carriages, and also for power in works, turn-tables, cranes, etc. The use of multiphase current for transmission of power is making much headway. The price of incandescent lamps has reached the lowest point possible, and as many firms have been selling at a loss, an improvement is to be looked for.

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ELECTRIC LIGHT AND POWER.*

BY ARTHUR F. GUY, ASSOC. MEM. INST. ELECTRICAL ENGINEERS.

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TRACTION NOTES.

On first thoughts it may seem strange that, whilst a tramcar is ordinarily run by two horses, a third being generally attached for going up steep gradients, yet an electric tram line has two electromotors in each car, each perhaps capable of developing 12½ b.h.p, or a total of 25 b.h.p. when working at its maximum efficiency. The explanation of this may be traced to two chief facts: first, the great variation of efficiency which electromotors possess for various speeds; second, the undue amount of initial pull or torque required to start the car from rest and to get it up to speed. A horse by exertion can put forth double or treble its normal tractive power for a few seconds, just long enough to start the car and get it under way, as anyone can observe; but when dealing with machines the case is different: they will only give out the maximum power for which they are built—that is, taking their utmost maximum—and with a series motor its useful power is limited by its temperature, and if more than the safe maximum power be drawn from it, it will simply burn up. Hence, in the first place, a motor must exert a very strong torque in order to start the car, and to do this its armature must be built so that it can carry a heavy current for a length of time necessary to get up the speed of the car, perhaps six or eight miles per hour. At the instant of starting, and for three or four seconds afterwards, the motor may have to receive a current ten times the amount it would receive when the car is running at its normal speed on a level track, but although a great amount of power is thus *absorbed* by the motor, yet it *yields* only a small power, because the speed is so slow, the car being just on the move; hence the efficiency of the motor when thus working may be only from 5 to 10 per cent.

In order to calculate out the power requisite for running any vehicle, it is necessary to know the coefficients of friction for various conditions of the road. These coefficients of friction are usually worked out in pounds per ton weight, and for a carriage running on rails about 20lb. per ton may be taken as a fair value. It is very easy to obtain the horse-power necessary to propel a car. Given the weight of the car and the speed; each ton weight of the car signifies 20lb. of resistance, and expressing the speed as feet per minute, then the product of the total resistance and the speed per minute in feet will give the foot-pounds of work requisite to draw the car along at that speed; hence dividing by 33,000 will give the horse-power. For example, suppose we require to find the horse-power necessary to draw a car at eight miles per hour, the weight of the car being 12 tons, and the friction on the rails being 20lb. per ton. When it is stated that the frictional resistance of the car is 20lb. per ton weight, this signifies that pulling or pushing the ton weight on level rails is equivalent to lifting vertically against gravity a weight of 20lb.; hence the total resisting force offered by the car will be 12 × 20 = 240lb. Eight miles per hour = 704ft. per minute, and to exert a pull or force of 240lb. through a distance of 704ft. requires 240 × 704 = 168,960 foot-pounds of work; and since this is done in the space of one minute, hence the power exerted will be 168,960 ÷ 33,000 = 5·12 h.p. This is only for level roads; when there is a gradient to mount, an additional calculation must be made. Suppose that in the above case the car had to travel up an incline of 3 in 100—*i.e.*, every 100ft. produced a rise in elevation of 3ft. — then in 704ft. the rise of level would be 704 × 3 ÷ 100 = 21·12ft. Hence, the car would rise bodily a vertical distance of 21·12ft. when it has travelled 704ft. The weight of the car is 12 tons = 12 × 2,240 = 26,880lb., and 26,880lb. raised 21·12ft. signifies 26,800 × 21·12 = 567,705 foot-pounds of work. This is for one minute, and hence it requires 567,705 ÷ 33,000 = 17 h.p. The power required to run the car along a level is, say, 5 h.p., hence the total power required to run it up an incline of 3 in 100 will be 5 + 17 = 22 h.p.

At the central power station of an electric tram line the power required varies in a most remarkable degree, due to the sudden and irregular load that is thrown on the machinery. This is greatly intensified when the line has a number of steep gradients. At one instant the ammeters may show no current whatever, and the next hundreds of amperes. This extraordinary variation is due to the sudden stopping and starting of cars on the road, and when several cars happen to start at the same moment, then the effect is still more marked. All this variation of load signifies a great strain on the machinery in the generating station, because the engine governors have no time scarcely to act, and at one instant the engines may be working against a very heavy load, and in a second or two afterwards the load may be almost at zero. It is for this reason that nearly all engines in power-houses drive the dynamos by belting, as the belt forms a somewhat elastic connection between the engines and dynamos, and so prevents the great shocks to either that would inevitably occur if there was a rigid connection, as direct coupling.

At the City and South London Electric Railway there are four dynamos, of the Edison-Hopkinson type, each having an output of 450 amperes at 500 volts pressure, and weighing 17 tons. They are driven by link leather belting 28in. wide, a jockey pulley being mounted close by the dynamo to assist the drive. The engines are of vertical compound type, giving 375 i.h.p. each, each engine driving its own dynamo, and running at a speed of 100 revolutions per minute. At the Liverpool Overhead Railway the driving is by ropes, and the engines are horizontal instead of vertical. On both lines the working pressure is 500 volts, constant-pressure system. It is, however, impossible to keep the pressure constant, owing to the enormous fluctuations of current. This pressure is found to be the most suitable for tractive purposes, since it is not too high to be particularly dangerous, and it is sufficiently high to obviate the use of very heavy currents on the line. Nearly all the American tram lines on the overhead trolley system work at 500 volts pressure.

There are, broadly speaking, three systems of electric traction: (1) the conduit system; (2) the storage battery system; (3) the overhead or trolley wire system. So far, no really successful method on the conduit system has been obtained, although numerous attempts have been made to solve the problem. By the "conduit system" is signified the supply of electric energy to the cars by means of an insulated cable positioned in the ground along the track, and making contact with the car motor as it travels along by means of a trailing brush or sliding contact. The supply cable is usually fixed in a conduit or channel, which is flush with the track, a slot being made in the conduit through which the brush makes contact with the supply cable. The fatal objection to this method of making contact is that the slot allows rain and dirt to enter, and so the slot is liable to be filled with water and mud, and thus the insulation of the supply cable is partially, if not wholly, destroyed. The general opinion is that an open conduit, as the slotted conduit is named, can never become a thoroughly reliable method of supplying electric power to electric cars. Numerous attempts have therefore been made to produce a closed conduit, thus obviating the disadvantages of the open conduit, but so far no system has been brought forward that has not some drawbacks to it; and the advent of a perfectly reliable closed-conduit system would go a long way towards promoting the adoption of electric traction on our street tramways.

With regard to propelling cars by the use of storage batteries placed on the car, not very much success has been attained in this direction. The great weight of the batteries as compared with their output, the deterioration of the plates and the rough usage to which they must necessarily be subjected are all great drawbacks. Nothing damages a storage cell so much as to discharge it at a very high rate, and this is precisely what would be required if used to drive electric cars. The sudden starting of the cars, particularly if on a gradient, would in time ruin the cells. Improvements in storage cells are still going on, but they will require to be very much improved before they can be used as a cheap and satisfactory medium for tractive purposes.

The third system—namely, the overhead trolley wire system—has much to commend it. It is in use almost every-

* This forms the concluding extract from a book bearing the above title, which will be published by Messrs. Biggs and Co. early in October.

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where in the States, and has been adopted in several places in this country: the first being the Roundhay Electric Tramway at Leeds, then on the South Staffordshire tram lines. The only objection that can be made against it is the appearance of a network of wires which span either across the road or half-way across, with the necessary supporting poles. It is possible, however, to make them look very trim, and the wires being thin do not present such a very objectionable appearance, after all. On the other hand, this system of working the cars has been brought to a high state of perfection, and the ease and reliability with which they run more than compensate for any imaginary æsthetic objections.

But perhaps the greatest field for electric traction at present is in the construction of tubular underground electric railways similar to the City and South London Electric Railway. The traffic of a city like London is already so enormous that the streets are almost impassable at times, and the construction of tubular electric railways underneath our main thoroughfares would provide an excellent means of rapid passenger conveyance, and so tend to relieve the congested traffic in the streets.

Cost of Electric Energy.

Within the last few years there has been a considerable decrease in the cost of electric energy. It was not an uncommon thing for a public supply company to charge 1s. per kilowatt-hour, and now the ruling charge is only 6d.; and as time goes on we may certainly look forward to a further reduction. Comparatively speaking, all electric supply companies are so far only on the threshold of their undertakings, and the largest of them does not supply more than 100,000 lamps or so, and this represents a small quantity of light compared to what is supplied by a gas company. The greater the scale upon which electricity is generated the cheaper does it become, and with this fact in view, it is not saying too much to state that there is great probability that we shall in time be able to procure electric energy at a lower rate than at present. Large private establishments can generate their own electricity for this small sum. At present supply companies are burdened by the heavy expense incurred in laying down miles of distributing mains over wide areas, and in return they only supply a small percentage of houses with light; but as the electric light gradually supplants gas, then these mains will become worked at higher efficiency. Another serious obstacle to the low price of electricity is the absence of a day load. For a few hours in the evening the machines are worked at their full load and efficiency; after midnight only a very small load is on; and if winter time, a fair load is obtained in the early morning—the rest of the day is almost unproductive. A foggy day is a source of great revenue to an electric supply company, since the machinery is kept at work all day and evening. It is hoped to remedy this deficiency of load in the daytime by supplying current to electromotors situated in workshops, factories, etc.; then when the day comes to a close and work stops, the power that supplied current to the machines can then supply current for lighting purposes, but at present the supply of current for motive power is extremely small, electromotors not yet having come into general use.

In large private premises, such as mills, business establishments, etc., the use of the electric light has been found to be cheaper than gas—in some cases 50 per cent. as cheap. Where a large amount of steam power is in use, the comparatively small amount taken by a dynamo does not entail much expense, because the steam boilers and engines are used for driving the mill machinery, and 1,000 h.p. is considered nothing out of the ordinary in mill work. Now, 10 per cent. of this power—namely, 100 h.p.—will run, say, 900 lamps of 16 c.p. each—a quantity sufficient to light a fair-sized place. The extra amount of coal and water consumed to produce the necessary amount of electrical energy is only a moderate amount when judged with the amount required to drive the mill machinery.

The attendance required need only be small, and that is limited to the electrical part of the plant, since the care of the boilers and engines is left to the usual mill staff. To put down a special plant in any premises, consisting of motive power in addition to the electrical equipment, is very expensive in first cost or outlay, and it also costs a fair amount to maintain in proper working order, since a stoker and driver, in addition to the dynamo attendant, is required; but even with this heavy expense, in certain large works and establishments it is found cheaper than using gas.

The following details of a gas-engine plant may be interesting, as showing the difference between burning gas direct to produce light and burning it in a gas-engine to produce light by means of electric energy. The data given embody average results extending over a period of six months' run, the figures having been taken by the author while running the plant. The dynamo had an output of 90 amperes at 100 volts, and so was a nine-unit machine; it was driven by one of Crossley's new high-speed gas-engines, F size, guaranteed to work to 14 b.h.p., the engine being fitted with two heavy flywheels, 5ft. 2½in. diameter with face of 8½in. These wheels were weighted near the boss with a large mass of metal, and their large size and high speed gave a great steadiness to the running of the engine. The dynamo was driven by a long heavy link leather belt, the distance between the centres of the engine driving wheel and the dynamo pulley being about 20ft. Owing to the length of drive and weight of belt, the impulses due to the explosions were not transmitted, and the running of the dynamo was as steady as if it were driven by a steam-engine. In a great number of cases, each explosion in the cylinder of a gas-engine produces a momentary flicker or pulsation of the light in the lamps, which is highly objectionable, and by this it is very often easy to tell that the light is produced by a gas-engine plant. In the above case the three things that cured these defects were:

1. The regular running of the engine.
2. The high speed and weight of the two flywheels.
3. The long drive by a heavy belt.

The stored energy in the flywheels prevented the periodic effect of the impulses from being felt. The plant ran for about 10 hours per day, except Sundays. The dynamo having a constant load of 9,000 watts, allowing a loss of 10 per cent. between the engine driving wheel and the dynamo terminals, part of this being due to the belt, the author calculated that fully 14 b.h.p. was developed by the engine. With 60 watts per incandescent lamp, the regular lamp load was about 150 lamps of 16 c.p.; this gives $150 \div 14 = 10{\cdot}7$, or over 10 lamps per brake horse-power of the gas-engine—an excellent performance.

Towards the evening it was found that the load could be slightly increased by adding more lamps, on account of the pressure of the gas being better. The consumption of gas was, over an average of six months, at the rate of 90,000 cubic feet per month, and price was 2s. 9d. per 1,000 cubic feet, so that the cost per month was £12 7s. 6d., or about £150 per annum. This gives the cost of gas alone for one incandescent lamp of 16 c.p. per annum as $150 \div 150 = £1$; 14 b.h.p. for 3,000 hours signifies 42,000 horse-power hours; 90,000 cubic feet per month =, say, 1,080,000 cubic feet per annum, and 1,080,000 divided by 42,000 gives us 25·75, or $25\frac{3}{4}$ cubic feet of gas consumed by the gas-engine per brake horse-power. A 14-c.p. gas jet takes about five cubic feet per hour, therefore $25\frac{3}{4}$ cubic feet would yield a fraction over five gas jets, or a total illuminating power of $5 \times 14 = 70$ c.p., but this same $25\frac{3}{4}$ cubic feet of gas, if put into a gas-engine and burnt, and allowed to do work by driving a dynamo, will give 1 b.h.p., or sufficient electrical energy to run $10\frac{1}{2}$ incandescent lamps of 16 c.p. each, or a total illuminating power of $10\frac{1}{2} \times 16 = 168$ c.p., so that when burnt in a gas-engine a certain quantity of gas will yield more than twice as much (or as 168 : 70) illuminating power than if it were burnt direct in a gas jet. Putting this in another way, gas burnt from a gas jet only gives 41 per cent. of the light that would be given when burnt in a gas-engine to produce electricity.

Telephony in Germany.—The telephone system between Berlin, Posen, Dantzic, and Elbing is to be extended to Königsberg, and afterwards to Memel, *viâ* Tilsit. Telephonic communication is to be established between Berlin and Vienna, *viâ* Dresden, by November. The charge for a message is to be 1s. 6d.

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LESSONS OF THE RICHMOND ELECTRIC RAILWAY.

BY FRANK J. SPRAGUE.

The year 1887 marked an epoch in one of the most important of modern industrial revolutions, and, curiously enough, a city in the southern United States was the place selected—largely by chance—for northern capital and enterprise to carry out a grave experiment. Scarcely seven years ago those enthusiastic pioneers who—poor in pocket and struggling against unbelief and ridicule, yet confident in the ultimate outcome of their endeavours—proclaimed the future success of electric railways, surely had little enough in the way of practical results on which to base their prophecies. There were altogether perhaps a dozen electric railways of various types in existence; none was so satisfactory as to warrant general adoption, and all were handicapped by their special experimental character. Capitalists, car builders, railway officials, engineers offered no encouragement; electricians themselves were in the main doubtful. The electric motor was limited in its applications. It was looked upon as a piece of complicated machinery to be carefully housed and suspiciously watched. It was hydrophobic in character, eccentric in operation. Its construction was crude, its design unsatisfactory, its functions more or less mysterious. The vagaries of the electric current were many, its evasiveness surprising.

When it was proposed to use this agent to overturn the existing tramway systems of the United States—to put a motor under a car, exposed to dust, moisture, and all the evils of negligent treatment, there were thought to be good grounds for insanity. To connect it to the wheel by gearing was to violate the laws of mechanics. To govern two or more such machines out of sight was "playing" a lottery. To tempt a wayward current of comparatively high pressure by using the ground as a return was enough to disturb the ghost of Ben Franklin. The ordinary conditions of a street car service were pronounced an insuperable obstacle to any self-propelled car; a greater than 6 per cent. grade was declared to be prohibitory. The investment of copper for a multiple-arc system of supply was financially forbidden. Four hundred and fifty volts potential threatened unknown terrors of torture and death, and a bare overhead wire promised innumerable holocausts. Even nature, with its mud, snow, and ice, was to rise in rebellion.

Such was the condition of affairs when, in the spring of 1887, a contract was made between the capitalists representing the Union City Railway of Richmond, Virginia, and the Sprague Electric Railway and Motor Company, of New York City. This contract was unique. It called for the completion in 90 days of the equipment of a road at that time unlaid, and with a route determined only in part. It provided for a complete steam and electric plant of 375 h.p. capacity, the furnishing of 40 cars with 80 motors and all appurtenances necessary for their operation, and a complete overhead system. Thirty of the cars were to be operated at one time, and grades as high as 8 per cent. to be ascended. The price for the equipment was 110,000dol., to be paid in cash after 60 days' "satisfactory" operation.

At the time of taking the contract, the Sprague Company had only a blue print of a railroad machine and some experimental motors used on the elevated road. The hundred and one details essential to success were undetermined. Such a contract is one which no business man would ordinarily assume, especially in view of the entirely unprepared state of the company. It was justified by subsequent events because of the pioneer character of the work. Considering all the difficulties which confronted the company, it is probable that, had they been known beforehand and the solution of them unforeseen, this contract would never have been made. Fortunately for the future of electric railways, the difficulties could not all be foretold, and did not have to be met simultaneously. The road cost before completion not less than 160,000dol., and only 45,000dol. was paid in cash, with a like amount in bonds. Enormous as this expense was, as grave the risks, the results have entirely justified them all, for the Richmond road stands as the prototype in almost every essential detail of the modern electric trolley system. There was met every difficulty which could be encountered in an overhead system on heavy grades and with sharp curves, and there was settled for all time the question of the economical operation of a large system of street railways by methods of direct supply.

The limits of this article prohibit more than a reference to the essential features of the new system, the special characteristics of the road, and some personal reminiscences of its development. Briefly speaking, the equipment was what is known as a single overhead trolley system with ground return. The current was distributed by feeders to certain central points from which it was taken by a main conductor extending the entire length of the road, it feeding in turn at intervals of about 1,000ft. a working conductor of constant size, ½in. diameter, of hard-drawn silicon wire, known technically as the "trolley" wire. From this the current was taken by an under-running trolley with upper-pressure contact carried in the middle of the car and having a universally flexible movement. Thence it was carried to the controlling switches on each platform, arranged to control the motors in series or multiple and to make the necessary changes in the field circuits.

The motors, of which there were two, were each centred on a driving axle, directly geared to it with single reduction, and flexibly supported at the free end, so as to allow perfect freedom of movement of the machine while maintaining parallelism between the axes of the car axle and the motor shaft. Fixed brushes were used on the commutators for forward and back motion. The current, after passing through the motors, went by way of the wheels into the track and thence, partly by the track, the rails of which were connected together and likewise reinforced by a continuous wire, and partly by the earth and the water-pipes and gas-pipes to which the rail system was connected at various points by earth-plates sunk in deep wells, back to the central station. The main features are those which are common to every trolley systems of to-day. Some of them, more particularly those relating to motor mounting, had been shown in 1886 in an experimental equipment on the Thirty-fourth-street branch of the elevated railroad in New York City, on some individual cars used for storage battery tests in New York, Philadelphia, and Boston, and on the initial equipment of the Union passenger railway of St. Joseph, Missouri, which contract slightly preceded that of Richmond, but generally they saw their first application on a commercial scale in the latter city.

A brief inspection of this road and the curve and grade characteristics will give some idea of the difficulties to be overcome, but these formed only a part, and it is fortunate that in the development of this road the writer had the assistance of two young officers—Lieutenant Crosby, a graduate of West Point, and Ensign S. Dana Greene, of Annapolis (which was my own *alma mater*)—who, though entirely inexperienced in electric street railway work, had energy, pluck, and endurance. It needed all the advantages of youth and enthusiasm, as well as a high technical training, to carry the work through to a successful end. Their work was largely supplemented by that of a number of men who, though not trained engineers, and under adverse conditions and with many hardships, faithfully worked for victory.

Our contract was made in May, and in July I was laid up with an attack of typhoid fever, which, with my period of convalescence, kept me away for nine weeks, leaving almost the entire burden on those who were associated with me. Returning to duty about October 1, I hastened to Richmond to go over the route and note the condition of the work. Up to that time I had never seen the road. Much of the trackwork had been finished, poles had been set, some of the machines constructed, the central station was well under way, and considerable experimental work was in hand. The owners of the road were clamorous to begin operations, while the excuses on our part were without number. I shall never forget the feeling I had when, returning from the improvised car-shed, I stopped at the foot of Franklin-street hill. As I looked up this incline under the bridge connecting the Ballard and Exchange Hotels, and saw a grade varying from 4 to 10 per cent. rising above the bridge, I was for a moment doubtful of the outcome, and I began to realise the difficulties, not

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only those pertinent to our own work, but others forced on us by the unusual and unforeseen conditions under which we had undertaken it.

The track was simply execrable, laid for profit, not for permanence, and with no adequate idea of the necessities. It was a flat 27lb. tram rail of antiquated shape, poorly jointed, unevenly laid in red clay, and insecurely tied together. The total trackage was about 12 miles; it ran in the most irregular way over about nine miles of streets. Part was double and part was single track, a part laid on paved streets, but the larger balance on macadam or unpaved streets. There were 29 curves, five being of less than 30ft. radius. On these sharp curves were grades as high as 8 per cent. There were straight grades as high as 10 per cent. The outer rails were often inches below the inner ones, and the whole track at times would disappear into the red clay, which froze over it, and stuck with remarkable tenacity. As I have said, the sight of the main grade was one of my most unpleasant sensations. There were two things which seemed probable. The first was that the car, for lack of track adhesion, would not ascend the grade at all, no matter how powerful the machines, and the second was that I knew the latter were lacking in capacity.

Our first machines had been built with one reduction of gearing, to which all street railway practice is now gravitating. An 8 per cent. grade would strain them, and a 10 per cent. grade was probably fatal. Hastening back to New York we held a consultation as to what should be done. The easiest way out of the difficulty seemed to be to run on heavy grades with a cable operated by electric motors in pits sunk beneath the track—a feasible plan if the car could not by its own adhesion mount a 10 per cent. grade; on the other hand, if it did have sufficient adhesion, then a change in the machines was necessary. The most direct thing which suggested itself was the introduction of an intermediate gear, and, as it was constructed, this proved to be a most serious problem.

Before deciding upon this, the laconic advice of the president of the company, Mr. E. H. Johnson, was "to find out whether the car can get up the grade at all"; this advice was sound enough, and I returned to Richmond to try the experiment. The first test was when we stopped in the middle of a sharp curve with the car apparently locked. I told the manager, Mr. George Burt, formerly of the Panama Railway Company, that I would pull the car out of the curve if it wrecked the machines, and when called upon they responded nobly. This was a very convincing experiment to him, although not entirely so to me, because it did not settle the question of track-adhesion. Having got out of our temporary difficulty, we made a run to the foot of the Franklin-street hill, our course being distinguished by a free fight, in which an eccentric inhabitant, somewhat the worse for liquor and politically excited, nearly cleaned out our party, until one or two of our best fighting men got into trim, after which we proceeded peaceably.

Arriving at the foot of the hill we stopped to survey the enemy. When I expressed doubt of the ability of the machines to make the ascent, Burt said: "If you can get out of such a curve as that we just left, you can go up the side of a wall." I knew that even if we succeeded the machines would probably be wrecked, but there was nothing to do but to try it, so, putting on the current, we steadily climbed up this hill, then another, and another around several curves, finally reaching the highest point in the heart of the city. By this time the machines were boiling hot, and we stopped in the centre of an admiring crowd in the hope that they would cool down so as to allow us to proceed. No sooner had we started than there was a peculiar movement, then strange, but afterwards very familiar, due to a crossed armature, and I knew that we were disabled. We ran on for a block in our crippled condition, surrounded by a howling mob who seemed bent on taking possession. Not caring to confess serious trouble, I told Greene in a tone so that I was generally heard that there was some slight disarrangement of the circuits, that he had better go and get his instruments; meanwhile I put out the lights and stretched out in the bottom of the car for a rest. The crowd dispersed, and after a long time Greene returned with his "instruments"—four big powerful mules, at that moment the most effective we could get. We soon began our retrograde journey, at first with the mules in the rear, because by cutting out one machine, I hoped to get back with the other. Being on the wrong track, and with severe grades and curve, I knew it to be a doubtful feat. On approaching one of them on a slight down grade I shouted for everyone to jump and give the car a push, put on the full current, and before I could realise it the car had left the curve and run into the foundation-stones of a hotel. There was no question this time about our being disabled, and we had reluctantly to turn to our mules for assistance. This is but one of many similar night experiences, but, despite our damaged condition, we had settled once for all one problem, and that was that with all the weight of the car used for traction, a 10 per cent. grade could be ascended; but having settled this, we were face to face with the necessity of introducing an intermediate gear with a distance between the armature shaft and car axle of only 12½in. on machines entirely unprepared for any such change. Hastening back to New York it occurred to me to put a stud on one end of the machine carrying a gear and a pinion of smaller size, into the former of which the armature pinion should mesh, while the latter should engage the teeth of an internally-split gear on the car axle. It was a happy thought, for the strain on the stud was largely removed because the moments were equal and opposite on one side. Hastening to the Brown and Sharpe Manufacturing Company, in Providence, R.I., I laid my difficulties before them, representing how vital every day's delay was to me, and gave orders that so far as it was possible, night and day, without regard to expense, they should get out a set of tools and jigs which would permit us to alter our machines in Richmond, and at the same time to make the necessary patterns and to cast the requisite gears. Their response was prompt, and in a few weeks we had removed all our machines, taken them apart, changed them over, introduced the new gears, and they were again ready for running.

Troubles with gear reduction, serious as they were, formed only a small part of our difficulties. Field magnets, hastily wound in sections with crude insulation, frequently grounded and crossed. The armatures had a commutator on each end, and were so connected as to bring the brushes at each end on top for easy inspection. Our overhead work was most unsatisfactory. No less than from 50 to 60 designs of trolleys of almost every conceivable shape and character had been brought out. The work of mounting the machines and changing them was conducted practically out-of-doors, subject to all the inclemencies of a wet Richmond winter.

Into the details of all the work I cannot enter here, but by the end of January the time had come when it was vital for us to start. The owners of the road, taking advantage of our difficulties and naturally disappointed and alarmed, threatened to cancel the contact and forced us to grave concessions. Meanwhile every man had been under intense strain; day and night work was the rule. Everything made under this pressure cost vastly more than under any other condition. Changes were frequent, decided upon almost instantly because of the necessity of doing something, and hence without careful deliberation. The road must be made to go; it meant financial ruin for many unless it did. To the railway development its failure would prove a most serious blow. My own reputation and future career, as well as that of my associates, seemed blasted if failure marked the Richmond road.

About the end of the month we prepared to open the road with 10 cars. At this time matters were going more smoothly, the overhead work had been gotten into fair condition, the central station was all right. The new gearing was apparently a success, many of the difficulties with machines and switches had been overcome. As a preliminary we spent a day carrying the children of the town, and on February 8, 1888, in a drizzling rain, we opened the line for regular service. The day was one of disappointment. The cars, crowded with passengers, would one after another suddenly stop in the street and refuse to move, or to be moved, because of locked gears.

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A man would go under the car, take off one gear, and continue, if possible, with the other machine, or bodily haul the car off the track so that another could go by. Opinions as to the difficulty were not agreed, but one reliable man, Pat O'Shaughnessy, who has been engaged at work with me for many years, and who is possessed of a most happy mechanical judgment, speedily detected the trouble and was not long in finding the remedy.

Of all the difficulties met, one of the most exasperating was that connected with running with fixed brushes. For a long time it seemed almost as if this would prove a failure. The armatures were continually grounding or crossing, and one of the commutators was particularly badly burned, the mica itself being charred and the copper blistered. After a time we found that this was largely due to the fact that the current always went into one brush and out at the other, and then we adopted the practice of reversing the armature circuits instead of the fields for a change in direction.

It seemed, however, that we had no copper commutator good enough, and there followed a change of every commutator on the road. Not only special forms of commutators were made, but special materials were made in various places. Before the final adoption of carbon, the variety of brushes tried was without number; sometimes flat ones, solid and laminated, which would wear through, double over and hug an arc of the commutator, or oblique, solid, and laminated brushes which would catch in the bars, reverse or split, and straddle the commutators, with the direct result of ruin to commutators, crossed armatures, and burned-out fields. It was a daily occurrence to see a loaded car climb a grade with a lurid green glare lighting up the track, but with no possibility of getting at it, although I knew that 100dol. worth of damage would be the result of the trip. Then we tried tilting brushes and variously-shaped pieces of copper, bronze, and brass set on end, and pressed down by all sorts of springs, and finally solid bars of brass set on end.

About this time 9dol. worth of brass per day, milled off by the rough bars of the commutator, lined the track with a glittering path; not a single trip was made without inspection, with generally a change of brushes or some other repair. But this was not all. Every armature was unwound, the bodies shortened, and then rewound. Disabled armatures were numberless, and to keep the road in operation tons of machinery were shipped by express. Frequent change of parts were necessary, and since the machines had not been built on the interchangeable principle, in a few weeks they were of the most heterogeneous character.

We managed, however, to keep the cars going, and gradually we saw our difficulties lessening, although new ones would crop up, and little by little the number of cars in operation was increased from 10 to 20, then to 30, and finally one of our most reliable men, David Mason, put 40 cars into operation, or 10 more than the station or line equipment called for. In the three months of operation from February until May, 1888, despite innumerable changes and troubles inconceivable, no car in Richmond was pulled a foot by animal power, for if any accident occurred to a motor the car went along with the crippled machine or with one good one, oftentimes with the heaviest loads and on the sharpest grades, and in some cases in tow of another car. One hundred and forty men, often with only a day's training, were soon broken in to handle the various parts of the system.

Saturday, May 4, was a red-letter day in our calendar. On that day, in the afternoon, when traffic was heavy, we put on 10 additional open cars, finally banking them up near the western terminus. Just at dusk 11 cars at close headway were run at full speed down one of the principal streets, and an hour later 30 cars, many of them heavily loaded, were in full operation. Three boilers rated at 375 h.p. supplied not only to the railroad dynamos, but lighting dynamos with an equivalent load of over 1,000 lamps.

The highest reading on the line was less than three-quarters of the normal capacity of the dynamos, and the average reading only one-half. This test settled conclusively all question as to distance, speed, and power, and practically ended the discussion as to the merits of the series and multiple arc systems of distribution. Fatigue, worry, and expense were all forgotten for the moment, such was the keenness of enjoyment in an assured victory. Subsequently one of the most beautiful sights that I had witnessed for a long time was the assembling of 16 cars in the centre of the town at night by reason of a mistake in the time of ending of an entertainment. This, too, was a most important demonstration upon the public mind of the possibilities in the line of work we were pursuing.

Another important experiment in banking cars occurred on the occasion of the visit to Richmond of president Henry M. Whitney and a number of the directors of the West End Railroad of Boston, then seriously considering the adoption of the cable system. For lack of better shelter the cars were banked out of doors at the eastern terminus. On this particular night 22 cars were so collected.

General-Manager Longstreet, of the West End road, having expressed doubts as to the handling of the cars electrically when bunched together, Burt and I made up our minds we would settle the question by a critical experiment, although it was overtaxing the line many times over. Mr. Whitney had retired, but on receiving word about midnight that we were willing to make such an experiment, he immediately arose, and we were soon on our way to the eastern sheds, two miles from the station. The current supply was by two paths over a silicon bronze wire $\frac{1}{4}$in. diameter, reinforced by another wire of about the same size. We loaded the feeder safety catches, raised the pressure to 500 volts, and ordered the engineer to hold the machines to duty no matter what happened. At the wave of a lantern, 22 motormen as quickly as possible started their cars at the termination of a line calculated for only four distributed cars. The potential dropped to 200 volts, then gradually rose, and soon all the cars were running out of reach of signals. This settled the cable question for Boston, and we shortly secured the contract for the first overhead line in that city.

Richmond was prolific in new experiences, which in variety and extent taxed our resources to a degree happily unknown on modern roads. Many were not inherent to the machines or the system, but were caused or augmented by local conditions. One of the most annoying was the jumping of the cars from the track. As has been stated, this was not only largely laid in dirt streets, the soil of which was of red or yellow clay, but the curves had only one guard-rail, and were not bound in by paving. The winter months brought frequent and heavy rains, the cars were large and heavy, and in a short time the curves spread. Mud and stones would get into the grooves, and on account of the tangential tendency of the cars, before an inexperienced man could check them they were off the track and the wheels were down several inches in the mud alongside the stringer pieces, and the track brakes hard fast.

For some time scarcely a trip was made without the cars jumping the track, and a heroic treatment was at first adopted which gave them the appearance of battering-rams. Twelve-foot sticks of timber and scaling-ladders were carried under the car bodies, and when a car left the rails and tried to bury itself in the mud, all hands, often aided by the passengers, pried it back into place. Gradually the soft places were filled up with cinders, the track rectified, the curves paved, and we soon learned to get a car back by using track plates and completing the ground circuit by a flexible cable which we termed an "electric kedge."

The bugbears of sleet, snow, and mud were frequently raised; it was impossible to keep the tracks from being thickly covered by the crowding of the passing vehicles, and when a sharp change of weather occurred at night the cars in the morning would play leapfrog with brilliant pyrotechnic displays. Virginia mud clung hard to cold iron, and it was a common thing to have to cut through clay, snow, and ice when the tracks were completely out of sight.

On one of the worst nights of winter I had gone to bed completely played out after a vain attempt to get the "Snowflake," our construction car, up a 6 per cent. grade on a slippery track with one motor, and had finally left it in the street for the morning's work. Dawn brought dis

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may, for tracks, trees, and trolley wire were covered with a heavy sleet. Not a car was in operation, and everything looked hopeless. In desperation I boarded my pet car, swept off some of the snow, wiped off the motors so that there was only a moderate display of leaks, and started to make the best of my way to the power-house. The sun had come out, water was dripping from the pendant icicles, and when I turned the corner at the head of the Franklin-street grade my astonished eyes were gladdened by the sight of a car slowly climbing the 10 per cent. grade, with Pat on top pounding the trolley wires with a broom and making the sleet drop off in great lengths. That settled the sleet question, and we gave ourselves no more concern on that account.

Thunderstorms are particularly severe in Richmond, and this brought us new anxieties. The length of the overhead circuit, the unguarded condition of the wires, and the numerous ground connections offered by lamps and motors invited frequent discharges. We awaited the result of the first attack of the heavens with interest. Like many other anticipated troubles, so far as they related to danger to life, our apprehensions were quickly allayed.

In one of the first storms lamps were broken, field magnets grounded, and switches burned out. On one occasion three men were sitting on the rear platform, one with his legs probably dangling over the switch, when there was a sharp flash and a loud clap, accompanied by a peculiar report in the switch beneath him where the discharge jumped to earth. Three terrified darkies disappearing as fast as their legs could carry them up the street was the sequel. As a rule, however, little personal difficulty was experienced because of this trouble. Passengers often did not know when the lightning discharged through the car circuits, or, if they did, they quickly got used to it.

We found that the lamp circuits offered a very free path, so when a thunderstorm appeared, the lamps, ostensibly to light the car, as was carefully explained to timid lady passengers, were turned on and the lightning given free play. The armatures, being on the ground side of the circuit, were rarely injured because the fields acted as choking coils and forced the discharge to earth at some weak point. Lightning arresters without number and with varying degree of success were introduced, but the lightning always remained more or less erratic.

Such are some of the reminiscences of Richmond days. The infant industry of seven years ago has grown to manhood and marks one of the most important of modern industrial advances. Six hundred railroads, 25,000 motors, and an investment of a quarter of a billion of dollars speak of its marvellous growth. The days of the horse car are limited. The cable is restricted to special localities. In suburban service already the electric car rivals the locomotive, and the latter is being gradually forced to its legitimate field of through trunk-line and freight service.—*Engineering Magazine.*

PRACTICAL NOTES ON DYNAMO CALCULATION.*

X.

BY ALFRED E. WIENER.

(Continued from page 252.)

21. *Running Value of Armature.*—In order to form an idea of the efficiency of an armature as an inductor, its "running value" has to be determined. In forming the quotient of the total energy induced by the product of the weight of copper on the armature and the field density, the number of watts generated per pound of copper at unit field density is obtained, an expression which indicates the relative inducing power of the armature:

$$\rho = \frac{E \times C}{lb_a \times \frac{\mathfrak{B}}{20{,}000}} = 20{,}000 \times \frac{E \times C}{lb_a \times \mathfrak{B}} \quad . \quad (54)$$

ρ = running value of armature in watts per pound of copper, at unit field density (20,000 lines of force per square inch);
E = total E.M.F., generated in armature, in volts;
C = total current, generated in armature, in amperes;
lb_a = weight of copper in armature, in pounds, formula (28);
$\mathfrak{B}$ = field density, in lines of force per square inch.

The value of ρ for a newly-designed armature being found, its relative inductor efficiency can then be judged at by comparison with other machines. The running value of modern dynamos, according to the kind of armature, varies between very wide limits, and the following are the averages:

TABLE XXXIII.—Running Values of Various Kinds of Armatures.

Kind of machine.		Kind of armature.	Running value. (Watts per lb. of copper at 20,000 lines per sq. in.)
High speed ..	Bipolar	Drum	300 to 600
		Ring	200 ,, 400
	Multipolar...	Drum	200 ,, 400
		Ring	150 ,, 300
Slow speed ...	Bipolar	Drum	150 ,, 300
		Ring	100 ,, 200
	Multipolar...	Drum	100 ,, 200
		Ring	75 ,, 150

22. *Armature Torque.*—The work done by the armature of a dynamo can be expressed in two ways: electrically, as the product of E.M.F. and current strength,

$$W = E \times C \text{ watts};$$

and mechanically, as the product of circumferential speed and turning moment, or torque,

$$W = 2\pi \times N \times T \times \frac{746}{33{,}000} = \cdot 142 \times N \times T \text{ watts};$$

W = total energy developed by machine, in watts;
E = total E.M.F. generated in armature, in volts;
C = total current generated in armature, in amperes;
N = speed, in revolutions per minute;
T = torque in foot-pounds.

Equating the above two expressions, we obtain:

$$E \times C = \cdot 142 \times N \times T,$$

from which follows:

$$T = \frac{E \times C}{\cdot 142 \times N} = 7 \cdot 042 \times \frac{E \times C}{N} \text{ foot-pounds} \quad . \quad (55)$$

But the E.M.F. generated in an armature can be expressed, compare formula (51), by:

$$E = \frac{K \times \Phi \times N}{P \times 10^8 \times 60},$$

hence: $$T = 7\,042 \times \frac{K \times \Phi \times N}{P \times 10^8 \times 60} \times \frac{C}{N}$$

$$= \frac{11 \cdot 74}{10^{10}} \times \frac{C}{P} \times K \times \Phi \text{ foot-pounds} \quad . \quad (56)$$

From this follows that in a given machine the torque depends in nowise upon the speed, but only upon the current flowing through the armature, and upon the magnetic flux.

23. *Peripheral Force of Armature Conductors.*—By means of the armature torque we can now calculate the drag of the armature conductors in a generator, respectively the pull exerted by the armature conductors in a motor.

The torque divided by the mean radius of the armature winding, in feet, gives the total peripheral force acting on the armature; and the latter, divided by the number of effective conductors, gives the peripheral force acting on each armature conductor:

$$t_p = \frac{T}{\frac{\frac{1}{2}d_a'}{12} \times K \times \beta'} = \frac{24 \times T}{d_a' \times K \times \beta'} \text{ pounds.}$$

Inserting in this equation the value of T from formula (55), we obtain:

$$f_p = \frac{24 \times 7\,042 \times \frac{E \times C}{N}}{d_a' \times K \times \beta'}$$

$$= \frac{2 \times 7 \cdot 042 \times \pi}{60} \times \frac{E \times C}{\left(\frac{N}{60} \times \frac{d_a' \times \pi}{12}\right) \times K \times \beta'}$$

or $$f_p = \cdot 7375 \times \frac{E \times C}{S \times K + \beta'} \text{ pounds} \quad . \quad (57)$$

* From the *Electrical World* (New York).

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f_p = peripheral force, per armature conductor, in pounds;
E × C = total output of armature in watts;
S = mean conductor velocity, in feet per minute;
K = total number of armature conductors;
β' = percentage of effective armature conductors, see Table XXXII.

A second expression of the peripheral force can be obtained by substituting in the original equation for f_p' the value of T, from formula (56), thus:

$$f_p = \frac{24 \times 11{\cdot}74}{10^{10}} \times \frac{C}{P} \times \frac{K}{K \times \beta'} \times \frac{\Phi}{d_a'},$$

$$= \frac{2{\cdot}82}{10^8} \times \frac{C \times \Phi}{P \times d_a' \times \beta'} \text{ pounds} \quad (58)$$

Replacing in this the total useful flux, Φ, by its equivalent, the product of gap area and field density, we find a third formula:

$$f_p \times \frac{2{\cdot}82}{10^8} \times \frac{C \times d_a' \times \frac{\pi}{2} \times \beta' \times l_a \times \mathfrak{B}}{P \times d_a' \times \beta'}$$

$$= \frac{4{\cdot}43}{10^8} \times \frac{C}{P} \times l_a \times \mathfrak{B} \quad . \quad (59)$$

f_p = peripheral force, per armature conductor, in pounds;
$\frac{C}{2P}$ = total current flowing through each armature conductor, in amperes;
l_a = length of armature core in inches;
$\mathfrak{B}$ = field density, in lines of force per square inch.

It is on account of this peripheral force exerted by the magnetic field upon the armature conductors that there is need of a good positive method of conveying the driving power from the shaft to the conductors, or *vice versâ*; in the generator it is the conductors and not the core discs that have to be driven; in the motor it is they that drive the shaft. Thus the construction of the armature is aggravated by the condition that, while the copper conductors must be mechanically connected to the shaft in the most positive way, yet they must be electrically insulated from all metallic parts of the core. In drum armatures the centrifugal force still more complicates matters in tending to lift the conductors from the core; it has therefore been found necesary to employ driving horns, which either are inserted into nicks in the periphery of the discs, or are supported from hubs keyed to the armature shaft at each end of the core. In ring armatures the centrifugal force presses the conductors at the inner circumference towards the armature core, and thus helps to drive, while the spider arms, by interlocking into the armature winding, serve as driving horns. If toothed discs are used, no better means of driving can be desired.

24. *Armature Thrust.*—If the field frame of a dynamo is not symmetrical, which is particularly the case in most of the bipolar types (see Figs 22 to 31), unless special precautions are taken there will be a denser magnetic field at one side of the armature than at the other, and an attractive force will be exerted upon the armature, resulting in an armature thrust toward the side of the denser field.

The force with which the armature would be attracted, if only one-half of the field were acting, in absolute (C.G.S.) units, is:

$$f_1' = 2\pi \times \frac{G'}{2} \times \left(\frac{\mathfrak{B}_1'}{4\pi}\right)^2 = G' \times \frac{\mathfrak{B}^{12}}{16\pi} \text{ dynes};$$

G' = gap area, in square centimetres;
$\mathfrak{B}_1'$ = field density, in lines of force per cm.²

Or, in English measure, one square inch being equal to 6·45cm.², and 1lb. equal to 444,980 dynes,

$$f_1 = \frac{6{\cdot}45 \times G \times \left(\frac{\mathfrak{B}_1'}{6{\cdot}45}\right)^2}{16\pi \times 444{,}980} = 7 \times 10^{-9} \times G \times \mathfrak{B}_1^2 \text{ pounds} \quad (60)$$

G = gap area, in square inches;
$\mathfrak{B}_1$ = field density, in lines of force per square inch.

Expressing the gap area, G, by the dimensions of the armature, we obtain;

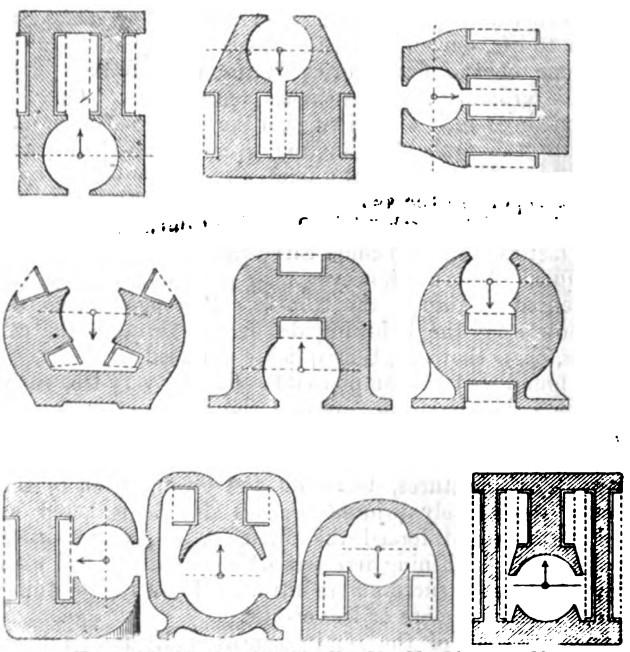
$$f_1 = 7 \times 10^{-9} \times \frac{d_a \times \pi}{2} \times l_a \times \beta' \times \mathfrak{B}_1^2$$

$$= 11 \times 10^{-9} \times d_a \times l_a \times \beta' \times \mathfrak{B}_1^2 \text{ pounds} \quad (61)$$

If, now, both halves of the field are in action, but one half is stronger than the other, the armature will be drawn towards the stronger side by the amount of the difference of their attractive forces. The armature thrust, therefore, is:

$$f_a = f_1 - f_2 = 11 \times 10^{-9} \times d_a \times l_a \times \beta' \times (\mathfrak{B}_1^2 - \mathfrak{B}_2^2) \text{ lbs.} \quad (62)$$

f_a = attracting force acting on armature, due to unsymmetrical field, or armature thrust, in pounds;
d_a = diameter of armature core, in inches;
l_a = length of armature core, in inches;
β' = percentage of effective gap circumference, see Table XXXII.;
$\mathfrak{B}_1$ = density of field, on stronger side, in lines of force per square inch;
$\mathfrak{B}_2$ = density of field, on weaker side, in lines of force per square inch.



FIGS. 22, 23, 24, 25, 26, 27, 28, 29, 30, AND 31.

In such types where the attracting force of the field manifests itself as a downward thrust, as in those shown in Figs. 23, 25, 27, and 30, the value obtained by (62) is to be added to the dead-weight of the armature, in order to obtain the total down thrust upon the bearings. If, however, f_a is an upward thrust, as is indicated in Figs. 22, 26, 29, and 31, the down thrust upon the bearings is the weight of the armature diminished by the amount of f_a. In the cases illustrated by Figs. 24 and 28, the action of the field causes a sideward thrust, which has to be taken care of by a proper design of the bearing pedestals or of the journal brackets.

(To be continued.)

THE ELECTRIC LAUNCH "APHRODITE."

In the *Electrical Engineer* of August 17 we referred to the use of chloride cells on the new launch "Aphrodite," which was recently employed by the Thames Conservancy for clearing the course during the holding of the Goring-on-Thames Regatta. We now have pleasure in giving the following details of the launch, which is illustrated in the accompanying engraving.

The general dimensions of the launch are 35ft. over all, 28ft. 6in. on the water-line, extreme beam 6ft., moulded depth 2ft. 4½in., and draught 15in. The hull is built on new and improved lines; all the framing is of best quality English oak, and the planking is of fine Honduras mahogany The top strake rubbing piece, and the whole of the inside fittings, decks, and floors are fitted up in fine-quality Moulmein teak, varnished. The metal fittings, including half-round rubbing band on covering board, are in rich

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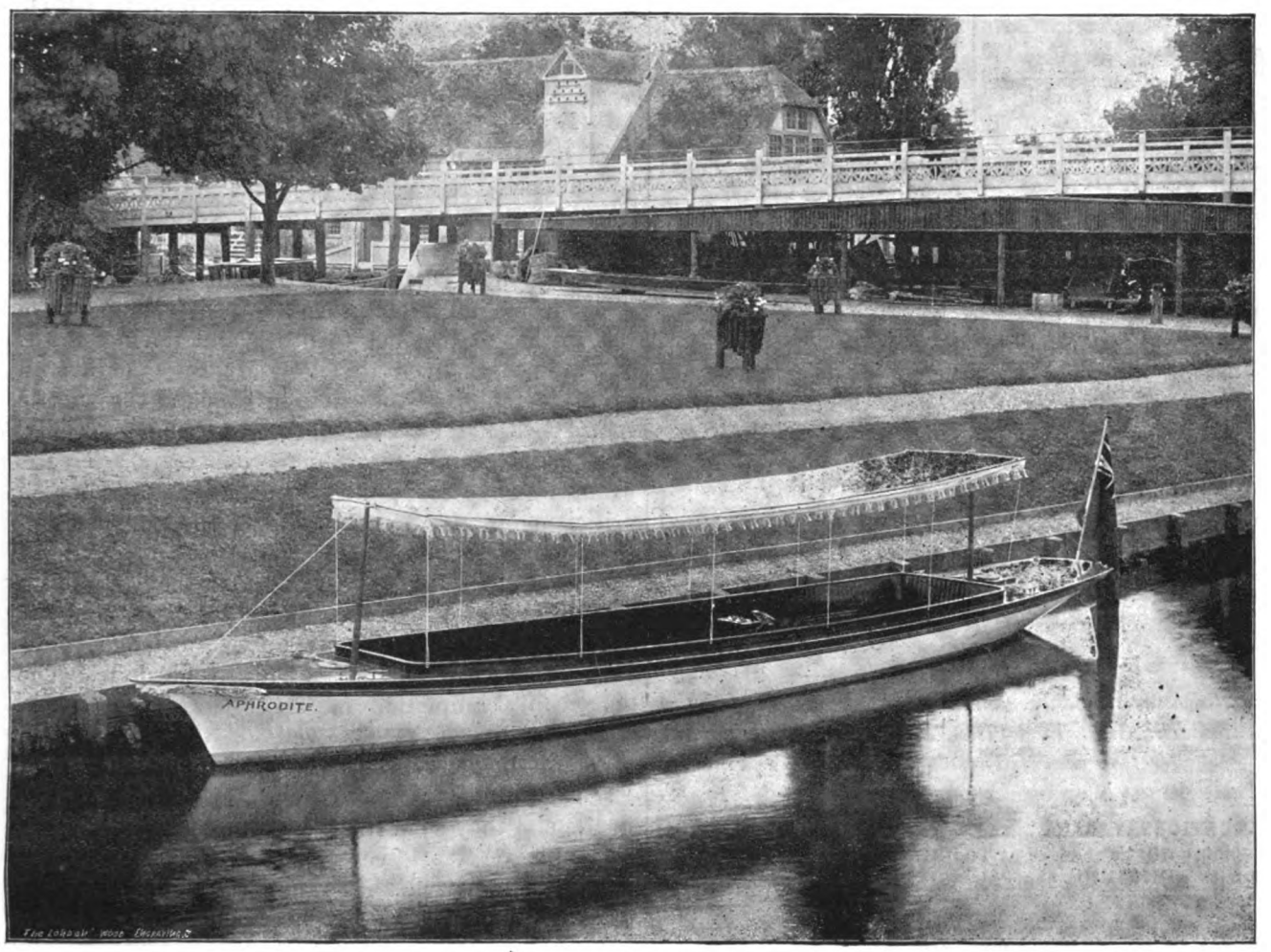
colour gunmetal, finely polished; brass screws and copper fastenings are used throughout. The arrangement of seats affords comfortable room for 12 persons, and the whole of the floor space is available. The storage cells are placed under the seats amidships, and removable lids are so arranged that any cell can be instantly inspected. The arrangement of steering gear and rudder is quite new, giving the launch very great steerage power, and enabling her to turn in but little over her own length when running at either half or full speed. The switch and steering wheel, as shown in the illustration, are fixed in the centre of the boat. The floor is covered with indiarubber mats shaped to fit, and the launch is fitted with an awning, hair-stuffed cushions, and all the necessary requirements of a first-class boat.

The launch is equipped with an electric motor of the Manchester type, wound to run at about 650 revolutions per minute, though this falls to 450 revolutions with the larger screws taking more current, but giving an increased



The Electric Launch "Aphrodite."

mileage per hour. The speed of the motor is considerably less than that generally employed on electric launches of this size, but the advantage gained is the absence of vibration and the reduced amount of attention required. A slow-speed motor is necessarily heavier than one of equal power running at a higher speed, but the weight is in this instance not of great importance, as the chloride cells give the requisite capacity with a weight considerably less than was formerly possible.

A number of tests has been made with screws of various powers running at speeds varying from 300 revolutions per minute up to 1,000, and the speed of 650 revolutions has now been decided to be the most suitable; the actual speeds per hour obtained with varying powers have been most carefully taken on a measured mile both up stream and down and the mean taken, and these are given below, together with the distances that can be travelled at these speeds with one charge:

5 miles per hour for 28 hours equalling 140 miles.
5·6 „ „ 23 „ „ 128 „
6·8 miles per hour for 6 hours equalling 41 miles.
9 „ „ 3 „ „ 27 „

Accurate times having been taken on a long day's run to ascertain what a six-hour capacity would represent, taking into account the delay at locks and the general stoppages of a pleasure party, it was found to be as follows: time running, six hours; time in locks, 1½ hours; stoppages, two hours; total, 9½ hours. It will be seen from this that the launch is capable of running at seven miles per hour for a long day's journey, and as the switch gear is fitted with full and half speed positions, and a resistance which gives four variations of each speed, power can be economised when required, so as to enable a run to be undertaken of over 100 miles.

At Goring Old Mill is fitted a 35-h.p. waterwheel, which is utilised to drive a Manchester dynamo, and a complete charging station has been fitted up. In connection with this charging station a set of accumulators has been set up which light Mr. James Shoolbred's house, some 300 yards distant, also the mill with its various workshops attached, and Mr. S. E. Saunders's new and picturesque boathouse.

It may be mentioned that Messrs. Mather and Platt, Limited, have recently been carrying out various trials with the chloride accumulators in order to prove their superiority for launch propulsion, for which purpose they are specially suited owing to their high capacity for a given weight and the rapid rates at which they can be discharged. It was for the purpose of testing these points in a practical manner that Mr. H. A. Earle, the London manager of Messrs. Mather and Platt, Limited, arranged with Mr. S. E. Saunders, of Goring-on-Thames, to build the above-mentioned launch, which, although not of a sufficient length to attain high speeds, is nevertheless one that gives ready comparison with those generally in use on the Thames. Messrs. Mather and Platt, Limited, also equipped the charging station already referred to, and which is of such a size as to be able to charge in seven hours the largest electric launch on the river.

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LESSONS.

The "Lessons of the Richmond Electric Railway," by Frank J. Sprague, reprinted elsewhere in this issue from our American contemporary the *Engineering Magazine*, reads like a chapter out of the "Arabian Nights." The lessons inculcated are nowhere tabulated, and they are left for the industrious reader to find, examine, and take to heart. We do not intend to supplement Mr. Sprague's article by tabulating the lessons. Indeed, it would be almost as Herculean a task as was the equipment of the Richmond tramways. However, there is one prominent lesson writ clearly all over the article, and more clearly all over the work. It is, given the banking account and men of ability, the pluck and energy of the scions of the Anglo-Saxons will still pull them through the most perilous and difficult paths. Fancy calmly telling us seven years after the event that the Richmond contract was taken with little or no knowledge of that class of work, except such as could be gleaned from a blue print and some experimental motors. Certainly, such a contract was unique. It was not business, yet, as the event proved, it paved the way to the vast system of electric street work that now exists in America; and though in itself a most costly contract to the contractors, no doubt it has indirectly proved a most remunerative job, in that it has led to other and paying work. We are not inclined to follow Mr. Sprague into all his statements. At that time in England the electric motor had not altogether the bad character Mr. Sprague attributes to it, but seven years after the event we may be permitted to say that the English criticism on Mr. Sprague, during the construction of the Richmond road, was that he had his business to learn. It seems that criticism was essentially correct, and that the contract was entered into without any knowledge whatsoever of the work that had to be done. The successful completion of an undertaking under these conditions speaks well for the indomitable pluck of the workers. They failed again and again. Each failure was replaced by something better, and in the end they achieved the task undertaken. Perhaps the greatest lesson to be learned is the old one so often inculcated, that a failure may prove of the utmost value to a learner. Tell us your failures as well as your successes, is often said, and here we see how, commencing in ignorance, failure with these men only meant the road to success. After all, this is really the ordinary road. No inventor, or at least hardly any, designs a perfect piece of apparatus at his first effort. He knows what he wants, and tries again and again before he succeeds. The world never knows the evolutionary processes in most cases, but here Mr. Sprague has written the inner history of one of the most important pieces of electrical work ever carried out. What lessons could be learned if, say, the inner history of electric lighting could be given. The loss at Richmond was not a Stock Exchange loss, but a loss incurred—not wilfully indeed, yet long before the work was accomplished—with eyes wide open, under the conviction that success meant a great reputation and future emoluments to the contractors, while failure meant

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dropping out of the industry ruined and disgraced perhaps for ever. The difference at Richmond and some of the English work in the early eighties was just this: the one side thought of fame and future, but the other of successful Stock Exchange transactions. Our work was not intended to succeed, but to draw money from the public pocket. We should like to hear what such men as Mr. Crompton could say in this matter. He, with one or two others, has borne the burden of the fight, right through evil to good report, and made it possible for an industry to exist among us. From the time of the Richmond success the progress of electric traction in the States has been uninterrupted. As Mr. Sprague says: "The infant industry of seven years ago has grown to manhood and marks one of the most important of modern industrial advances. Six hundred railroads, 25,000 motors, and an investment of a quarter of a billion of dollars speak of its marvellous growth. The days of the horse car are limited. The cable is restricted to special localities. In suburban service already the electric car rivals the locomotive, and the latter is being gradually forced to its legitimate field of through trunk-line and freight service."

We trust that our readers will not miss one single sentence of what Mr. Sprague has written, and will, as he intends they should, take the lessons to be learned therefrom to heart. He does not wish to induce others to contract under similar conditions, but, on the contrary, to eschew such rash experiments.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ALTERNATING-CURRENT DISTRIBUTION.

SIR,—In reply to Mr. Faber's letter in your last issue, I would like to inform him that poles *are* formed on a closed magnetic circuit if the primary and secondary coils are not superposed; that when such a closed circuit is divided through these poles and left free to move, they *do* repel each other; that strong currents in both coils are just what is required; that converters do not burn up as readily as he appears to think when the secondary coil is short-circuited; that when the conditions require it, the short-circuit can be made through a resistance. With regard to the other points not being in accord with ordinary converter practice, he should remember that my controller switch plays a unique part in the circuit, being, first, a converter; secondly, a potential raiser; and, thirdly, when the primary circuit is broken, simply a pair of electromagnets, both coils being excited from the same source. I do not, therefore, expect he will find ready-made formula to suit the case.

I may further inform him that converters which I designed and made with my own hands before any of the present most excellent formulæ were thought out are still working, and can give points and a beating to many modern types, both for economy and insulation. It is not necessary that an inventor should follow accepted rules as long as he thoroughly understands natural laws and obeys them. Surely the man who built the first iron ship knew it would float, yet the vast majority were certain it would sink because it had not been publicly demonstrated. In conclusion, I can assure you, Sir, that I thoroughly appreciate the value and necessity of public trials before vast sums of money are spent on inventions, but I believe that letters such as Mr. Faber's tend to prevent inventors receiving the support necessary to such demonstrations, and therefore stop industrial development. Premature publication is more often made from necessity than choice by inventors.—Yours, etc.,

WM. LOWRIE.

September 4, 1894.

P.S.—I hope Mr. Faber's law of titles does not apply to man as well as inventions; if it does, the high places in this world must be unworthily filled.

OBITUARY.

MR. CHARLES WOOD.

We regret to record the death of Mr. Charles Wood, late chief engineer of the mechanical department at the Silvertown Works, which occurred on the 30th ult., at the early age of 55.

Charles Wood was a native of Glasgow, where he had been apprenticed to the Basin Foundry Company, for whom he worked till 1871, when he was offered the above-mentioned appointment at Silvertown, which he held up to the time of his death.

Charles Wood was highly esteemed by all with whom he came in contact in whatever capacity, and will be badly missed both as a friend and as an engineer. In his department at Silvertown all the company's cable machinery was constructed, besides various forms of electric lighting machines and apparatus, in addition to which all repairs and alterations for the various departments of the works were here carried out.

On Monday last a number of Charles Wood's friends and fellow-workers paid a last token of respect and friendship at his graveside.

CITY AND GUILDS OF LONDON INSTITUTE.

ELECTRIC LIGHTING AND POWER TRANSMISSION

PRELIMINARY EXAMINATION.—LECTURE I.

(Specially contributed.)

Gentlemen,—I suppose that each of you who has joined these classes has a particular object in view. That object may be good, bad, or indifferent, according to the standpoint from which we look. Before entering upon the real work of the session I should like to explain to you how I think these lectures and the examinations to follow can be made of the greatest use. Your aim is to get on in the world, and a noble aim it is, if properly followed. To get on does not necessarily mean the trampling upon other competitors. It may be that you simply distance them in a race which they have neglected to prepare for—in fact, in the race for existence. Now, as ever, knowledge is power; but something in your case is required besides knowledge—you must have the ability to practically utilise the knowledge you possess, so that to succeed in the profession you appear to have chosen you must have both knowledge and ability to use that knowledge. Again, the knowledge you obtain may be of two kinds—general and superficial, or real. The great value of answering questions, working problems, and attending examinations, is to ensure reality, to give concreteness, so to speak, to your knowledge. In actual work the problems are ever varying—sometimes simple, sometimes difficult, and it is the successful solution of these practical problems that gives a man position and pecuniary remuneration in his profession. Do not look upon passing this preliminary examination and the succeeding examination as your sole aim, but rather to attend these lectures, to work the questions set, to show the examiners that what you have learnt is understood and can be utilised in order to be able to employ the knowledge obtained to the grappling with the questions which arise in practical work. Success in the examination should not be *the* end; what you ought to look forward to is success in your chosen profession. Here I shall try to furnish you with some of the tools you need for that purpose, but neither I nor any other man can guarantee your using the tools to the best advantage. This

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depends upon yourselves. Tools do not make a workman. His equipment may be good, his practice bad. Where both equipment and practice are good, there is not much to fear for his future. Lastly, do not be alarmed at hearing about the overcrowding of the profession. There is plenty of room at the top. It is only at the bottom that crowding takes place. Once show superiority to the ruck and you get more freedom, more scope for your abilities, more money, and more honour. The higher you rise the greater this freedom. So try to equip yourselves thoroughly for the fight, practise the use of your tools constantly, do not flag in your efforts to gain perfection, and by always doing your best you may depend upon it there will be a time in your affairs when your opportunity must come.

You are now, so far as the City and Guilds of London Institute is concerned, commencing your career. That institute is not a hard taskmaster, but should be looked upon as a friend using inducement and allurement to lead you along arduous paths, which, when traversed, prove beneficial to the traveller. It has in its wisdom divided this course into three divisions—the preliminary, the ordinary, and the honours. We have now to deal with the preliminary course, and as you each have a syllabus, it is unnecessary for me to point out the scope of the work. I shall assume that you are beginners, and know nothing of the subject.

I.—General Notions about Electromotive Force, Current, and Resistance.

The carpenter uses a 2ft. rule to measure the length of his timber, the land surveyor uses a chain to find his lengths and areas, the cornfactor uses a bushel to measure his corn, and the grocer his pound weight to weigh his goods, and so on through a variety of industries. The world of science is nothing if not exact, and thus, whenever possible, exactitude in measurement is held to be an essential. Thanks to the labours of Lord Kelvin, Latimer Clark, and others, it is perhaps more easy to make exact electrical measurements than to make exact measurements in any other branch of science or its applications. Measurement implies something to be measured. Let us try and ascertain some at least of the quantities that can be measured in a voltaic combination. You need not trouble yourselves at present about the various parts of the apparatus before you: they will each and all be explained in due course.

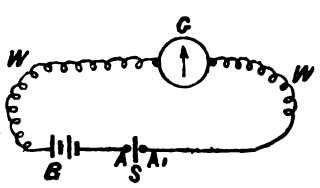

Fig. 1.

On the board I will represent the apparatus by a diagram, where B represents the battery, G a galvanometer, S a switch, W W wire connections. At the present moment the battery, B, is connected to the galvanometer, G, all round, except at A A. To connect this break I have simply to turn the switch, S, till the ends of the metal piece of the switch rest on A A_1. Before doing this, let us throw a reflection of the galvanometer on the screen. You see there is no movement of the needle.

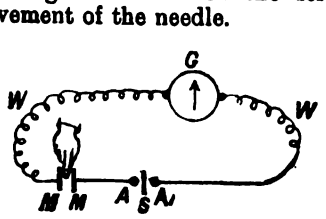

Fig. 2.

Now turn S and metallically connect A A_1. The needle moves. It comes to rest in a new position. Something has caused that needle to move, and it is our duty to investigate that something. Turn S so as to break contact between A A_1, the needle resumes its original position. Instead of the battery, B, I join the ends of the wire to these two metal plates, M M. One is a piece of zinc, the other a piece of copper. I now turn S and connect A A_1, but there is no motion of the needle. Dipping my finger into this salt water, and bringing the plates to touch the finger, as in Fig. 2, the needle again moves and comes to rest. Taking my finger away, the needle goes back to its original position. I have another battery different from the first, and connecting it up as the other, the needle swings further, but comes back again to the original position when I break the switch connection.

I am now going to indicate something similar to this outside of electricity. Here stands a glass jar filled with water connected to this glass tube by means of rubber tubing. A small piece of cork floats on the surface of the water in the tube. I lift the jar of water and immediately, as you see, the water in the tube rises, as is shown by the height of the cork. I raise the jar higher and the cork floats higher. I rest the jar once more on the table and the cork regains its original height.

In the one case I had a needle swinging further and further as I changed the battery, in the other a cork floating higher and higher as I raised the jar of water. You may have noticed that with the jar of water on the table the height of water in the jar and in the tube was the same. As soon as I raised the jar, and so increased the height of the water it contained, the water in the tube followed suit till the level of the water both in the jar and in the tube was once more the same.

Instead of the glass tube I will connect the jar to this little fountain. The jar is standing on the table and the water spurts from the nozzle. I raise the jar, and the jet gets higher and higher. I lower it to its old resting place, and the jet returns to its original height. This is not quite correct, because we have now lost some of our water from the jar. The experiment, however, will serve my present purpose, which is, that you should notice that whenever I made a *difference of level* betwixt the two ends of the connected water, that which stood lowest commenced to rise, till in the tube the water reached the same height as that in the jar: and the top of the jet would also have reached the same height as the water in the jar had there been no air in its path. You will see that directly I alter the levels of water the column of water moves in the attempt to regain levelness.

The electrical experiment has much in common with the water experiment.

The battery, whether the ordinary kind or the one made by my finger and the two metals, is a piece of apparatus we use in order to get a *difference of electrical level*. To use the electrical terminology, by its means we get a difference of *electrical potential*. There are other ways besides these I have shown you for getting a difference of electrical potential, and a large part of your time will be spent in examining the various ways.

I shall assume for the moment that whenever we have a difference of electrical potential under proper conditions we shall have a flow of something which we call electricity, and it is this electricity which causes the needle of the galvanometer to move.

Now, we can with a 2ft. rule measure the difference in the level of the water. If instead of a cork I use a piston working watertight in the tube and connected with this spring balance, as in this apparatus, when I lift the jar a pressure is made against the under part of the piston, and, as you see, by raising the jar the pressure increases, as shown by the pointer on the dial of the balance.

The pressure is proportional to the difference of level. Increasing this difference, increases the pressure; decreasing it, decreases the pressure.

The difference of electrical potential is the cause of electrical pressure, and, again, this pressure is proportional to the difference of potential, and by increasing or decreasing the latter you increase or decrease the former. Using the electrical terms, what I have called electrical pressure due to difference of electrical potential is technically called *electromotive force*. I prefer to use the term "pressure."

Just as there will be no flow of water between two pieces of water, though at different levels, and therefore under different pressures, unless there is a connecting channel, so there can be no flow of electricity unless there is a proper channel—in our case it was this copper wire. This flow of electricity we call *current*. Whatever channel water flows

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through offers some opposition to the flow, and also by whatever channel or path electric current flows some opposition is made to that flow. This opposition is called *resistance*.

The phenomena of *electric pressure*, *current*, and *resistance* are the most important with which we have to deal. Each can be measured, and thus we are able to compare different pressures, currents, and resistances.

THE USE OF ACCUMULATORS WITH MOTORS.

(Concluded from page 239.)

To make this experiment still more convincing, and to show also that the results obtained are not simply due to the haphazard choice of cells, the groups thus tested were reversed in arrangement—that is, the five cells originally discharged in parallel were now discharged in series, and *vice versâ*. The following table shows the figures thus obtained from eight tests:

DISCHARGED IN PARALLEL.

No. of test.	Average current. Amperes.	Average potential difference. Volts.	Total capacity. Ampere-hours.	Watt-hours.
1	69·4	1·88	486	914
2	76·3	1·84	407	751
3	85·7	1·85	406	751
4	85·7	1·84	385	709
5	95·8	1·86	335	622
6	82·6	1·85	495	916
7	82·8	1·83	373	683
8	90·1	1·84	405	745
Mean ...	83·5	1·85	411	758

DISCHARGED IN SERIES.

No. of test.	Average current. Amperes.	Average potential difference. Volts.	Total capacity. Ampere-hours.	Watt-hours.
1	16·9	9·34	113	1,055
2	15·7	9·46	100	946
3	16·4	9·55	102	974
4	16·1	9·41	112	1,054
5	16·2	9·48	89	844
6	16·1	9·45	105	992
7	16·8	9·46	97	918
8	16·9	9·44	106	1,001
Mean ...	16·4	9·45	103	973

The difference in average efficiency or net output of energy given by these two methods is not less than 23 per cent., whilst, in addition, it should be noted that considerable discrepancies are shown by the various tests in the watt-hours obtained when discharging in parallel. All the tests were conducted with an electrolyte of identical density, so that no error might arise from serious variations therein.

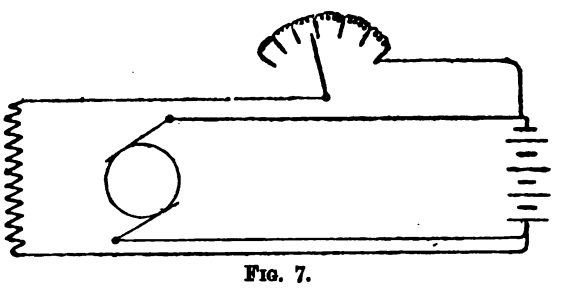

FIG. 7.

The ultimate economy of such a method as that above criticised is therefore very questionable, and the only conclusion we may safely draw is that accumulators should be arranged in series in a single group. For instance, if a battery is required to furnish a power of 10,000 watts (say 100 amperes at 100 volts) to the motor terminals, it should be composed of $\frac{100}{1·9} = 53$ cells in series; 1·9 volts being the mean potential difference of a cell having 100, 50, or 33 kilogrammes of plates according to the specific requirements.

Returning, however, to the main problem, there is still to be noticed the effect due to variations in the magnetic field, which may be of service in varying the motor speed. In connecting the field magnets in parallel with the accumulator (see Fig. 7), the excitation may be considered independent so that the working of a rheostat in the exciting circuit will produce variations in the field, and hence in the speed. An increase in the field will diminish the speed, and *vice versâ*. But in order to give a sufficiently extensive scale to the speed variations in this way, the magnets must be heavy and short with very low magnetic resistance, and not nearly saturated in ordinary working.

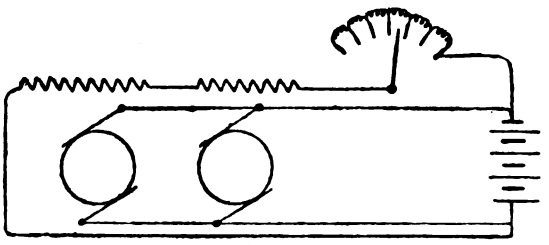

FIG. 8.

This method, when employed with a motor suitably designed, will give excellent results if the scale of varied speeds be not too extensive. When great variations are necessary, a further plan must be adopted. In this, two separate motors are employed, with the consequent advantage that there is always at least one motor to fall back upon if either fails. Two speeds at once are given by adopting this plan, according as the motors are connected in series or in parallel (see Figs. 8 and 9). Intermediate speeds are given by working a rheostat in the manner already described.

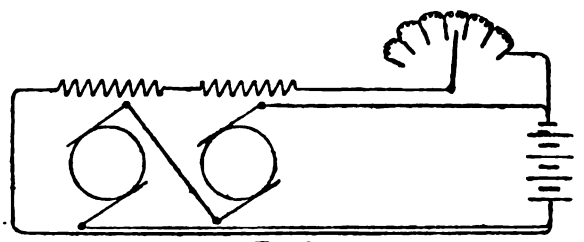

FIG. 9.

A still further refinement or means of adjusting and varying speeds is given by the use of an alternative or double winding on the motor armatures—that is, the original armature coils or sections are changed for two with twice as many turns, but with wire of half the cross-section. Two commutators are thereby necessary, as shown in Fig. 10, but their combined size need be no greater than that of the single one otherwise used. When the brushes of the same polarity of the two commutators are joined in parallel, the ordinary working is followed, but when connected in series for the same difference of potential at the termina

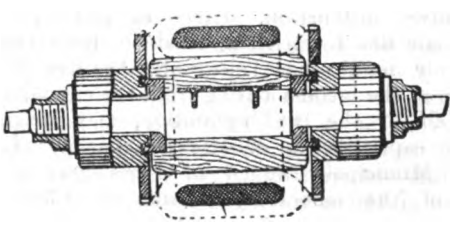

FIG. 10.

the speed is reduced one-half. This follows from the ordinary law connecting the motor speed with the armature-turns.

With two motors whose armatures are thus double wound a large number of possible variations in speed may be obtained, the rheostat in the exciting circuit being also put into use together with the different arrangements thus outlined. Moreover, this combined method seems the more satisfactory because it allows the accumulators supplying energy to be permanently coupled up in series.

Electric Lighting in France.—It is proposed to utilise the water power available at Chatillon-de-Michaille, in the Ain Department, for the purpose of driving turbines and dynamos for the electrical transmission of power.

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CENTRAL ELECTRICAL LABORATORY IN PARIS.

At an assembly of the Société des Ingenieurs Civils de France, M. Max de Nansouty presented a paper dealing with the central electrical laboratory in Paris. The author pointed out that the idea of establishing such an institution for standardising or gauging instruments and to facilitate researches was of French origin, seeing that in 1881, when the guarantee committee handed over to M. Cochery the £12,000 balance of the electrical exhibition with a view to the foundation of this laboratory, no institution of this kind was in existence abroad. In consequence of delays this advance was lost, and whilst the French laboratory was only set in operation in February, 1888, a laboratory of the same kind, the Electrische Versuchsanstalt, was established in Munich in 1885-86. This laboratory, the author observed, is less important than the French one, and has been regularly worked since that time. Towards 1889 there was founded in Berlin the Physikalisch Reichsanstalt, a most important and remarkable institution. It was established by the Government, with the aid of private subscriptions. The construction and equipment of the institution necessitated considerable expenditure, and its maintenance is assured by an annual vote of £4,000. This institution, which is under the direct control of the State, undertakes all possible measurements of interest in physics and mechanics. It is under the management of Prof. von Helmholtz. A reference to the electrical laboratory of the Board of Trade was followed by a note concerning the measuring instruments in the Electrotechnical Institute at Liège, and in the Zurich Polytechnic School. Proceeding to deal with the Paris laboratory, the author stated that by a decree of February 24, 1882, the profits realised by the 1881 exhibition were directed to be devoted to the creation of an electrical laboratory in Paris under the chief management of the Minister of Telegraphs. This sum of £13,240 (331,000f.) lay idle for several years. In 1885 the Société Internationale des Electriciens proposed to the Minister of Telegraphs to undertake the establishment of the laboratory. By decree of July 12, 1886, the Minister placed at the disposal of the Société a credit of £1,200 for a provisional installation, and later in the same year the income of the 300,000f. (£12,000) remaining was provisionally devoted to the maintenance of the laboratory. As a result the Société undertook to establish a preliminary laboratory. MM. Ménier granted a site, the principal instrument and other makers presented machinery and apparatus, and the laboratory commenced work in February, 1888. The laboratory remained for five years in the Place Saint-Charles. Notwithstanding the deplorable conditions surrounding it, numerous experiments were made and many pupils received instruction. Early in 1892 the Société Internationale des Electriciens obtained from the Direction Générale des Posts et Telegraphes the free disposal of the arrears of the income arising from the capitalisation of the 300,000f. of the 1881 exhibition, and permission to devote the capital to a definite installation. In April, 1892, the Municipal Council of Paris granted for the purposes of the laboratory a site of 1,500 metres, situated in the Rue de Staël. At the same time a subscription list opened by the Société realised £4,000. The construction of the new building in that street was commenced in September, 1892, and the laboratory, completely equipped, was inaugurated in June, 1893. Since that time, owing to efforts put forth by M. Mascart, a sum of £4,000 has been granted from the funds of the Giffard legacy. This sum will defray the cost of new works in course of being carried out. Since the foundation of the laboratory more than 1,300 experiments, resulting in the issue of certificates, have been carried out. No less than 95 French or foreign pupils have received practical instructions, and *savants* and engineers have been authorised to take advantage of the resources of the laboratory for undertaking individual investigations or repeat important experiments. It is desired to make the laboratory as completely equipped as possible, and in a few months apparatus for the measurement of alternating currents will be installed.

ELECTRICITY IN HEAVY RAILROAD SERVICE.

In a recent issue (under date of May 18 last) we published an abstract of a very interesting paper brought before the Western Railroad Club by Mr. D. L. Barnes under the above title. The detailed discussion, which followed on the reading of the paper at the subsequent meetings of the club, is now before us, and since the topics involved have some considerable value for engineers in this country, more especially after the favourable working results achieved on the Liverpool Overhead Railway (results that have in all probability been responsible for serious enquiries into the advantages of working the adjacent Mersey Railway by the same system), we therefore abstract herewith the more important speeches evoked by Mr. Barnes's subject and method of dealing with it.

The discussion was opened by Mr. GIBBS, who gave it as his opinion that in average railroad service electric transmission of power will not be found more economical than the use of the steam locomotive, except where there is a substantial difference in the character and cost of fuel which is burned, could hardly be controverted. The conclusion that the same weight of bituminous coal in a stationary plant will produce the same results at the drawbar of the train is important, as showing that the alleged fuel saving by use of electricity is not in the weight used. This is a little discouraging to electricians, but they will have to devise a motor which is of higher average efficiency under different conditions of speed and power before they will accomplish anything over this result. The even pull of an electric motor, allowing an increase in hauling power, is a very important point, and will be found to be a matter of substantial gain in using the electric motor. In some late tests a locomotive with 3,000lb. less weight on the drivers and a 6in. smaller wheel, was able to haul about one car and a half more over a hill than a larger and heavier locomotive. Of course, in this comparison each locomotive had cylinder power sufficient to utilise all the adhesion due to its weight.

Mr. BAKER (general manager of the Intramural Railway at the World's Fair, and now in charge of the rolling-stock of the Metropolitan Elevated, Chicago) said that the use of alternating currents is not a matter of great importance on short lines. It may come into use later on lines of greater length The differences between it and the continuous current or in the machines used in the two currents are not so serious as to make much difference in the machines themselves, but when it comes to distribution of the current it becomes a matter of a great deal of importance. On the Intramural Railway electric motors were used under the car. The weight of the passengers assisted in getting the weight on the wheels necessary for traction. The motors themselves weigh about 20,000lb., with their attachments, whereas a locomotive to do the same work and give the same traction would weigh about 30,000lb. The result is that the trains only weigh about 80 per cent. of what they would if a locomotive, either electrical or steam, is used. That means that we have less actual work to perform in moving the train passengers over the road, and is a saving of some 20 per cent. Four motors make a very economical arrangement, because at one-fourth speed, the four motors being in series, we get the utmost economy—that is, a few seconds after leaving a station the motors are working to their full efficiency. With two motors we have to accelerate the speed through a distance of half a train length before the motors are working to their full efficiency, and with one motor it must be working at full or normal speed before this efficiency is attained. The number of passengers carried on the Intramural road May 1 to November 1 averaged a little over 33 passengers per train mile, including the light month of May. Passengers on the Manhattan road in New York average about 24 to the train mile, and on the roads in Chicago it must be considerably under what they are in New York. In the month of October we carried over 50 passengers to the train mile, so that, as far as the service goes, while we did run we did a pretty heavy service. The average speed was not fast; it was about 10 miles an hour, but it would have

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been much better except for the great curvature of the line. The result of this was that after we had expended the power necessary to accelerate the train to a speed of, say, 20 or 25 miles an hour, we could have continued at that speed until necessary to put on brakes to stop at the next station for the curves. A speed curve for the train would rise to about 20 or 25 miles an hour, and then fall off to about 10 miles an hour, and continue at that speed until within braking distance of the next station. Now we could have maintained 20 miles with a very slight expenditure of power if the track had been straight. Our total cost for fuel for the month of August was 4·3 cents per train mile. For the previous months it was somewhat larger than that, but considering the disadvantages under which we worked, the short time we had to effect an organisation, and the fact that economies which we plainly saw before us could not be put in operation on account of the time required, that figure is not too low, and it can be done under the same conditions for less money than that. The arrangement of the locomotive spoken of in this paper would not make the strain on the track or structure much less than with the steam locomotive. It can be arranged, however, so that a lighter structure will do. As to the wisdom of building a lighter structure, that is another question; most of the elevated roads have been built lighter than they should be for the increased traffic. There are very few facts and figures by which you can compare the expenses of repairs of motors and locomotives, but the motor is the more simple apparatus.

Mr. BARNES: The Chicago Metropolitan Elevated will commence operations this autumn with electric motors, and the North-Western Elevated (now projected) will also be operated by electricity. It is generally conceded now that no new elevated roads will be operated except by electricity, and the Manhattan, in New York, is considering the feasibility of changing, for the reason that motor trucks can be put under the cars and the concentrated weight can be reduced. I do not see how the number of "passengers to the train mile" on the Intramural forms any indication of the traffic. That road was two or three miles long. The Manhattan is 12 miles long. In once case a man rides 12 miles for five cents and in the other two. Now on the "Alley" road here, they formerly had more passengers to the train mile even with a light traffic than they had on the Manhattan, in New York City. The weight of traffic is measured by the individual weight and speed of the individual trains when loaded. The difference between a maximum speed of 20 to 25 miles on the Intramural and the 30 to 35 miles made on the elevated roads is a ratio of 4 to 9 as the stored energy varies as the square of the speed. Also there is quite a difference in the average speeds of 10 and 15 miles an hour under the two conditions. The weight of the structure can be reduced by putting motors on cars, but the structures must be strong enough to stand the strain when the brakes are applied; the weight is not reduced as much as one would suppose, but considerably lighter structures are possible where electric motors are used.

Mr. BAKER: We ordinarily ran four cars on a train. We only had motors on the first car. Motors on every axle represent one extreme and the locomotive the other. One of our cars, weighing about 26,000lb., with about 14,000lb. passengers and about 20,000lb. motors and appliances, would make a weight of 60,000lb., which gives the traction of a 30-ton locomotive and a little more, as that only has about 20 tons on the drivers, the rest being carried by the pilot wheels. You get more traction than with the locomotive, and it is not necessary to go any further back with the motors. We have pulled eight loaded cars with one motor car, and I handled one night 12 cars with a motor car at the head and one in the middle and pulled them very easily. In letting the cars down the incline of the road at the conclusion of the fair, we had a string of over 30 cars handled by two motor cars at the head, so I do not really know exactly what they would do if they were put to it. The motors will slip the wheels, and you get all the advantage of the traction. There would be no advantage in going to the other extreme, and put a motor on each axle. You would get too complicated a state of things. But when it is a question of one large motor on a locomotive and four smaller ones on the train, I believe the question will about balance. It is a matter that would probably be very hard to get at, and would require perhaps a number of years' experience under different conditions.

Mr. GIBBS: I would like to ask Mr. Baker how he would expect to collect from outside conductors a current of 800 amperes at a speed of 40 miles an hour.

Mr. BAKER: We have run experimental trains on our own road at night at a speed of 37 miles an hour, and had no difficulty in collecting the current from the very simple arrangements we had, but it might be, if that speed had continued for a long time, the shoe with which we collect the current would have become hot. The shoe we used was a common cast-iron shoe running on a rail and kept fairly cool all the time. With the stops as frequent as on an elevated road or suburban service I do not think any trouble would be experienced at all. For long-distance service I am not prepared to meet the problem.

Mr. GIBBS: The problem that our electrical friends should solve for us as railroad men is to run a power station and supply current to a considerable and variable length of railroad line with a variable traffic, having, say, sometimes 60 trains on the road, at other times two, with a first cost of plant not unreasonably in excess of that of our present plant, and a fuel economy comparable with the figure mentioned by Mr. Barnes—1·8lb. coal per indicated horse-power per hour. This figure has been reached by a triple-expansion engine running at the most economical point of cut-off and generating a constant amount of power, but there is an immense amount of data lacking to show us that the electric railroad and power stations are at present doing the same thing for anything like that cost. The average amount of power generated by the consumption of 1lb. of coal at the central station in the principal power and electric light stations in the country are so low that we would be ashamed to acknowledge them as the average for locomotive performance. We would like to have figures for depreciation on electrical apparatus, especially on motors and their connections. From one point of view these should constitute a most durable class of machines, having no mechanically unbalanced parts, and subject only to journal and commutator friction for wear. But practice has indicated a number of structurally weak points, and frequent liability besides to impairment of insulation by reason of excess current and other causes.

Mr. STILWELL: Whether or not the actual efficiency obtained by the electric generators and motors is equal to the results obtained in the steam railway practice, I do not know. It will take some time to get sufficient experience on the electric side of that question to know its exact value. In any large steam plant that is reasonably well planned, we can operate with a consumption of 3lb. of coal per horse-power per hour.

President FORSYTH: Let me ask if this is horse-power at the drawbar of the train.

Mr. STILWELL: No, sir; at the shaft of the engine. Brake horse-power. Now the efficiency of our electrical transmission, if you assume about 20 miles distance, including the efficiency of the generator, the transformers for increasing the pressure, the transmitting circuit, reducing transformers and a motor at the other end, is at least 65 per cent. You can obtain a guarantee of the best companies in this country covering that figure, and some of them would attempt to guarantee higher figures. In some cases you can get 70 per cent. Now, if you take the efficiency to be 65 per cent., we have a horse-power for less than 5lb. of coal at our generating station. There will be some further loss in getting that to your drawbar pull undoubtedly, but I do not think that the results obtained on the Intramural road at the fair are a fair criterion for a broad comparison of the relative efficiency of these two systems. We certainly have in starting with our stationary engines a great advantage in efficiency, and we may hope in time to compete with the steam locomotive.

Mr. BARNES: I would like to ask Mr. Quereau as to the fuel required per horse-power hour on steam locomotives.

Mr. QUEREAU: A horse-power hour can be generated on a locomotive with from 25lb. to 28lb. of water with a simple locomotive. We evaporate anywhere from 5½lb. to

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6lb. of water to a pound of coal in average service, not under the best conditions, which will bring it possibly to, say, 5lb. of coal. I suppose that is a little rough, but think it is perfectly safe.

TRANSMISSION OF POWER AT A CHOCOLATE FACTORY.

In a recent issue we referred to plant in use for the transmission of power at Messrs. Menier's factory at Noisiel (Seine and Marne). The following further details of the installation are given in the *Journal* of the Institution of Electrical Engineers.

There are still some objections raised against non-synchronous alternating motors. Amongst the criticisms there are perhaps two which may in some cases be justifiable. In the first case the initial torque is relatively small with a constant current. This is of little importance in cases where the torque is small at first, and increases with the speed, as with a ventilating fan, for instance; but when it is necessary to start machines offering a constant resistance and large inertia the motor will require a proportionally large starting current, and special starting devices have then to be used in order to prevent too large a strain being placed on the generators. These devices are almost as simple as those used for starting continuous-current shunt motors. The second objection raised against alternating-current motors—which in many cases need not be considered—is the impossibility of varying the speed of the machine without introducing resistances into the armature circuit. This is the main reason why such motors have not yet been employed for traction work, but apart from this case, it is usual to require a constant speed for motors. The author describes one of the first power stations in France, where motors with rotating magnetic fields are used.

MM. Menier own a large estate at Noisiel (Seine and Marne) on which water power is available. This estate has several villages, a private railway, a farm, and the well-known chocolate factory. The latter is built on the banks of the river, and is worked by three turbines of about 200 h.p. each.

The electrical installation in question is used for working agricultural appliances, and for lighting a farm at a distance of two kilometres from the factory. The installation has been working for a year, and the results have proved most satisfactory. The height of the fall varies from one to four metres, depending on the time of the year. The whole of the electrical apparatus was made by the firm of Weyher and Richemond, and designed by Mr. C. E. L. Brown.

The alternator works on the two-phase system, has eight poles, and is capable of giving 75 h.p. at 600 revolutions, and equivalent to a frequency of 40 complete alternations per second. Each half of the armature gives 150 volts at 165 amperes. The weight of the whole machine is 2,700 kilogrammes. The eight field coils are fixed radially to an outside ring of cast iron. The armature consists of a hollow drum of laminated iron discs, on the outside surface of which are fixed flat coils, and those of one phase being placed above those of the other phase. Each circuit consists of eight coils coupled in two series parallels. The ends of each circuit are connected to suitable collecting rings. Lubrication for the bearings is effected by means of rings revolving in oil-boxes.

The exciter is separately driven, and is capable of giving 90 volts and 15 amperes at 1,800 revolutions per minute, and is used for exciting a Bovet magnetic coupling as well as the alternator. This coupling requires about 50 volts and 1·5 amperes when the alternator is working at full load. A careful test was made to obtain the efficiency of this type of alternator, and the system adopted was as follows: The alternator was first run at its normal speed, and so excited as to give the normal voltage at full load; readings being also taken of the exciting current, in order to determine what power was wasted in the field. Next, the losses from friction and windage, hysteresis, and Foucault currents were measured: and from these losses, added to those in the armature and field, can be determined the efficiency of the machine. This method, although not correct in the case of a single-phase alternator, where the armature reactions produce Foucault currents in the polar masses, is, on the contrary, as correct for a two-phase alternator as it is for a continuous-current machine. The two phases of such an alternator when equally loaded produce a rotating magnetic field with respect to the armature, and having an equal velocity, but opposite in sign, to that of the armature, is consequently fixed in space like the armature field of an ordinary continuous-current machine. In an ordinary single-phase alternator there is superimposed on this fixed field a rotating field having a velocity double of that of the armature, producing extra losses, and consequently prohibiting the use of the above method for determining the efficiency. It is for the above reasons that it is possible to obtain with any given carcass a greater output with a two-phase than with a single-phase winding. For instance, the above alternator could only give an output of 40,000 watts instead of 50,000 watts if it had a single-phase winding.

For determining the internal losses, the armature was rotated by means of a small continuous-current motor the losses in which had been carefully predetermined. A first test was made with the field not excited, to ascertain what losses were due to friction and windage, and a second series of tests were then made with the field excited to give normal voltage and speed. Tests were also made at different speeds, in order to separate the losses due to hysteresis (or losses proportional to speed) from those due to Foucault and internal currents (or losses proportional to the square of the speed).

The results obtained are plotted in curves, and an abstract of the tests is given in the following table:

	At full load.	At half load.	At tenth load.
Loss in the armature	1,700	420	20
Loss in the field	1,370	1,260	1,160
Friction	540	540	540
Hysteresis	390	380	370
Foucault and internal currents	1,550	1,500	1,460
Useful power	50,000	25,000	5,000
Total power	55,560	29,090	8,550
Efficiency	90%	86%	58%

The switchboard is of polished marble, and contains a double-pole switch and fuses, an ammeter, and a hot-wire voltmeter; also, for the exciter, a voltmeter, an ammeter, and a field rheostat. There are no instruments or regulating appliances on the high-tension side. The step-up transformers are each of 15,000 watts capacity, making in all 30,000 watts. The surplus power of the alternator to be used for future extensions. These transformers raise the pressure from 150 to 2,700 volts, and are placed in a special non-oxidisable insulating oil. The windings were previously well heated in the oil, in order to drive out all moisture.

The following table gives the losses and efficiencies of these transformers:

	At full load.	At half load.	At tenth load.
Loss in the primary	150	45	6
Loss in the secondary	150	40	2
Iron losses	325	325	325
Useful power	15,000	7,500	1,500
Total power	15,625	7,910	1,833
Efficiency	96%	95%	82%

The high-tension line on leaving the transformers runs underground for 500 metres, and consists of a lead-covered steel-armoured cable, consisting of four strands, each 7mm.^{2} section, insulated with rubber. This cable was manufactured at MM. Menier's factory at Grenelle. The line is protected by double-pole lightning arresters placed in the same box as the double-pole switches and fuses. These lightning arresters consist of zinc discs separated by mica. The centre disc is connected to earth, and the outer ones to the line. The boxes containing the switches are so designed that they cannot be opened while the alternators are excited. After the underground section of 500 metres the lines runs overhead for about one kilometre, and consists of a phosphor-bronze wire 3mm. diameter.

The total resistance of each circuit is from 4·5 to 5 ohms. The maximum loss is about 2 per cent. The efficiency of the line then becomes 98 per cent. at full load, 99 per cent. at half load, and 99·8 per cent. at tenth load. The step-

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down transformers are similar to the step-up transformers described above.

This installation has in use at present two biphase motors of 15 h.p. to 20 h.p., and one single-phase motor of 1½ h.p. One of the large motors drives a thrashing machine, and the other works on to a countershafting from which other agricultural appliances are driven. The small 1½-h.p. motor is used for a hay-lift. Special precautions have been taken to box in all collectors and brushes where sparking is liable to take place, in order to minimise all fire risks during the process of thrashing. The starting torque of these motors is very large, perhaps greater than at full load. The starting device consists of coils of high self-induction placed at the moment of starting across the terminals of each circuit, the motor circuits being connected to only a small number of the turns. When full speed is attained these coils are cut out.

A motor with closed armature is absolutely equivalent when at rest to a transformer with a short-circuited secondary. Placing such a machine in circuit is then equivalent to short-circuiting it at that moment. For this reason it would be necessary to place in each circuit a resistance of self-induction, in order that the current taken from the generator should not be abnormal. But, on the other hand, a strong current at low pressure is necessary in each circuit in order that the motor should start at full load. A self-induction coil or a resistance would then in themselves not be sufficient to prevent this rush of current. A transformer might be used with its fine coil connected to line, and thick coil to one of the motor circuits, but, unfortunately, by this method a high enough speed could not be obtained to allow of the transformer to be disconnected, on account of the low voltage at the transformer terminals, and, consequently, the weak field in the motor.

The combined method described above allows the motor to take a large current on starting without loading the generator, and also to obtain a high enough speed in order that the starting device may be promptly disconnected. The line current necessary for starting the motors depends on the machinery they are driving, but it varies from 40 to 50 per cent. below or above the full-load current.

Particulars and efficiencies of the system when working under different conditions are given in the following list:

1. When the Transformers are Fully Loaded and the Two Large Motors are Working Alone.

		Watts.
Useful power at the motor pulleys	13,000 + 13,000 =	26,000
Losses in the motors	2,000 + 2,000 =	4,000
Losses in the low-tension lines	120 + 280 =	400
Losses in the step-down transformers		1,200
Losses in the high-tension line		600
Losses in the step-up transformers		1,250
Losses in the alternator	700 + 1,300 + 2,450 =	4,450
Total power at the pulley of the alternator		37,900

Total efficiency of transmission = 69 per cent.

2. For a Mean Load on Three Motors.

Useful power at the motor pulleys	10,000 + 10,000 + 1,000 =	21,000
Losses in the motors		2,550
Losses in the low-tension line	65 + 155 + 20 =	240
Losses in the step-down transformers		950
Losses in the high-tension line		350
Losses in the step-up transformers		970
Alternator losses	460 + 1,260 + 2,420 =	4,140
Total power at the alternator pulley		30,200

Total efficiency of transmission = 69·5 per cent.

3. The Thrashing Machine Working Alone with an Average Load.

Power at the motor pulley		10,000
Loss in the motor		1,100
Loss in the low-tension line		65
Loss in the step-down transformers		685
Loss in high-tension line		80
Loss in step-up transformers		710
Alternator losses	110 + 1,200 + 2,370 =	3,680
Total power at the alternator pulley		16,320

Total efficiency of transmission = 61.3 per cent.

THE PACIFIC CABLE QUESTION.

The invitation of the Canadian Government to cable-manufacturing contractors to tender for the construction of a Pacific cable has now reached this country, accompanied by the specification of the conditions under which the proposed cable is to be made.

Three different forms of establishing the cable are put forward, and tenders are invited under any one of them. Under Form A it is proposed that the cable should be owned and controlled by Government, worked under Government authority, and kept in repair by the contractor for three years; under Form B the cable is to be owned, maintained, and worked by a subsidised company; under Form C the cable is to be owned, maintained, and worked by a company under a Government guarantee. Form A requires contractors to state the lowest cash price for which they will be prepared to supply and lay the cable, and the annual payment for which they will maintain it in efficient condition for three years after the whole line shall have been completed and put in operation. Form B requires the contractors to find the capital for, establish, work, and maintain the cable in efficient condition, for a subsidy to be paid to them annually for a term of years by the contributing Governments. The offers are to state the amount of subsidy to be paid and the number of years for which it will be needed. The maximum rates to be charged on messages between Great Britain and the Australasian colonies under this arrangement are to be 3s. a word for ordinary telegrams, 2s. a word for Government telegrams, and 1s. 6d. for Press telegrams. The charges on messages between Canada and the colonies to be proportionate. Form C requires the same conditions as Form B on the part of the contractor, and the offers are to state what guarantee of gross revenue will be required, the difference between gross earnings and the amount guaranteed to be made good each year to the company by the contributing Governments; the tariff of charges to be subject to official sanction. Eight routes are then given over which the cable may be carried. Of these, three have a double terminus at the southern end, one branch going to New Zealand and another to Tweedmouth, near the boundary of New South Wales and Queensland; three go direct to Queensland, and two to New Zealand only. The limit of time for the completion of the cable is three years from the date of the contract, but it is proposed that offers may be made on the basis of the shortest period within which the undertaking can be accomplished.

Time, price, quality, and distance are the four elements that contractors will have to consider, and the nature of the tenders will make it clear which of the proposed forms of contract is the most popular. Mr. Sandford Fleming, whose name is so prominently associated with the scheme, is strongly in favour of constructing the cable directly by Government as a public work. In a paper which he read before the Ottawa Conference he gave his reasons at length. They were briefly that the interests of a company and the interests of the public are not in such a matter as this identical; that while a company keeps its own profits very legitimately in sight, and endeavours to secure high dividends by keeping up the charge per message, the interest of the public is to obtain cheap telegraphy. This end can be better attained with Government money at 3 per cent. than with private money seeking to make 9 or 10 per cent., and there is, in Mr. Sandford Fleming's opinion, no reason why there should not be as great a reduction in the near future on Government telegraph messages throughout the Empire as there has been within the last 50 years upon the rates of letter postage. Such an anticipation involves, of course, the acquirement by Government of a complete system of submarine cables, and Mr. Fleming does not shrink from such a result. He quoted before the conference the example of the lately constructed cable to the Bahamas, where the first intention was to have the work done by a company with a Government subsidy of £3,000 a year for 25 years. This intention was not carried out. It was decided to make the cable a Government work, and already the charge on the colony is reduced to £1,800 a year, after full provision has been made for sinking funds and other necessary reserves. Mr. Fleming said: "Speaking for myself, I have arrived at the conclusion that the true principle to follow, looking solely at the public interests, present and prospective, is to establish the Pacific cable as a Government work. To give it to the existing company on their own terms, or perhaps on any terms, would, in my judgment, be a grave and irremediable mistake. Even to hand over the work to a new company entirely distinct from the Eastern Extension Company would scarcely mend matters. It would be impossible to prevent the two companies combining in some form to advance their common advantage to the detriment of the public interests."

His entire scheme would embrace the establishment of the Pacific cable, the purchase of all the cables of the Eastern Extension Company, and the transfer of all the telegraphs of the separate Australian colonies, together with the Pacific cable and Eastern Extension cables, to a trust or commission created by the co-operating Governments. The capital required for such a scheme he would propose to raise on the joint guarantee of the colonies and the Imperial Government. The money would be obtained at the very lowest rate of interest,

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and it would thus become practicable to reduce charges on messages to the lowest possible tariff rates. By the adoption of such a scheme he considers that all conflicting interests would be conciliated. Existing companies would obtain fair terms of purchase, and the public requirement of cheap communication would henceforth become the paramount object to be kept in view.

A further letter from Mr. Sandford Fleming to Mr. Mackenzie Bowell, the Canadian Minister of Trade, dated 12 days after the rising of the conference, makes some additional statements with regard to the financial aspect of the Pacific cable undertaking which are not without interest. If the cable should take, as is generally supposed, three years to establish, 1898 will be the first year of its operation. Taking this year as the first of his estimate of revenue, Mr. Sandford Fleming calculates that the business likely to be done in that year will be 1,100,000 words, which at 2s. a word would yield a gross revenue of £110,000. This estimate, as Mr. Sandford Fleming points out, is for European business, and includes nothing for the business between Canada, the United States, and Australia, which the existence of a cable and the natural expansion of trade will undoubtedly create. The average normal increase of telegraph business between the Australasian colonies and Europe, under a tariff rate of 9s. 4d. a word, was, for the eight years between 1882 and 1890, 14 per cent. per annum. Mr. Sandford Fleming considers that, under the proposed low rates, he is justified in assuming that the increase will be greater. He takes 15 per cent. as the basis of his estimate, and works out the probable revenue of the cable for 10 years after its completion.

He also works out the charges on revenue. These are (1) interest on capital; (2) working staff and management; (3) repairs and maintenance. Of these he says that the first and second are constant and the third is variable, but experience goes to show that failure and interruptions due to defects in manufacture or causes connected with laying generally take place within the first year or two. For this reason it is proposed in the specification for constructing a Government cable that the contractor shall be responsible for repairs during the first three years, and this variable charge is for the present eliminated from the estimate prepared. Mr. Fleming takes note, therefore, only of interest on capital and cost of working. Assuming that the capital cost of the cable and its maintenance for three years will be £2,000,000, he takes interest at 3 per cent. as £60,000 a year, and cost of staff and management as £30,000. His estimate for 10 years works out then as follows: "Estimate of the business of the Pacific cable for 10 years after its completion, calculated on the basis of 1,100,000 words for the year 1898, and an average normal increase of 15 per cent. per annum thereafter:

	Gross earnings.	Interest and working expenses.	Surplus.
1898	£110,000	£90,000	£20,000
1899	126,500	90,000	36,500
1900	143,000	90,000	53,000
1901	159,500	90,000	69,500
1902	176,000	90,000	86,000
1903	192,500	90,000	102,500
1904	209,000	90,000	119,000
1905	225,000	90,000	135,500
1906	242,000	90,000	152,000
1907	258,500	90,000	168,500

"As we have eliminated all but the fixed charges on revenue for the first three years, an examination of the above table will show that the surplus up to the fourth year will have accumulated to £109,500, which sum, together with the annually increasing surplus thereafter accruing, would be sufficient to meet all charges for repairs and maintenance, and leave a balance to be carried to a cumulative reserve, for renewals at some future day."

It is worth noting in relation to Mr. Sandford Fleming's qualifications for drawing up such an estimate that at the Colonial Conference of 1887 he estimated, in a memorandum which he laid before the conference, that the business between Europe and Australasia would amount in 1893 to about 1,330,000 words. The actual business for the past year is given by Sir John Pender as 1,306,716 words, and according to Australian returns it was 1,401,293 words.

Not the least important of the papers accompanying Mr. Sandford Fleming's communication to Mr. Bowell is a statement by Mr. Alexander Siemens, which throws some light on the limits within which tenders for the construction of the cable must confine their competition.

Mr. Siemens considers, in the first place, that the proposed further survey of the cable route is unnecessary. It is in his opinion sufficiently established that the route proposed at the Wellington Conference passes nowhere through water more than 3,500 fathoms deep. The necessity for exact survey has hitherto been due to the requirements of the engineer laying the cable, who has to know at every moment the precise depth of water into which the cable passes. The brake power with which the cable is held back and by which the percentage of slack is regulated has to be adjusted according to the depth of water. If the adjustment depended entirely, as it used to do, on a knowledge of the soundings of the route, further survey would be necessary. But by a contrivance which has been used, according to Mr. Siemens, with perfect success in the laying of six Atlantic cables, "means have been devised to indicate to the brakesman continuously the percentage of slack with which the cable is paid out, and thus it is possible to lay a cable over a route of which only the general features are known." The depth offers no insuperable difficulty, as it has been found possible to construct cables for the Atlantic which will carry 7,000 fathoms of their own length before they break.

It may, therefore, in Mr. Siemens's opinion, be taken for granted that any technical obstacles which were apprehended in 1887 have now been overcome, and that the cable can be laid as soon as the financial question has been settled. In relation to the financial question, Mr. Siemens has worked out a scheme in which he assumes that the capital sum of £2,000,000 will cover the cost of the cable, of two repairing steamers of about 1,800 tons each, and of proving instruments, and leave a working capital of about £50,000. He puts the total working expenses, including repairs and maintenance, at £119,000, of which sum £90,000, or £12 per nautical mile of cable laid, are allotted to repairs. In making this very high estimate for the purpose, he states that he does so in order to be safe in the figures which he is using, and gives the ordinary calculation as £6 per nautical mile, while "one at least of the Atlantic companies is able to keep its 6,000 miles of cable in efficient working order for £4 per nautical mile." Mr. Siemens's calculation of the probable returns of the cable assumes that in regular working there will be a surplus after the first two or three years of £101,000 per annum.

The time required for the construction he estimates at three years; but for an additional outlay of £30,000 a second large cable steamer could be employed, and the time shortened to two years after commencing the manufacture.—*The Times.*

THE LEEDS TRAMWAYS.

A few months ago we published the exclusive information concerning the offers received by the Leeds Town Council for the working of the tramways, which have passed into the possession of the Council. As the Council will shortly have to decide the tramway question, a local paper summarises as follows the present position of affairs:

By the recent decision of the House of Lords in the case of the London County Council and the London Street Tramways Company (which was taken in connection with the case of the Edinburgh Corporation and the Edinburgh Street Tramways Company), which cases were on all-fours with the situation in Leeds, the Corporation are saved the difference of the arbitrator's award upon the purchase price to be paid by the Corporation to the late tramways company, this difference amounting to £61,000. The costs to the Corporation of the tramways as they now stand, therefore, amount approximately to the following figures: the initial cost of the Roundhay line was £15,232, the cost of the Harehills-road and Beckett-street extensions of the Roundhay line was £5,098, these sums being expended by the Corporation independently of the Leeds Tramways Company's undertaking. The costs at which the Corporation acquired the undertaking of the tramways company were as follows: for the line as laid they paid the sum of £58,000; for the land, depôts and offices, etc., £23,250; for the fixed plant in connection with the undertaking the sum of £823; and for the loose plant, including the engines, rolling-stock, telephones, office furniture, horses, harness, stores, etc., the sum of £35,999. To these amounts must be added the cost of the arbitration proceedings paid by the Corporation, estimated to amount to about £11,927. This makes a grand total cost to the Corporation for the entire tramway lines, including the Roundhay and Harehills-road and Beckett-street sections, together with all the property of the late tramways company taken over by the Corporation, of £150,329.

A careful estimate of the cost of relaying and putting into good order all those portions of the tram lines throughout the city which are not in perfect condition has been made by a Leeds engineer, and it amounts, in round figures, to £77,000, to which must be added the £150,329 mentioned above in order to arrive at the cost at which the tramways undertaking will stand on the books of the Corporation. From this, however, must be deducted the sum of £35,999, which, in the event of a lease of the tramways being granted, would have to be paid by the lessees to the Corporation for loose plant. Assuming that the Corporation determine to lease the tramways in accordance with the terms of the general conditions accompanying the tenders which they invited some time ago, they would have to regard the capital expenditure by them in connection with the tramways as amounting to approximately £191,330, and would have to carefully consider in what financial

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way the rent to be derived from the lease of the tramways would affect such principal sum. By the conditions under which tenders were invited the Corporation are under no obligation to purchase from the lessees, at the expiration of the lease, any of the plant or material used by the lessees in connection with the tramways, and the lessees are bound by such conditions to leave any plant or material used in connection with the equipment which is placed underground, for the benefit and use of the Corporation, without receiving any consideration therefor, unless such plant or equipment can be taken up by the lessees without disturbing the surface of the streets.

In response to the advertisements of the Corporation inviting tenders for the lease of the tramways, subject to the conditions referred to above, only one tender was received, this being sent in by Mr. W. S. Graff-Baker, who instituted the Roundhay electric tramways. Mr. Graff-Baker's tender was sent in on behalf of a company with which he is associated, and the terms were as follows: for a lease of the tramway lines in Leeds for a period of 21 years, with a right to use a conduit or underground electric service in the centre of the city and an overhead wire electric service outside such centre, he offered, subject to the conditions governing the tenders, the sum of £615 per mile of single line per annum by way of rental. Including the Roundhay and Harehills-road and Beckett-street tramways, the total length of single line within the city is, in round numbers, about 28 miles, and for the use of this Mr. Graff-Baker offers £17,220 per annum. With regard to the financial effect of such rental upon the capital expended by the Corporation upon the tramways, our informant points out that this would amount, in the event of a lease being given as stated above, to £191,330; and that the interest charge per annum upon such capital outlay at 3 per cent. would amount to £5,740, which, deducted from the rent offered of £17,220, would leave the Corporation the annual sum of £11,480. Suppose that they desired to amortise the entirety of the capital cost during the period of the lease, to effect such purpose they would have to set aside a sum per annum representing just under 3½ per cent. upon the amount of capital to be amortised. Assuming that it was 3½ per cent., such sum would be equivalent to £6,696 per annum, which, deducted from the balance remaining after paying interest upon the money borrowed on capital account, would leave the annual sum of £4,784. Out of that amount the Corporation would have to pay for the maintenance of the permanent way in good order and repair, for which an allowance of £50 per mile of single line per annum would seem to be ample, having regard to the fact that the lines would be in absolutely first-class or new condition at the commencement of the lease. Such allowance would amount, for the 28 miles of single line, to £1,400 per annum, which, deducted from the £4,784 left after paying interest and amortisation, would leave an annual net sum of £3,384, to be regarded by the Corporation either as a financial profit upon their transaction in connection with the tramways undertaking or as an annual sum to be set aside for any contingencies that might arise during their ownership of the tramways.

If these figures may be relied upon, therefore, the result of a lease being granted upon the terms of Mr. Graff-Baker's offer would appear to be, that during the continuance of the lease the Corporation would have provided for them interest upon their capital expenditure in connection with the tramways undertaking, together with a fund sufficient at the expiration of the lease to amortise the entirety of such capital expenditure, in addition to providing for the maintenance and repair of the permanent way, and leaving a sum of over £3,300 per annum profit. The result of such an arrangement would, it is pointed out, be that the Leeds Corporation, at the expiration of the 21 years' lease, would find themselves owners of the entire tramway system in the city at a nominal cost only to the ratepayers, besides (according to the conditions of the tender) being under no obligation to take over the plant used by the lessees.

GLASGOW CORPORATION ELECTRIC LIGHTING.

At yesterday's (Thursday) monthly meeting of the Town Council of Glasgow, there was submitted by the Committee on Gas Supply and Electric Lighting the report, with statement of accounts, for the financial year ending May 31 last. The report stated that the gross revenue amounted to £18,591. 19s. 5d., and the gross expenditure to £9,591. 19s. 5d., to which was added the sum of £4,393. 0s. 11d. in the shape of depreciation written off capital. These two items together gave a total of £13,985. 0s. 4d., which, being deducted from the gross revenue, left a balance of £4,030. 18s. 1d., which was carried to profit and loss account. The committee had to meet the following required: (1) interest on loans, £3,438. 6s. 7d., and (2) sinking fund, £1,200—together £4,638. 6s. 7d.; and when the above-mentioned balance was deducted from that amount, there remained a deficiency on the year's operations of £607. 7s. 9d., which, in terms of the electric lighting provisional order, had been transferred to the debit of the gas account. According to the report, that deficiency was due to the public lighting rate having been fixed too low to be remunerative. Subsequently the committee went on to say that this result of the first full year's working of the three-wire low-tension system with current supplied from Waterloo-street central electric lighting station, compared favourably with the result of the previous year's (really 15 months) operations, when the deficiency was £1,773. 12s. 1d. That improvement arose from the station having been fully employed, the revenue having increased from £7,784. 5s. 4d. to £18,015. 19s. 2d., the expenditure not having increased in the same ratio. It is anticipated by the committee that this improvement will not only be maintained, but that the use of electricity will be further developed during the coming year, in which anticipation the committee are confirmed by the numerous applications for a supply of electricity which have been received since the beginning of the current year.

In order to meet the increasing demand the committee have resolved to lay down at the Waterloo-street station additional plant, consisting of two engines and dynamos and two boilers, which it is thought will be sufficient. In view of the favourable state of matters mentioned in their report, the committee, on July 25, recommended that the price of current should be reduced from 7d. to 6d. per Board of Trade unit as from June 1, which recommendation was agreed to by the Town Council at their meeting on August 2. The number of consumers at May 31 last was 378, being an increase of 270 over the number at the corresponding date of last year. The quantity of electricity sold during the year 1893-94 to private consumers, irrespective of the public lighting, was 543,178 Board of Trade units, being an increase of 107·14 per cent. over the sales made during the preceding 15 months, which is the length of time that had elapsed from the date of the electric lighting undertaking passing from the hands of Messrs Muir, Mavor, and Coulson, Limited, into those of the Corporation of the city.

When the year's electric lighting accounts in Glasgow were closed at May 31 last, the outstanding rents were estimated in the balance-sheet at £1,847. 15s. 7d., and up to August 29 there had been recovered a sum of £1,606. 2s. 7d., leaving a balance of £241. 13s. still outstanding. At the same date the gas rents still outstanding amounted to £1,510. 13s. 4d., but the amount of the outstanding rental at the close of the financial year was estimated in the balance-sheet at £61,070. 6s. 4d.

COMPANIES' REPORTS.

ELECTRIC CONSTRUCTION COMPANY, LIMITED.

Directors: Sir Daniel Cooper, Bart., G.C.M.G. (chairman); James William Barclay; Philip Edward Beachcroft; John Irving Courtenay; the Right Hon. D. R. Plunket, Q.C., M.P.; Sir Henry C. Mance, C.I.E; James Pender; Emile Garcke (managing director). Chief engineer: A. B. Blackburn, M.I.C.E Secretary: James Gray, Queen-street chambers, E.C.

Report of the directors to be presented to the shareholders at the first annual general meeting to be held on Thursday, September 13, 1894, at Cannon-street Hotel, London, E.C., at 2.30 p.m.

During the year shares and debentures of other companies have been sold at a profit of £15,764. 10s. The profit and loss account shows a gross profit of £55,362. 2s. 9d., and, after deducting all general charges, interest on debentures and borrowed capital, and cost of maintaining buildings, plant, and patents, and a sum of £3,000 for depreciation, there remains £18,467. 13s. 8d. The directors recommend that this balance be appropriated as follows: £12,500 in reducing the amount at debit of "shares and debentures of other companies' account"; £1,888. 2s. 1d. in writing off the reconstruction and preliminary expenses, and £1,819. 6s. in paying the dividend on the preference shares at the rate of 7 per cent. per annum for the year, leaving £2,260. 5s. 7d. to be carried forward to next account, making a total of £18,467. 13s. 8d. The working expenses compare favourably with those of the old company, and further economies will be carried out as opportunity offers. The liabilities of the Company have been reduced during the year by £48,236. 6s. The business has to some extent been interrupted by the reconstruction of the Company and the reorganisation at Bushbury, and under the circumstances the results for the year may be considered satisfactory. The directors have confidence in the ability and loyalty of the staff, and with the excellent factories and capable artisans of the Company improved results to the shareholders may reasonably be expected. Several important electrical contracts have been carried out during the year. The working of the Liverpool Overhead Railway was handed over to that company to their entire satisfaction on January 1 last. The electrical tramway of the South Staffordshire Tramways Company continues to be worked by this Company, and the cost of working for a period now exceeding 18 months demonstrates the great superiority and economy of electricity as compared with other modes of traction. Numerous orders for electric lighting and other applications of electricity are being executed. Messrs. James Meston and Co. were appointed to audit the present accounts, and they offer themselves for election as auditors for the ensuing year. Sir Daniel Cooper, Bart., and the Right Hon. David Plunket are the retiring directors. Sir Daniel Cooper is eligible for re-election, but Mr. Plunket, in consequence of other engagements, does not offer himself for re-election, and the directors recommend that the vacancy be not at present filled up.

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BALANCE-SHEET, YEAR ENDED JUNE 30, 1894.

Capital and Liabilities.	£	s.	d.
Capital authorised: 150,000 ordinary shares of £2 each	300,000	0	0
50,000 cumulative 7 per cent. preference shares of £2 each	100,000	0	0
	£400,000	0	0
Capital issued: 120,000 ordinary shares of £2 each, fully paid	£240,000	0	0
Of which 10,000 shares (issued for income bonds under scheme of reconstruction) held as security, since released	20,000	0	0
	£220,000	0	0
12,995 cumulative 7 per cent. preference shares of £2 each, fully paid	25,990	0	0
	£245,990	0	0
Debentures issued—1,254 first mortgage 6 per cent. debenture bonds of £100 each (authorised issue, £150,000) £125,400 0 0			
246 ditto, issued and deposited as security £24,600 0 0			
6 per cent. second mortgage debenture bonds, authorised issue, £100,000, less £6,180, amount drawn and cancelled. Current at July 1, 1893, £49,020; less drawn and paid off since, £2,120 46,900 0 0	172,300	0	0
Loans (secured by deposit of 246 first mortgage debentures, and of shares and debentures in other companies)	78,350	0	0
Sundry creditors 13,970 18 11			
Debenture interest accrued 4,911 0 6			
Bills payable 4,478 15 2	23,360	14	7
Depreciation account	3,000	0	0
Net profit carried to appropriation account as per report	18,467	13	8
	£541,468	8	3

Assets.	£	s.	d.
Properties, patents, and goodwill—freehold and leasehold land and buildings at Bushbury, Wolverhampton, and Millwall; plant, machinery, tools, and patterns at works; patents and goodwill—at date of transfer	303,059	19	4
Paid for patents during year	1,000	0	0
New office furniture and fittings	326	15	8
Shares and debentures of other companies*	147,872	6	7
Sundry debtors (after providing for bad and doubtful debts	32,757	10	11
Bills receivable	3,036	7	6
Work and contracts in progress (cost)	21,444	2	3
Stock—finished goods and materials on hand (cost)	21,329	16	1
Reconstruction and preliminary expenses	1,888	2	1
Cash at bankers and in hand	8,753	7	10
	£541,468	8	3

* There is a contingent liability in respect of amounts uncalled on certain of these shares.

PROFIT AND LOSS ACCOUNT FOR YEAR ENDED JUNE 30, 1894.

Dr.	£	s.	d.
General charges—Salaries of managing director, late works director, chief engineer, head office and works staff	9,329	6	5
Trustees for first and second mortgage debenture holders, fees and expenses	228	9	0
Directors' fees	1,500	0	0
Travelling expenses	1,463	15	5
Rent, rates, and taxes at head office and works	970	14	7
Advertising	920	9	2
Law charges	404	5	4
Insurances	105	0	3
Postages and stationery	910	5	2
General and office expenses, bank charges, stamp duties, and sundries	983	9	5
Commissions and agency charges	237	16	3
	17,053	11	0
Additions to plant and buildings and maintenance thereof, and patent fees £1,669 4 3			
Amount placed to depreciation account 3,000 0 0			
Interest on loans and debentures to June 30, 1894—	4,669	4	3
On loans 4,739 9 10			
On debentures 10,432 4 0	15,171	13	10
	£36,894	9	1
Net profit carried to balance-sheet	18,467	13	8
	£55,362	2	9

Cr.	£	s.	d.
Gross profit—viz., On manufacturing and contracting	25,754	10	5
Rents, profit on maintenance contracts, premiums from pupils, and sundry profits	8,140	8	6
Interests and dividends on debentures and shares of other companies	5,680	7	10
Transfer and registration fees	22	6	0
	39,597	12	9
Profit on realisation of shares and debentures of other companies	15,764	10	0
	£55,362	2	9

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Portsmouth.—The Town Council invite tenders by the 22nd inst. for the purchase of electrical plant at the Town Hall. Particulars may be obtained of the town clerk.

Edinburgh.—The Corporation, as stated in our last issue, invite tenders for the supply of arc lamp-posts. Tenders are to be directed to Mr. Wm. Skinner, W.S., town clerk, by 17th inst.

London, E.C.—The Postmaster-General invites tenders by Thursday next for the purchase of old telegraph stores. Tenders are to be sent to Mr. C. E. Stuart, controller of stores, Telegraph-street, E.C.

Barnsley.—The proprietors of the Empire Palace of Varieties, Westgate, Barnsley, require by to-morrow (Saturday) tenders for the lighting of the outside of the hall with three arc lamps, and the supply of gas-engine and dynamo. Mr. E. Haigh is the manager.

Cardiff.—Tenders are invited for wiring the Town Hall and market buildings for electric lighting purposes, including the supply and fixing of all cables, casings, switch and distributing boards, etc., but not lamps and fittings, for the Corporation of Cardiff. Plans may be seen, and copy of specification and particulars may be obtained, at the office of the borough engineer, Mr. W. Harpur, M.I.C.E., Town Hall, Cardiff, upon deposit of £1. 1s., which will be returned upon the receipt of a *bonâ fide* tender. Sealed tenders, endorsed "Town Hall, etc., Wiring," must be delivered at the office of Mr. J. L. Wheatley, town clerk, Town Hall, Cardiff, by 12th inst.

London.—The County of London and Brush Provincial Electric Lighting Company, Limited, require tenders for the supply and delivery of about 700 tons 2in. and 2½in. cast-iron spigot and socket pipes, the 2in. in 6ft. lengths, weighing not less than 42lb., and the 2½in. in 9ft. lengths, weighing not less than 84lb. per length. The interior surface must be reamed with steel-faced disc reamer to render the bore perfectly smooth, and the inside edges of both spigot and socket ends must be rounded. All to be coated inside and outside when hot with Dr. Angus Smith's composition, and to accord in every respect with the Post Office specification for similar pipes. The whole delivered by weekly instalments in barge, City-road basin, Regent's Canal, by November 1. Apply to Mr. A. J. Lawson, engineer and manager.

Ottawa.—The Government of Canada invites cable-manufacturing contractors and others to state the terms upon which they will be prepared to lay, and maintain in efficient condition, a submarine electric cable across the Pacific from Canada to the Australasian colonies. General conditions under which the offers are to be made may be ascertained on application at the Department of Trade and Commerce in Ottawa, or at the office of the High Commissioner for Canada, 17, Victoria-street, London, S.W. Proposals, based on such general conditions and in either of the three forms set forth below, to be addressed to the Minister of Trade and Commerce, and delivered at his department in Ottawa on or before November 1, 1894. Form A: The cable to be owned and controlled by Government; to be worked under Government authority, and to be kept in repair by the contractor for three years. Form B: The cable to be owned, maintained, and worked by a subsidised company. Form C: The cable to be owned, maintained, and worked by a company under a Government guarantee.

RESULTS OF TENDERS.

Reading. — The Reading Electric Supply Company have accepted the tender of Mr. E. Blackwell, Reading, for basement, etc., works at the central station, Vastern-road.

BUSINESS NOTES.

Warwick.—Warwick Castle is to be lighted by electricity.

Reigate.—The subject of introducing the electric light is being locally discussed.

Fulham, S.W.—It is suggested that the Vestry should introduce a supply of electric light.

Blackburn.—The question of lighting the streets by means of arc lamps is to be discussed.

Direct Spanish Telegraph Company.—For the month of August the receipts were £1,583, as against £1,670 for the corresponding period.

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Western and Brazilian Telegraph Company.—For the past week the receipts were £2,542.

Tunbridge Wells.—The new central electric light station is to be completed by February next.

Commercial Cable Company.—The directors announce a quarterly dividend of 1¾ per cent.

Great Northern Telegraph Company.—For the month of August the receipts were £26,800.

Yorkshire House-to-House Electricity Company.—On Monday a call of £1 on 2,634 £5 shares was made.

Montrose.—The new building to be erected by the Asylum and Infirmary Board is to be lighted by electricity.

Pontypool.—The new market is lighted electrically. The installation has been carried out by a Bristol firm.

Norwich.—A new Roman Catholic church, St. John the Baptist, has been partly completed. It is lighted electrically.

Southwark.—St. Olave's Grammar School, which has just been rebuilt at a cost of about £23,000, is to be lighted electrically.

Eastern Telegraph Company.—The receipts for the month of August were £60,279, as against £51,991 for the corresponding period.

Dundee.—The Works Committee of the Dundee Gas Commission have authorised the extension of the electric light to the police offices.

Cuba Submarine Telegraph Company.—For the month of August the receipts were £51 less than for the corresponding period of last year.

Eastern Extension Telegraph Company.—For the month of August the receipts show an increase of £2,847 as compared with the corresponding period of last year.

Leeds.—The Leeds Co-operative Society have erected new central stores in Albion-street. The building has been fitted up with the electric light by Mr. J. A. Edmundson.

Stockton.—The Board of Trade have deferred the question of revoking the Corporation's provisional order, provided that the undertaking is carried out within a certain time.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending 2nd inst. amounted to £1,152, as compared with £814 in the corresponding week of last year.

Sale of Plant.—The sale of the electrical engineering plant of Messrs. Latimer Clark, Muirhead, and Co., of Regency-street, Westminster, by Messrs. Fuller, Horsey, and Co., commenced on Tuesday.

New Swindon.—A motion on the agenda of the Local Board, in the name of Mr. Hinton, to propose the advisability of obtaining a provisional order with respect to the electric lighting of the town has been referred to a committee.

Abergavenny.—The Improvement Commissioners have decided to abandon the contemplated scheme for lighting the town by electricity, and to proceed with the extension of the gasworks to meet the requirements of the town.

Isle of Man.—A company has been registered with the object of constructing an electric tramway from Laxey to Snaefell Mountain. The capital is 25,000 shares of £1 each. The registered office of the company is 7, Athol-street, Douglas.

Wrexham.—A letter has been received by the Town Council from the Board of Trade intimating that the Board will be prepared to defer the consideration of the question of the revocation of the order of the Wrexham and District Electric Supply Company, Limited, for 12 months.

Eccles.—The Town Hall, Tramways, and Electric Lighting Committee of the Town Council have reported upon a visit they had made to Whitehaven to inspect the electric lighting works there. They were, however, not in a position yet to make any recommendations to the Council.

Redditch.—The necessity of erecting additional lamps in various parts of the district has been brought before the Local Board, but it was decided to let the matter remain in abeyance until the committee appointed to consider the subject of lighting the town by electricity have furnished their report.

City and South London Railway.—The receipts of the Company for the week ended September 2 were £794, against £747 for the corresponding week of 1893, or an increase of £47. The total receipts for the current period of the present half-year amount to £7,736, as against £7,394 in the corresponding period of 1893.

Wolverhampton.—At a meeting of the Wolverhampton Gas Company, Mr. Annan said that they had passed through a severe struggle. The electric light was being pushed forward. It would be of some disadvantage, but he did not consider it would be a great one, inasmuch as their increase went on month by month.

The Unique Switch.—We are informed that the Unique switches in all sizes and patterns are still in great request, and that, though the majority remain in England, a large number are sent abroad. A proof of this is shown by the fact that Mr. A. P. Lundberg has just received an order from Austria for 1,000, and from Africa for 500.

Lynton and Lynmouth Electric Light Company, Limited.—This Company has been registered with a capital of £8,000 to enter into an agreement with Mr. H. H. Benn, and to acquire the electric lighting business now carried on at Lynton and Lynmouth, in the county of Devon, under the style of the Lynton and Lynmouth Electric Company.

Refusal of an Application.—The St. George's, Hanover-square, Vestry have declined to give permission to the St. James's and Pall Mall Electric Lighting Company to lay an electric main in New Bond-street on the ground that the company had no powers to lay mains in the parish, in which, the surveyor stated to the Vestry, there were quite enough companies already.

Birkenhead Tramways.—The Birkenhead Town Council will meet on October 3 to consider a resolution to purchase for the sum of £2,250 the tramway rails and undertaking of the Wirral Tramway Company, Limited, situated within and outside the boundary of the borough of Birkenhead, or in the alternative so much of the tramway and undertaking only as is situated within the borough of Birkenhead.

Appointments Vacant.—As will be seen from our advertisement columns, the Town Council of Salford require a mechanical and electrical engineer. The Electric Lighting Committee of the Southport Corporation require an attendant for engines and alternators. Applications are to be sent in to Mr. J. Davies, town clerk, Southport, not later than the 15th inst. The Vestry of St. Mary, Islington, invite applications for a road foreman.

Worcester.—It was reported to the Watch Committee on Friday by the sub-committee that a number of applications for the electric light had been received. The applications acceded to included several churches, and it was stated that the dean was anxious to have it put in the cathedral. It was decided to recommend the Council to vote a sum of £1,000 as working capital to pay the cost of such extensions as the committee might decide were necessary.

Manchester.—The annual financial statement of the Manchester Corporation, issued on Friday, states that in the electric lighting department the expenditure on capital account in the past year has amounted to £86,264. 16s. 11d., and the total indebtedness of the Corporation for loans now amounts to £127,830. After setting aside £1,376. 17s. 7d. for liquidation of debt, and providing £610. 16s. 3d. for interest during construction, the year's working shows a deficit of £209. 18s. 10d.

Warminster.—With regard to the extension of the electric light in the town, the committee of the Local Board appointed to consider the question recommended that the electric light should be extended to the top of Town Hall-hill by the erection of three additional arc lamps. Mr. Brown, electrical engineer, of Walsall, had been consulted on the matter, and he has arranged to visit Warminster. It was decided to adjourn the further consideration of the matter till Mr. Brown's visit.

Cooking by Electricity.—Messrs. Crompton and Co., Limited, are showing electric heating and cooking appliances at the Food and Cooking Exhibition now being held in Manchester, and their demonstrations are exciting great interest. Several dinners have been cooked, and chops and steaks are daily supplied to visitors. The new electric grill recently introduced cooks to a nicety at a small expenditure of current. Messrs. Crompton and Co. have been awarded a diploma for gold medal.

Lincoln.—The Town Council have decided to inform the County of London and Brush Provincial Electric Lighting Company that the Corporation refuse their consent to a provisional order being granted them by the Board of Trade, as the Corporation themselves possess special facilities for lighting the city with electricity, and are quite prepared to undertake the work as soon as they are satisfied that the true interests and advantage of the citizens demand such a mode of lighting in the city.

Derby.—The electric light will probably soon illuminate Ashford Hall, the residence of Mr. R. Clifford Smith, J.P., owing to an addition being made in the shape of a billiard-room. Mr. Smith resolved upon having the electric light, and communicated with Messrs. Drake and Gorham, of London, who designed and carried out the lighting of Chatsworth. Messrs. Cox, Wilson, and Sons, of Chatsworth, have fixed a turbine which drives the dynamo. From this dynamo a cable will run to Ashford Hall, a distance of 400 yards, charging a battery of accumulators.

Chelmsford.—It has been suggested at a meeting of the Town Council that the bandstand should be lighted electrically. The Board of Trade have sanctioned the erection of overhead electric lighting wires in certain new streets, and in Barrack-square, on condition that in the event of the wires in Moulsham-street being placed underground the wires in Barrack-square should be put underground. The Board could not consent to the wires being erected overhead in King Edward's-avenue, as that appeared to be an important thoroughfare, and was in close proximity to underground wires.

Halifax.—Arrangements are to be made for lighting the new markets with the electric light. The shop known as "My Bootmakers," Bull-green, has been lighted electrically. The light, which attracted much notice in the neighbourhood, is remarkable for its steadiness and brilliancy, and proved very economical in working. The cost for running the entire installation for 4½ hours was rather less than 4d. per hour, and the actual gas consumption 630ft. The installation, which is put down by the Imperial Gas and Oil Engine Company, of West View, Booth Town, comprise 4-h.p. Imperial gas-engine, dynamo, voltmeter, 40 16-c.p. incandescent lamps, five 16-c.p. portable lamps, with all fittings complete.

Bristol.—Mr. Essery, at a meeting of the St. George's Local Board, on Wednesday raised the question of the lighting of the parish, and suggested that it was time for St. George to place itself upon a level with other districts, and adopt the latest and best system of lighting by electricity. Such a system, he said, would not cost more than gas, and with it they might have at least 100 more lamps. He proposed that a committee should be appointed to consider the matter of making provision for the

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public and private lighting of the parish. Mr. Brain seconded the proposal, which was carried.

Belfast.—The Town Council have adopted the following report of the Electric Lighting Committee: "Your committee have to report that they have drawn up the following scale of rebates to be made on accounts for electric current: on quarterly accounts of £2. 10s. and up to £5, 2½ per cent.; of £5 to £7. 10s., 5 per cent.; of £7. 10s. to £10, 7½ per cent.; of £10 to £20, 10 per cent.; of £20 to £40, 12½ per cent.; of £40 to £70, 15 per cent.; of £70 and upwards, 17½ per cent. The works in connection with the central station and the laying of the mains are progressing satisfactory, and some of the engines have undergone preliminary tests."

Electric Lighting at Leigh (Lancashire).—The directors of the Leigh Co-operative Society, Limited, have decided to adopt electric lighting throughout their central premises, and are putting down a horizontal steam-engine of 18 h.p., and a large dynamo capable of supplying current to 240 lights with wires and fittings complete. By doing this they will effect a considerable reduction in their insurance policies in connection with the flour mill. Messrs. B. Verity and Sons, electrical engineers, of 29, Princes-street, Manchester, who are extremely busy in all departments at present, have been instructed to carry out the necessary work.

Birkenhead.—The confirmation of the proceedings of the Finance Committee of the Town Council was moved on Wednesday by Alderman Deakin, who said there were several rather important questions contained in the minutes. One matter was that referring to electric lighting, and he therefore proposed that the plan prepared by Mr. J. N. Shoolbred in connection with the central electric station be, with certain alterations, approved, and that the town clerk be instructed to submit the same to the Local Government Board for their approval in connection with the application for sanction to borrow £20,000 for electric lighting purposes. The resolution was seconded and carried.

Ship-Lighting.—Messrs. Ramage and Ferguson, of Leith, have launched a passenger and cargo steamer built specially for the Eastern Mediterranean local trade for foreign owners. All the cabins are lighted by electricity. A steel screw steamer, named the "Independencia," has been launched from the yard of Messrs. Napier, Shanks, and Bell, Yoker, for the Government of San Domingo. Electric light will be fitted throughout the vessel, and she will also carry a powerful search-light. A complete electric light installation has been carried out by Messrs. Paterson and Cooper in the "Oopack," which has been built by Messrs. Workman, Clark, and Co., of Belfast, for the China trade.

Dublin.—In the month of October next the Dublin Southern Tramways Company will commence operations for applying electricity to the working of their cars on the overhead system between Haddington-road, Kingstown, and Dalkey. The scheme has been mainly brought to a successful issue by the energy of Mr. J. Clifton Robinson, C.E., general manager of the Southern line of tramways, and will be of immense benefit to residents along the line. At the next half-yearly meeting of the Dublin and Lucan Steam Tramway Company the question of the reconstruction of the line will be brought forward and considered, when it is expected that a definite statement will be made on the subject by the directors.

Darlington.—Some time ago the Darlington Corporation, who own the gasworks, considered it advisable to obtain powers for the lighting of the borough by electricity. It has been deemed desirable to make an application to the Board of Trade in respect of the same, and through the borough member (Sir Theodore Fry, M.P.) a deputation of the Town Council have had an interview with the Board of Trade officials. They received assurances from Mr. Hopwood that the Board would not take any steps to revoke the powers granted to the Corporation in 1890 in regard to electric lighting, and it was also stated that the aid of the Board of Trade would be given towards including the remaining portion of the borough within the area of supply.

Dover.—Workmen from London are now engaged in putting in the conductors in the offices of the Mayor in Wood-street, and in the private house of the deputy mayor in High-street, and also in Mr. Luckhurst's jewellery shop in Snargate-street. The wiring is being carried out under the supervision of Mr. W. Sluigo, the electrical engineer who was recently engaged by the Town Council to give them advice with reference to the requirements of the Board of Trade. The work of building the electric light station is going on rapidly. The chimney shaft is nearly 90ft. high, and has about 30ft. more to be added before the top stone is put on. The top stone, or stones, will be in the shape of a large terra-cotta cap. The walls of the engine-house and boiler-house are now up.

Sheffield.—New offices and warehouses have been erected by the Midland Railway Company in Savile-street. On the Spital Hill side of the station is the engine-house, containing the latest machinery for providing the electricity and the hydraulic power. The electric light installation consists of three single-cylinder engines, made by Marshall and Sons, Gainsborough, two indicating 80 h.p., and one 30 h.p.; four 35-light arc dynamos of the Thomson-Houston pattern, and one incandescent dynamo for 300 16-c.p. lamps to light the offices, made by Mather and Platt. These not only provide the current for lighting the offices, sheds, and warehouse, but for lamps on the Grimesthorpe engine shed and Cardigan sidings. The company's electricians, under the supervision of Mr. W. Langdon, have carried out the electric installation.

Glasgow.—The Gas and Electric Committee of the Town Council have agreed that the price of gas should remain at 2s. 6d. per 1,000 cubic feet, and that the price of electric light should be continued at 6d. per Board of Trade unit, being the price to which it was reduced from 7d. some time ago. A joint meeting of the Electric Lighting Committee and the Sub-Committee of the Watching and Lighting Committee in Glasgow on the electric lighting of streets, has been held to consider the cost of lighting the streets with electricity. It was represented that, as the cost of each lamp is £30 per annum, the gas company could not continue to supply electricity at £20, as had been done since the adoption of the new illuminant. It appears that the cost is very much more than was anticipated, and £26 was suggested as the figure that should be paid in future. The sub-committee resolved to submit the proposal to the Watching and Lighting Committee.

Inverness.—Official intimation was made at a meeting of the Inverness Town Council of the intention on the part of two electric companies to apply to the Board of Trade for provisional orders to supply electricity for public and private purposes in Inverness. Mr. W. J. Smith said if the Council did not oppose the application, it was quite possible that the Board of Trade might grant one of the orders, with the result that the town might have in the future to take over the plant of the company. The Clerk stated that the Act provided that the consent of the Council must be obtained before the Board of Trade could grant the order, except under certain special circumstances. Provost Ross said it would be well that they should preserve their rights, and so be in a position, if they thought it desirable, to make a bargain with any company for the introduction of electricity. Meantime, it was resolved to refuse the consent of the Council to the applications.

"On Appro."—On Monday Mr. Commissioner Kerr heard the case of Braulik *v.* Sharpe and Kent in the City of London Court. The plaintiff, Mr. George Braulik, of 217, Upper Thames-street, claimed the sum of £2. 2s. 6d. for electrical goods supplied to the defendants, Messrs. Sharpe and Kent, of Victoria-street, Westminster. Mr. Kent, one of the defendants, said that the goods were bought on appro. The plaintiff's traveller said he admitted having taken the order on appro, but he said it was explained at the time that if the defendants wanted to return the goods in a fortnight or three weeks the plaintiff would be willing. But the defendants had kept the goods for 12 months. The defendant Kent said he bought the goods on appro, which meant that if they were not sold they were to be returned. Mr. Commissioner Kerr said he did not know the meaning of the words in the electrical trade. He adjourned the case until October 4 for trial before a jury.

Collier Audible Telephone Syndicate.—Meetings of the creditors and shareholders of this syndicate were held on Friday at Carey-street, W.C., before Mr. Wincarls, assistant receiver, who intimated that the question of a liquidator's appointment would have to be referred to the Court for decision. The syndicate was registered in April, 1891, to acquire and develop the inventions of Mr. A. T. Collier for improved telephonic receivers and transmitters, and to carry on the business of a telephone and electrical manufacturing and supply company. The promoters were the London and Colonial Finance Corporation, Limited, and the nominal capital was put at £9,000. In 1892 the Collier-Marr Telephone and Electrical Manufacturing Company, Limited, acquired the assets for £50,000, payable in cash and shares, and, with a view to carrying through the sale, the syndicate went into voluntary liquidation, but later a compulsory winding-up order was made on a creditor's petition.

Ipswich.—The Paving and Lighting Committee of the Town Council have held a meeting, at which the gas inspector said the gas company asked the co-operation of the committee in providing Welsbach lamps throughout Tavern-street and Westgate-street. Ten would be required—six for Tavern-street, and four for Westgate-street—and the gas company were willing to pay the cost of erecting six if the committee would pay for four. The cost would be 15s. each burner, and the cost of gas would be exactly the same as the present lamps, with this difference—that instead of 13 c.p. they would have about 70 c.p. Mr. Churchman: I will move that no more expenditure be incurred in experimental gas-lighting till the electric lighting question is settled. The Vice-Chairman seconded the motion. Mr. Robinson: We have no objection to the new burners being put up at the expense of the company. Mr. Churchman concurred, and added words to that effect to his resolution, which was carried.

Gas and Electricity at Hanley.—The town clerk has submitted to the Town Council a communication from the British Gaslight Company intimating that the price of gas to the private consumers in their district would be reduced from 2s. 9d. to 2s. 6d. per 1,000 cubic feet; and that there would also be a reduction in the price charged for public lighting of 5s. per lamp, making the charge £2. 15s. per lamp, from July 1 last. The Mayor remarked that their electrical energy was being rapidly taken up, and he expected that there would soon be a demand which would make it necessary for them to obtain further powers This would be pleasant news for the Council, and it would also be satisfactory for them to know that the British Gaslight Company had brought down their price for gas from 3s. 6d. per thousand (as it was when they started their agitation) to 2s. 6d. per thousand. He found by calculation that from 1888 to 1893 the sum contributed from private rentals was £152,962, and about an average of £3,000 a year from public lighting under contracts. Up to the time of the first reduction to 3s. per thousand the statutory dividends had not been paid or scarcely paid, and no amount had been placed to the

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credit of the reserve fund. From that time, however, the statutory dividends had been paid, and the reserve fund had grown to £9,316. And further, in those six years the public had paid £23,860 less than they would have done under the 3s. 6d. rate, £6,050 being about the reduction in last year when the gas was reduced from 3s. to 2s. 9d. Upon the present price—reduced from 2s. 9d. to 2s. 6d.—about £5,000 per year would be saved to the ratepayers and consumers, £4,900 of which would directly affect the pockets of the consumers. The agitation of the Corporation had saved to the consumers during the six years £23,869—the whole cost of their electrical works. Those who advocated the establishment of those works knew perfectly well what the effect would be, and he was certain that those people who last year thought they were taking a bolder course than they ought to do would now be perfectly satisfied and thoroughly in harmony with any future proposals for the extension of the scheme of electric lighting. Tunstall would benefit by the reduction in the price of gas, and they ought to thank the Hanley Corporation for it. The result had thoroughly justified the action of the Town Council.

Preston.—The minutes of the Markets and Town Hall Committee of the Town Council comprised a recommendation that "to aid the sub-committee in their deliberations as to the advisability of lighting the Town Hall and Public Hall with the electric light, they be authorised to confer with Dr. John Hopkinson, of Manchester, whose terms would be at the rate of 5 per cent. on the cost of lighting, with a minimum fee of 50 guineas for travelling expenses." Alderman Birley moved a resolution to this effect, and said there had been some outside talk about employing a local firm, but he must remind them that Dr. Hopkinson was an eminent electrician, whereas the local firm in question had been established only a few years. Mr. Healey seconded the motion, and Mr. Green proposed an amendment that the matter be referred back for further consideration, as he did not see the force of engaging an electrician at a cost of 50 guineas merely to tell them where to put the light. Mr. Hale seconded the amendment. A heated discussion ensued, in which Alderman Birley emphatically denied that it was the committee's intention to give the work out of the town, and the amendment was lost by 21 votes to 7. The original motion was then agreed to.

Leeds Tramways.—The Tramways Committee of the Leeds Corporation visited Douglas on Thursday of last week, and inspected the new electric tramway to Laxey. The committee first carefully inspected the generating station at Douglas, and then, accompanied by the directors of the tramways company and the chairman of the Douglas Town Commissioners, they proceeded by special car to Laxey, and expressed admiration at the fine marine scenery opened out in the course of the seven miles' journey. At Laxey they were shown over the generating station, and made an examination of the electrical plant. The return journey was broken at Groudle, where the accumulator station was inspected. Afterwards the party were entertained to luncheon at the Groudle Hotel by the directors of the tramway company. The members of the Tramways Committee are, a local paper states, well satisfied with their visit. They obtained a good deal of information, which must be of value in coming to a decision as to the system which is best adapted to the requirements of Leeds. What the committee saw only tended to confirm the opinion formed from experience of electric traction at home. The town clerk and borough engineer are to prepare reports on the visit, and these will in due course be presented to the committee. It would, therefore, be premature to say more than this, that, so far as can be gathered, there is a very strong leaning towards electricity on the part of several members of the committee, and that the unquestionable efficiency, together with the comparative inexpensiveness of it, are outweighing the objection relative to the unsightliness of the overhead wires. The cost in Leeds must be an important consideration. The Corporation have a very extensive area to serve. If the present extent of track were doubled the city would not be too well provided for, and that would mean between 40 and 50 miles of single line. The committee have ascertained that the overhead system, including cars and full equipment, would cost between £7,000 and £7,500 per mile, and that the electric underground or the cable system would entail an expenditure of £10,000 per mile. There is thus a difference of from £2,500 to £3,000 per mile, and where so extensive a track is required that is a very important item. The question is still under consideration, but the committee are probably of opinion, after their protracted investigation, that there is little further information to be obtained in the matter, and their decision may not be much longer deferred.

Leicester.—The adoption of the Gas Committee's report with reference to the electric light undertaking has been moved by Alderman Lennard at a meeting of the Town Council. With regard to the progress of the work, he would like to say that the building was now completed. It had been erected under the direction of Mr. Colson, instead of being contracted for. The foundations for the engines and dynamos had been put in, a good part of the plant was now delivered, and the erection would be proceeded with in a few days. With regard to the price which the committee recommended, he might say that the price fixed by the order was 8d. per Board of Trade unit. The price the committee proposed to charge was 6d. per unit only. He believed the majority of towns had adopted the same price. Here and there one or two corporations had gone a little lower to begin with in order to put themselves in a better position to compete with the gas companies. There was no finality about the charge which the committee proposed to make at the outset. In course of time if they did not think it was enough they could ask for more, and, on the other hand, if they found they were making a fair profit out of it, they would be only too pleased to come and propose a reduction. A circular the gas department issued some three years ago suggested that if consumers took the current it would cost something like two or three times as much as gas. He wanted to explain that the statement was made with the idea that the maximum of 8d. would be charged, but what with the reduction in price and improvements in lamps, it would enable it to be had at much less cost, and at a greater efficiency with less amount of current than was anticipated. He should say, taking improvements and reduced price into consideration, that now electricity might be looked upon as equal in cost to gas, and he did not think any tradesman or shopkeeper would find his bills any heavier at the end of the quarter if electricity were used instead of gas. They had considerable demand for installations, having had 1,300 16-c.p. lamps applied for. The work in the town was being proceeded with rapidly, the cables would be finished in the course of a few days, and it had been done with as little inconvenience as possible to the public and tradesmen as possible. Councillor Billings seconded. In reply to Alderman Sir Thomas Wright, Alderman Lennard said his own impression was that in the course of two or three years they would be able to come to the Council and ask that the price might be reduced. The report was adopted. The Council want £17,574 for electric lighting purposes.

Hertford.—The Finance and General Committee of the Town Council have reported that they had received the following report from the Lighting Committee: "A statement of the terms on which the Corporation would be able, under the proposed scheme of electric lighting, to supply electrical energy for the lighting of private and public buildings, etc., has been circulated amongst the householders, etc., residing within the district which it is proposed to serve, with the object of obtaining some idea as to the amount of favour with which it was likely to be regarded. The information thus obtained is of service, although it was never pretended that it would be necessarily conclusive, for the experience of other towns has invariably shown that, when once such a plant is started, the demand quickly exceeds the estimate based upon previous quasi-promises. It is, however, satisfactory to the committee to find that the returns which have so far come to hand are distinctly encouraging in this respect. They represent applications for electrical energy for lighting purposes to something like treble the amount of last year's carefully revised canvass; and they indicate in addition that the proposed installation of the electric light in Hertford is regarded with favour by many who have not yet sent in returns as to the actual number of lamps which they would be prepared to instal, because they have not yet been able to ascertain their precise requirements. Negotiations with certain large consumers, including the railway companies, the post office, and the building committee of the new church are now pending, and these have not been taken into account in framing the estimates on which this report is based. Having regard, then, to the general tenor of the replies and to the returns actually received, and being assured that no further material reduction in the cost of plant or in the expenses of the generating station can be looked for in the future, and believing that no better opportunity for securing to the ratepayers of the borough a valuable and remunerative property will be gained by further delay in this matter, this committee recommends: (1) That the electric lighting scheme proposed by the engineer—extended so as to supply the Hertford General Infirmary—be carried out as speedily as possible. (2) That the engineer be instructed, with the assistance of the borough surveyor, to prepare the detailed plans for carrying out the scheme, and the requisite forms of tender for the several sections of the same. (3) That application be made to the Local Government Board for their sanction to a loan of £6,000 for the purpose of carrying out the scheme." The consideration of the subject has been postponed to allow of the ratepayers going into the question.

Canterbury.—The Town Clerk has read at a meeting of the Town Council the following letter from Messrs. Mowll and Mowll: "73, Castle-street, Canterbury, August 20, 1894. Dear Sir,—We regret that your letter of the 3rd inst. has not been answered before, but circumstances have prevented us sending you a reply. The engineer states that he is unable to give the number of gas lamps which an arc lamp would replace, as he has no data as to the number of gas lamps in use in Canterbury or plans showing their position. We beg to give you the following extract from the letter which we received from the engineer, which we trust will give you all the information you require: I beg to state, in reply to the letter, that I am unable to give the number of gas lamps which an arc lamp would replace, as I have no data as to the number of gas lamps in use in Canterbury or plan showing their position. Each arc lamp would give at least 1,000 effective candle-power, as against about 12 c.p. effective for each gas lamp. The arc lamps, however, would not replace the number of gas jets which this extra efficiency in power would represent, as each arc lamp would only replace five or six gas lamps. The cost per arc lamp for all night running would be £30, or £23 for lamps burning from dusk to midnight, these being the prices we are to charge at Dover. Assuming, therefore, that each arc lamp replaces six gas jets, the result would be that for an increase of 14 times the illumination the cost would be less than 50 per cent. increase upon the present cost of lighting by gas, the standard price of gas being £3. 13s. 6d. per street lamp for all night running. As, however, owing to the narrowness of some of your streets, additional arc lamps might be required, reducing the number of gas lamps which they would displace, you will safely assume that the illumination will be at least 20 times that from the present gas lights, and that the cost would be about double. As to the first cost of each arc

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lamp, this would be provided for by the company undertaking the lighting, so that beyond the charge already mentioned the Corporation would not have to pay anything further, provided a contract were made for a term of years; but should the Corporation wish to supply their own lamps and posts, with all accessories, the cost would be between £20 and £30 per lamp, according to the system adopted and the design of the post and lamp. Any further information we shall be glad to furnish the Council with.—Yours truly, Mowll and Mowll." Alderman Cross said he thought the company had information as to the probable number of lamps that would be required, as the Electric Light Committee went round with the company's engineer and marked the places where it was thought desirable that lamps should be placed. He thought the decision then come to was that in no case could they do away with more than three lamps, and in many cases not even two. The Surveyor said the engineer the company had then was not the same as they had now. He thought they must send the company a copy of the plan showing the gas lamps. Councillor Dunn said that, seeing they had a gas contract for another 12 months, they could not go into the matter that morning, and Councillor Lukey moved that the letter be received. He did not think they need discuss it that morning, as they had nothing definite before them as to the lighting of the public streets. It was a question they might fairly leave over until the time came for the next agreement with the gas company. Councillor Harris enquired what the Electric Light Committee were doing? If the scheme were practicable he expected to have heard from them. Councillor Lukey: Will Councillor Harris move that the letter be referred to the committee? Councillor Harris: Oh, no. I shall refer it to no committee. I believe it is a dead letter. Alderman Cross moved that the letter be referred to the committee, and Councillor Dunn seconded. The motion was agreed to.

PROVISIONAL PATENTS, 1894.

AUGUST 27.

16278. **Improvements in and connected with electrical measuring instruments, organs, electrolysis, and working aluminium.** James Swinburne, Broom Hall Works, Teddington.

16280. **Utilisation of the rise and fall of the tides through the medium of floating and falling "caissons" or drums acting upon a system of multiplying wheels for production of electricity for all purposes.** Richard Manifold Craig, Hanwell-park, Hanwell, London.

16331. **Improvements in electric organs.** Percy Ross Harrison, 6, Bream's-buildings, Chancery-lane, London.

AUGUST 28.

16366. **Heat electric alarm.** Richard Brown, 7, St. Peter's-street, Preston, Lancs.

16391. **Improvements in electrical switches.** William Paul Theermann and George Christopher Elliott, 11, Great Ducie-street, Manchester.

16400. **Improvements in apparatus for generating and applying electricity to the human body.** Walter Joseph Newton, Henry James Purbrook, and Herbert de Carle Hudson, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

16408. **Improvements in printing telegraphs.** Robert Ashworth Fowden, Norfolk House, Norfolk-street, London. (Complete specification.)

16418. **Improvements in and connected with telephonic apparatus.** Jules Cerpaux and Georges de l'Escaille, 23, Southampton-buildings, Chancery-lane, London. (Complete specification.)

16423. **Improvements in or applicable to electric lamps.** Robert James Rae, 4, South-street, Finsbury, London.

16425. **Improvements in electric accumulators or storage batteries.** David Young, 11, Southampton-buildings, Chancery-lane, London. (The Hess Storage Battery Company, United States.) (Complete specification.)

AUGUST 29.

16473. **An improved system or method of arranging telephones and appliances in connection with the same, by which no currents are required either for calling for or notifying the completion of communications to the different subscribers, both the above-named signs being given automatically.** Georg Ritter, 65, Chancery-lane, London. (Complete specification.)

AUGUST 30.

16532. **An improved switch or key for electric glow lamps.** Wilhelm Emil Conze, 28, Southampton-buildings, Chancery-lane, London. (The firm of F. W. Busch, Germany.)

16540. **Improvements in apparatus for firing mines electrically.** Charles Andrew Terrey, 22, Southampton-buildings, Chancery-lane, London.

16542. **Improvements in or connected with search-light projectors.** John Brokenshire Furneaux and Henry Walker, 46, Lincoln's-inn-fields, London.

AUGUST 31.

16599. **Regulating electric currents.** Leslie Bradley Miller, 2, Gray's-inn-road, London.

16606. **Improvements in or connected with carbons for electric arc lights.** Henry Charles Barker, jun., 33, Chancery-lane, London.

SEPTEMBER 1.

16686. **Improvements in the construction of galvanic cells.** Cæsar Vogt, 38, Chancery-lane, London.

16687. **Improvements in electric alarums.** Cæsar Vogt, 38, Chancery-lane, London.

16695. **Improvements in electric lighting and extinguishing devices for gas lamps.** Siegbert Bruck, 89, Chancery-lane, London. (Complete specification.)

16696. **Improvements in or relating to electro-depositing apparatus.** Henry Le Roy Bridgman, 323, High Holborn, London.

16697. **Improvements in or relating to electro-depositing apparatus and to products obtained thereby.** Henry Le Roy Bridgman, 323, High Holborn, London.

16710. **An electric lighting apparatus to be used in connection with gas burners.** Leo Elliasson, 24, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1886.

14673. **Preparing bleaching solutions by electrolysis.** Hermite and others. (Second edition.)

1893.

7594.* **Electrolytical decomposition of chlorides, etc.** Lyte. (Amended.)

18661. **Electric telegraphs for steering, engine-room, etc., signalling.** Preston.

18805. **Electric measuring instruments.** Davies.

18951. **Electricity meters.** Edmondson.

19018. **Electrical transmission.** Davis and Fowden.

19465. **Electric distribution.** Allison. (Mailloux and another.)

1894.

7322. **Electric alarm.** Christgau.

10171. **Writing telegraphs.** Newton. (Gray.)

13208. **Field magnets for dynamos.** Allen and others.

13319. **Electric arc lamps.** Kirkegaard.

13410. **Electrical switches.** Derman and Smith.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	5	5¼-5½
Bournemouth Electric Company	—	—
Brighton and Hove Company Original	100	210-215
—— "A" Ordinary	—	162-166
Brush Company, Ordinary	3	2¾-2¾
—— Nom. Cum, 6 per cent. Pref.	2	2¾-2¾
—— 4½ Debenture Stock	100	109-112
Charing Cross and Strand	5	4¼-5¼
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	12¾-13¼
—— 6 per cent. Cumulative Pref.	10	14¼-14¾
—— 5 per cent. Debenture Stock	115	129-132
City and South London Railway, Consolidated Ordinary	100	86-88
—— Debenture Stock	100	121-123
—— 5 per cent. Pref. Shares	10	12¼-12¾
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¾-2¼
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	96-100
Electric Construction, Limited	2	¼-¾
—— 6 per cent. Debentures	—	87-92
—— 7 per cent. Cumulative Pref.	2	1¼-2
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1¼-1⅝
Elmore's French Company	2	¾-1
Elmore's Wire Company	2	1-1¼
Fowler-Waring Cables	5	¼-1¼
W. T. Henley's Telegraph Works, Ordinary	10	7¾-8¼
House-to-House Company, Ordinary	5	1-1¼
—— 7 per cent. Preference	5	5¼-5¾
India Rubber and Gutta Percha Works	10	22¾-24¼
—— 4½ per cent. Debentures	100	104-106
International Okonite, Ordinary	—	—
Kensington and Knightsbridge	5	4¾-5¼
—— 6 per cent. Pref.	—	6¼-6¾
Liverpool Electric Supply, Ordinary	5	6¾-7
—— Pref.	—	—
Liverpool Overhead Railway	10	7¼-7¾
—— Pref.	10	12¾-13
—— 4 per cent. Mortgage Debentures of £100	100	111-113
London Electric	5	¼-1¼
Metropolitan Electric Supply	10	8¾-9
—— 5 per cent. Reg. Debentures, 1-10,000 in Bonds of £10, £20, and £40	—	—
National Telephone, Ordinary	5	4¾-5¼
—— 6 per cent. Cum. First Pref.	10	14-15
—— 6 per cent. Cum. Second Pref.	10	13¼-14¼
—— 5 per cent. Nom. Cum. Third Pref.	5	5¼-5¾
—— 4½ per cent. Deb. Stock	—	109-111
Notting Hill Company	10	4¼-5¼
Oriental and Electric Company, £1 shares	1	1-1¼
—— £5 Shares	—	6¾-7¼
—— £4½ shares	—	5¼-6¼
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7-7¼
—— 7 per cent. Pref.	5	8¼-8¾
Swan United	—	—
Telegraph Construction and Maintenance	12	40-42
—— 5 per cent. Bonds	100	103-105
Westminster Electric Supply, Ordinary	5	6¼-6¾
Yorkshire House-to-House	4½	4¼-4¾

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NOTES.

Telephony at Aberdeen.—Telephonic communication is now established between Aberdeen and the villages of Skene and Echt.

Personal.—Viscount Templetown, M.I.E.E., has been elected a director of the Portrush Electric Railway Company in succession to Lord Kelvin.

Rectifiers.—Mr. Sydney F. Walker is again writing to the Welsh papers on his pet subject of rectifiers, which he now describes as "a laboratory toy."

A Fine Job.—Twenty-five pounds for supplying gas of less illuminating power than it should have been. See Monday's proceedings at Bow-street.

Exhibition at Santiago.—A mining and metallurgical exhibition is to be opened this month at Santiago. The second class is devoted to electricity.

Liquid Fuel for Central Stations.—A mixture of tar and creosote is being used for firing boilers at the central station of the Bath Electric Light Company.

A Rise.—We pointed out last week that shares of electrical concerns in this country had risen. The same thing has, we learn, taken place in the shares of Austrian electrical companies.

Gas-Motor Cars.—We learn from the *Elektrotechnischer Anzeiger* that of six Lührig gas-motor cars which were put in July on the Dresden tramway, four have from various causes been withdrawn.

Indian Telegraphs.—Including the cost of free and Government messages, the Indian telegraphs for the year 1893-94 show a profit of 2½ per cent. on the capital. This is the best return yet presented.

Manchester Technical School.—The syllabus of the Municipal Technical School and Municipal School of Art in Manchester has been issued. The institution includes an electrical engineering school.

What's Wrong?—It is a matter of notoriety that the *Times* is usually most particular about the class of advertisements which it prints, but it has this week published an advertisement of an "electric belt" maker.

Electric Lighting at Oran. — The Compagnie Nationale d'Electricité, who are represented in Algiers by Mr. Vivarez, General-Councillor, are endeavouring to obtain a concession from the Mayor of Oran for the electric lighting of the town.

Telegraphy in the East.—According to the Tientsin correspondent of the *Times*, Mr. N. R. O'Connor, C.B., the British Minister, and the Viceroy have signed the convention by which the Chinese telegraphs are to be connected with those of Burma and India.

Battersea Polytechnic.—The second session of this institution will be opened for day classes on the 17th inst. and for evening classes on the 24th inst. It may be remembered that among the laboratories possessed by the institution is one for electrical science.

Oil and Gas.—The streets of Winchcombe were lighted by gas at one time, but last year the streets were lighted by oil lamps. Now the authorities are going back to gas. Some day perhaps they will discover that there is such a thing as the electric light in existence.

Institution of Mining Engineers.—Among the visits made by the Federated Institution of Mining Engineers, who have been holding their annual meeting in Newcastle, was one to Ashington Colliery, where the electric light is employed in various departments.

Gas or Electricity.—The Hoylake Local Board have decided to advertise for a scheme and estimates for lighting the streets by electricity, but is intended to make arrangements for lighting them by gas during the ensuing winter. By the winter of 1895 there should be another story.

The Mercers' Companies Schools.—These new schools, which have been erected on the site of Barnard's-inn, in the angle between Holborn-bars and Fetter-lane, and which were opened on Tuesday, are lighted throughout by electricity, and there are no gas-mains in the building.

Telegraphy in Borneo.—The British North Borneo Company has received the following telegram in connection with the telegraph line which is being constructed across the country: "Total track cut about 90 miles. Gangs engaged in exploring for mountain route and cutting posts."

Electric Traction in France.—Among the various schemes for the introduction of electric traction in France may be mentioned that at Angoulême, where a tramway system is intended to be established. Powers have been given to Messrs. Grammont, Bellantant, and Faye for the construction of an electric tramway at Dijon.

King's College, London.—A course in architecture, building construction, and modern practice, under Prof. Banister Fletcher, F.R.I.B.A., for the session 1894-95, will be commenced at this college in the first week of October. The demonstrator is Mr. James Bartlett, and the studio instructor Mr. Banister F. Fletcher, A.R.I.B.A.

Telephonic Precision.—With reference to the statement by Mr. W. H. Preece to the effect that the telephone as an instrument of precision is scarcely sufficiently appreciated, a skit appears in *Judy* this week in which the conclusion is arrived at that the hansom cab is more to be appreciated as an instrument of precision than the telephone.

Exhibition at Sunderland.—Prospectuses and plans of the forthcoming exhibition to be opened at Sunderland in November for two months, have been issued. The exhibition will be one of marine and electrical engineering. A special building is being erected for machinery in motion. The whole of the buildings inside and out will be fitted with electric light.

Telephony in Germany.—The postal authorities have arranged for the establishment of telephonic communication between Armstadt and Erfurt and between Jena and Weimar. A long-distance telephone system is to be made between Stolp-Stolpmünde and Stettin. Berlin and Greifswald have been connected by telephone. Improvements are to be carried out in the telephone system of Munich.

Refuse Destructors for Electric Lighting.—Dr. Arthur, of London, attended a meeting of the Cardiff Health and Port Sanitary Committee and laid before them a refuse destructor scheme. He stated that taking the refuse, and removing the larger stuff, the balance "was converted into pure carbon, which could be utilised for electric lighting. . . . There would be enough carbon manufactured to light the town with electricity." The committee are going to consider the matter.

Epping Forest Railway.—One of the most interesting of the new railways authorised during last session is the Walthamstow and Epping Forest line. Starting from South-place, Finsbury, it will run underground through St. Luke's, Hoxton, Shoreditch, Kingsland, Hackney, and Upper Clapton. All this underground portion will be constructed on the Greathead shield principle. It then runs right away to High Beech *vid* Walthamstow and Chingford,

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skirting the Epping Forest. It is the only line that is authorised to use either steam or electricity.

Electrically-Lighted Carriage.—According to a daily paper, a new carriage built for the German Emperor is provided with electric lamps, fed by small accumulators. One is placed on the breast of each horse, also on the point of the pole of the carriage, at the sides, and at the rear of the vehicle. Thus distributed, they will make the route at night as light as at noonday for a distance of about 50 paces from the equipage, while the vehicle itself, with its Imperial occupants, will remain in perfect darkness. At the same time the horses' eyes will not be in any way injured by the glare from the lamps.

Electric Traction at Coventry.—The hitch respecting the construction of the proposed electric tramways seems likely to be overcome, the Board of Trade, as the result of an inspection by Major-General Hutchinson, agreeing to the diversion of the line on the Warwick-road and its being placed along the side instead of the centre, provided a clear space of not less than 2ft. wide be left between the side of the car nearest the Grey Friars-green railings and those railings or any projection of them. It is proposed to proceed with the work as an unauthorised undertaking; parliamentary powers to be obtained in the next session in an omnibus Bill of the Board of Trade.

Electricity in Italy.—If the French journal *Sciences et Commerce* is to be credited, the electrical industry in Italy is in rather a bad way. At Verona, it appears, the electric supply company has lost an action brought against the gas company, and has gone into liquidation. The electric lighting company of Reggio d'Emilia has become bankrupt. At Lodi an accumulator company which undertook lighting has gone into liquidation. At Venice the Société Lyonnaise d'Eclairage au Gaz has taken action against the Municipality to withdraw the concession granted to Messrs. Walter, Mendel, and Co. for private electric lighting as infringing their monopoly, which they hold till 1927. Truly, a chapter of misfortunes.

Electrolysis.—Mr. O. Wiedeburg, in the *Zeit. Physikal. Chem.*, considers the question whether a certain maximum E.M.F. is required before electrolysis can be effected. The author believes that with any E.M.F., A, there corresponds a certain pressure, p, of the gaseous product according to the equation $A_1 - A_2 = c \log \frac{p_1}{p_2}$, and hence is of opinion that by any E.M.F., however small, electrolysis is set up. The ratio of current to E.M.F. is given by a curve consisting of two straight lines connected by a short curve, approximately a hyperbola. Where the curve is very short, an apparent break occurs, the position corresponding with the maximum of polarisation.

New Lightning Conductor.—Dr. Elliott, professor of engineering at the University College of South Wales and Monmouthshire, in providing for the protection of the chimney stack attached to the new engineering laboratory that is being built for the college by Messrs. Lattey and Co., has arranged for a coronet of galvanised iron points to surmount the chimney, resting on the ornamental swell of the coping-stone, from which two stout galvanised iron ropes, securely fastened to the body of the chimney with stout galvanised iron staples, are led to separate substantial earth-plates embedded in moist ground in the neighbourhood. The conductors have been made and erected to Prof. Elliott's designs by Messrs. Sydney F. Walker and Co., of Cardiff.

Objections to the Overhead Trolley System.—The Municipality of Dantsic have been discussing the *pros* and *cons.* of the overhead trolley system for electric cars. According to the opponents of the system, the overhead wires conveyed the idea of a hop field, the contact rollers made the noise of a swarm of bees, and the movement of the cars was like the rolling of a ship at sea. After this the *Elektrotechnischer Anzeiger* of Berlin suggests that cars should be provided with remedies for sea sickness, or that each car should have a doctor attached. Notwithstanding these remarkable assertions, the Municipality have decided to turn the horse tramways into electric tramways. The work will be given to the Allgemeine Elektricitäts-Gesellschaft, of Berlin.

Sanitary Congress, Liverpool.—A conference of Municipal and County Engineers will be held in connection with the Sanitary Congress at Liverpool on Tuesday, September 25, at 10 30 a.m. The conference will be under the presidency of Mr. A. M. Fowler, M.I.C.E., and the following papers will be read: "A Description of Some Recent Improvements in Destructors," Mr. John A. Brodie; "Disposal of Town and other Refuse by Burning," Mr. James Deas; and "The Acme Refuse Destructor," Mr. H. Royle, A.M.I.C.E. Visits will be made to the Liverpool destructor works, to the Hydraulic Power Company's station, Athol-street, to the Toxteth Park destructor works (in course of construction), and to the Liverpool Electric Supply Company's central station in Lark-lane.

Glasgow and West of Scotland Technical College.—A copy of the calendar of this Glasgow college, to which we referred in our issue of the 31st ult., has reached us for the 1894-95 session, which commences on October 1. There are both day and evening classes. In the former the departments in which regular courses have been organised are civil engineering, mechanical engineering, naval architecture, electrical engineering, architecture, chemical engineering, metallurgy, mining engineering, agriculture, mathematics and physics, and chemistry. In the evening classes the courses are in mathematics and physics, chemistry, mechanical engineering, naval architecture, electrical engineering, architecture, building construction, mining, metallurgy, agriculture, chemical industries, textile industries, art industries, and commerce. The secretary to the college is Mr. John Young, B.Sc., from whom further information may be obtained.

Another Electric Launch.—On Monday afternoon a trip was made on the Thames upon the "Velvoca," an electric launch belonging to the Battery and Motor Company, St. Margaret's Offices, 53, Victoria-street, S.W. She is 35ft. long, 6ft. 6in. beam, and 1ft. 4in. draught, and ran from Petersham Island to Teddington Lock, and thence to the new Richmond Lock and back. The batteries weigh 14cwt., and are placed in the centre of the boat, having a cover which can be used as a seat. There were used 48 cells of the company's velvo-carbon primary batteries, each capable of an output of 60 amperes for 10 hours. The velvo-carbon is a special class of negative electrode for electric batteries, consisting of ordinary carbon with a surface of carbonised cotton velvet. The batteries employing these carbons may be used with a weak solution of sulphuric acid only as a excitant. The patent incorrodible connections are made of pure silver or platinum.

Railway Carriage-Lighting in Germany.—The charging station for the electrically-lighted railway sorting tenders at the Schlesischer Railway Station, Berlin, is now in full operation. The new charging station is placed in part of the basement of the old railway station hall and consists of two rooms—one for the machinery and the other for the accumulators. There are two gas motors, furnished by Krupp, of 20 h.p. and 8 h.p. respectively, with two dynamos of corresponding size. The larger plant

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is intended for ordinary working, and the smaller as a reserve. The accumulator-room is arranged so that 864 cells can be charged simultaneously. They take about 15 hours for charging. Altogether there have been fitted 445 railway sorting tenders, the work having been carried out by Messrs. W. A. Böse and Co., of Berlin. The electric light has proved to be 10s. per 24 hours per car cheaper than lighting by gas. Similar charging stations have been erected at Hamburg and Eisenach.

G. A. S.—Although the initials of the name of Mr. George Augustus Sala spell gas, he is evidently a reader of the *Electrical Engineer*. In a note in our issue of 31st ult., on the death of the Earl of Albemarle, we said that he "took a great interest in the applications of electricity, and was chairman of the late General Electric Power and Traction Company, Limited. It will be remembered that in 1890, when Lord Bury, he wrote to the *Times* a letter asking for suggestions for a verb to express progression by electric power, which called forth a large number of answers. 'To motor,' was the verb which was selected as the most suitable, but neither that nor any other of the words proposed seem to have been adopted." Now Mr. Sala writes that "when the deceased nobleman was Lord Bury, he wrote to the *Times* asking for suggestions for a verb to express progression by electric power. Many suggestions were made, and 'to motor' was the verb which was selected as the most suitable, but neither that nor any other of the words proposed seem to have passed into general use."

Electric Lighting in the City.—A correspondent, signing himself "Fiat Lux," writes to the *City Press* as follows: "It is now, I suppose, two years, more or less, since the electric light was installed in the streets of the City. Up to the present, however, the authorities have failed to extend the system to Old Jewry, which, moreover, is practically deprived of all gas lamps. At this moment, when Princes-street is up for repairs and much of the traffic is diverted through this street, locomotion becomes positively dangerous after nightfall, the Cimmerian gloom being almost unrelieved by any illuminant. Ladies of my acquaintance have objected to pass through this street at night, although the headquarters of the City police are there situated, and a vigilant officer is always on duty at the portal. It may be that the persons responsible for this state of things desire that Old Jewry should be, as far as possible, in keeping with its quaint mediæval name, and retain the aspect which it presented in the Dark Ages. But now that the surrounding Gentiles have been lightened, it is surely high time that we dwellers in Jewry should be relieved from our present benighted condition."

National Association of Colliery Managers.—The annual meeting of this society has been held this year in the Forest of Dean. Mr. F. W. T. Brain, general manager of the Trafalgar Collieries, who was elected president, in the course of his inaugural address, said that he was satisfied electricity would be largely applied for mining work in the near future. With three electric pumps working underground, the first one running since 1882, which he believed was the first known application of electricity to mining work, he could speak with confidence as to its utility. So satisfied were his company as to the advantages afforded by electricity that they were now putting down an extensive system of underground main and tail rope haulage of about 150 h.p. at a cost of several thousand pounds. Electricity applied to pumping, hauling, and coal-cutting was now in constant work in several parts of the country. With the improvements now being introduced its use would become much more general. As it was, scarcely a week passed without one seeing particulars of some new electric plant in connection with mining, and the progress shown was very notable. Electricity had passed from the experimental to the practical working stage in a short time, and against considerable odds. He regarded its future as assured and full of hope. The plant was subsequently visited, as were the works of the Electric Blasting Apparatus Company.

The Electro-Harmonic Society.—The next smoking concert of this society will take place on Friday, September 28, 1894, at the St. James's Hall Restaurant (Banquet-room), Regent-street, W., commencing at eight o'clock. The following is the programme. Artistes: The Westminster Singers, Mr. Walter Coward, Mr. Charles Ackerman, Mr. Harper Kearton, Mr. W. H. Brereton violoncello, Mr. Leo Taussig; solo pianist, Mr. Alfred E. Izard; humorous songs, Mr. James Kift; musical directors, Messrs. T. E. Gatehouse and Alfred E. Izard. Programme—Part I.: glee, "Discord, Dire Sister" (Webbe), the Westminster Singers; songs (*a*) "O, Mistress Mine," (*b*) "O, my Love's like the Red Red Rose" (traditional sixteenth century), Mr. Harper Kearton; pianoforte solo, "Ballade in G Minor" (Chopin), Mr. Alfred E. Izard; "Droop not, Young Lover" (Handel), Mr. W. H. Brereton; plantation melody, "Yo, Yah, Yo" (air by H. Kearton), the Westminster Singers, solo by Mr. C. Ackerman; violoncello solo, Mr. Leo Taussig; song, "The Sons of Mars" (Trotère), Mr. Charles Ackerman; humorous song, Mr. James Kift. Part II.: part song, "The Vacant Chair" (Root), the Westminster Singers; song, "My Pretty Jane" (Bishop), Mr. Harper Kearton; song, "Lazily, Drowsily" (I. Caryll), Mr. Walter Coward; violoncello solo, Mr. Leo Taussig; serenade, "German Polka" (Schæffer), the Westminster Singers; song, "Oh, Hear the Wild Winds Blow" (Mattei), Mr. W. H. Brereton; humorous song, Mr. James Kift.

Electric Lighting in Germany.—A scheme for the introduction of the electric light at Linden, Hanover, is projected. A commencement has been made in introducing the electric light into Biberach, where Mr. Georg Straub and Mr. Julius Mühlschlegel, millowners in a suburb, have carried out installations in their works. A petition is to be presented to the Senate for a reduction in the price for current in Hamburg. Good progress is being made with the laying of conductors in Hanover. The Limburger Elektricitätswerk intends to erect a central electric light station in Diez. After a lengthy and heated discussion the Municipality of Friederichroda have rejected the proposal to establish a central electric light station. The railway station and sidings at Kaiserslautern have been lighted electrically, and it is hoped that this fact will prove an incentive to other towns in the neighbourhood to go in for electricity. A central station is almost ready for the commencement of operations at Eibau. It is one of the largest in Germany, and the fourth in size in Saxony, where it is only exceeded by Dresden, Chemnitz, and Zwickau. It has been erected on their own account by the electrical firm of Messrs. Nitzschmann and Zschockelt, of Eibau. Two systems are employed. In Eibau and Walddorf continuous current on the three-wire system is employed, while for outlying districts to the distance of four miles rotary current will be used, and there will eventually be accumulator sub-stations. There are two large dynamos, one for continuous and one for rotary current, driven by compound engines made by the Görlitz Engineering Company. There is also a battery of accumulators comprising 136 cells. In Eibau there have been connected about 2,000 incandescent lamps, 10 arc lamps, and five electric motors. The firm have also established an independent station in Oberoderwitz in the

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neighbourhood, which is used for transmission of power in the Hamann mill.

A Cool Million.—We thought that the palm for electrical fiction had been awarded to this journal on account of the wonderful adventures which befell Garnesdon some time ago (see the *Electrical Engineer* under date of May 11, 1894, and August 31, 1894), but pending the advent of Edison-and-collaborateur's novel, we feel obliged to confess that the New York *World* of August 26 last comes out easily ahead of ourselves and everybody else. This enterprising newspaper has a great genius who composes headlines, a greater one who writes column after column of elegant, high-sounding language, and the greatest of all in the person of Miss Meg Merrilies—a young and attractive lady with an ambition to rival Tesla and experience a million-volt current (number, or rather fraction, of milliamperes not stated, nor yet the periodicity, within 100,000 per second—but what do newspapers know of these things any way?). She did *it*, too, whatever the experience may be to take volts without amperes at any sort of frequency, and being a girl of scientific turn of mind, went and weighed herself on a slot machine before taking and after taking the dose. Weight—111lb.—remained the same, and the only ill effects, according to the young lady, which might have resulted were just that the "electricity would have stayed in her clothes for a time if the atmosphere had not been so humid." We wonder how many (or let us say, for the sake of credulous humanity, how few) of the ordinary public who read this elaborate effusion will take it at its proper value! As a first-rate "write-up" of Tesla's experiments, based on the plan of saying a thousand words where three single ones would do, and giving absolutely no information of any use to anybody, the *World's* startler is pre-eminently calculated to fulfil its main object—viz., to gull the public and extract some additional cents from the pockets of those who have no knowledge of electricity or its real marvels—greater than any Miss Meg Merrilies could write about.

Electric Traction in Germany.—The Hildesheim Municipality have laid down the conditions under which an electric tramway will be allowed. These have been accepted by the promoters. A project has been formulated for the construction of an electric tramway from Pössneck *viâ* Krölpa, Ranis, and Ziegenrück to Schleiz. Plans have been laid before the authorities by Mr. Müller and Mr. Krüssing. The power station will be erected in Pössneck, the water power of the River Saale being utilised, steam-engines serving as a reserve. The estimated cost of the undertaking is £75,000. Another elevated electrical railway is proposed for Berlin. The Königsberg Municipality intend themselves to construct and operate the electric tramway between Pillau railway station and Augustastrasse, to which we referred in our issue of 17th ult. The line of electric tramway between Mulhouse and Dornach, which has been carried out by Messrs. Siemens and Halske from plans by Mr. Nordmann, has now been opened for traffic. Authority has been given for the construction of an electric line between Gross-Lichterfelde, Steglitz, and Südende, which will be carried out on the Siemens and Halske system. This is the first line of the kind in the neighbourhood of Berlin through a district of a distinctly urban character. Mr. Engel has projected a line of railway at Friedland, but it has not yet been decided whether steam or electric traction will be adopted. The traffic on the electric rack railway at Barmen, which was opened in April last, is proving very satisfactory. The Municipality of Oberhausen have decided to have plans drawn up for an electric tramway between that place and Mülheim-on-the-Rühr. The Street Tramway Company of Hamburg, which has now three electric lines, has found the introduction of the system very advantageous, for in seven months their receipts have gone up by £4,042. In consequence of this, the Hamburg-Altona Horse Tramway Company are desirous of obtaining powers for an overhead trolley system on their lines. The Street Tramway Company also want to apply electric traction to further of their lines.

Terrible Indeed!—Mr. Waterhouse, R.A., in his capacity as president of the National Society for Checking the Abuses of Public Advertising, has rushed into print to protest against the use of search-light advertising. Some time ago we gave in our columns an account of what was being done by Mr. Ronald Scott in this direction when he gave a demonstration in Trafalgar-square, but Mr. Waterhouse evidently did not read the issue in question, for he has taken a long time to find out what he calls "Desecrating Nelson's Monument." He starts off with his lucubration by saying: "Perverted energy and ingenuity have been exercised in the construction of an electric lantern (*sic*), which flashes the names of articles, which the makers presumably desire to sell, on the public monuments in and around Trafalgar-square, 'the finest site in Europe.' . . . The nightly exhibition has caused great annoyance . . . depriving an indefinite number of fellow-citizens of comfort and pleasure by practising on their eyes in this way. . . . The lantern (*sic*) in Trafalgar-square is a beacon light to warn Englishmen of the results of the absence of regulation in the matter of advertising." Mr. Waterhouse, it will be seen, shifts his standpoint. First of all, he takes up the subject of desecrating Nelson's monument by advertising. He has never protested against the advertising of themselves by demagogues under the monument, which was surely worse than a harmless use of the electric light. Then he departs from that point and states that the light hurts people's eyesight, which is a statement that lacks verification—and here it may be mentioned that this Mr. Waterhouse is not the Mr. Waterhouse who invented the electricity meter which we described last June. Trafalgar-square undoubtedly has been described as the handsomest *site* in Europe, but that people go there for "comfort and pleasure" at night is a debatable point. We believe tramps go to sleep on the seats. The site is all right, but there is no beauty in the buildings. Moreover, Mr. Waterhouse, as an R.A., should know that the Nelson column should architecturally not exist at all. A column is really a portion of a building, and should support an architrave. The Nelson column supports a statue to which the griffin at Temple Bar is a thing of beauty. We may next expect a protest against the electric lights in front of the Royal Exchange which light up the statue of Wellington. Mr. Waterhouse says that there is no regulation of advertising. He is not a member of the London County Council, and evidently does not know that regulations exist with regard to sky-signs. Among the abuses of advertising which he has omitted to mention is that of writing signed letters to the daily Press with a view to making known to the public the existence of certain bodies without paying for the publicity. The people who want to study the "beauties" of Trafalgar-square go there in the daytime, when there are no electrically-flashed advertisements. They do not go there at night to view the architecture, and hence there can be no desecration of the structures.

Automatic Control of Current Intensity.—In the course of an article on this subject published in *L'Electricien* of the 1st inst., M. Leroy points out that in all cases where the electric current is used it is absolutely necessary to previously determine certain limits within which the value of the current must be constant. The minimum limit is often

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of no importance, and in practice the only case where account is taken of this is in the charging of accumulators. The weakening of the current in this case is frequently the commencement of a reversal, and the use of automatic disconnecting switches has come into practice. It happens at times, owing to the irregularities in the working of the moter driving the dynamo, that the reversals referred to are frequent, and would be only of short duration if the circuit was not broken by the automatic disconnecting switch. Combination switches are employed, which open or close the circuit according as the generating dynamo develops a lower or higher E.M.F. than that of the battery. Apparatus of the same kind, M. Leroy says, could be used in an analogous case in sub-transformer stations, the employment of which has a tendency to become general in alternating-current distribution; automatic apparatus withdraw or switch in transformers according to the fluctuations of the discharge in such a manner as to cause these secondary generators to work at the highest efficiency. In the majority of cases the intensity of the current may fall to a value represented by nil without any inconvenience resulting, but the maximum limit allowable is important. The use of metallic cut-outs more or less fusible answers roughly to this condition of maximum intensity. The author goes on to say that from all points of view it is absolutely essential that the central-station engineer should be able to effectively control the maximum intensity of current that a consumer can ask for at any moment. Lead-wire cut-outs, he contends, are quite incapable of taking this part, because they are capricious and hardly safe; magnetic cut-outs, which are superior to them in regard to precision and safety, would not be much better, because they are "brutal" in their effect, and when placed in a locked box they open on the least increase of current above the maximum without being able to be closed until the arrival of the central-station representative. What is required, M. Leroy submits, is an apparatus which would cut off the current when it exceeds a certain value, but would re-establish it as soon as the resistance of the network controlled has again become such that once the circuit is closed, the intensity will not exceed the maximum value. The problem is difficult of solution, but it can be solved. There are, the author continues, two appliances the object of which is to fulfil the purpose indicated, but a third, superior to the others, he will shortly describe. In many towns in France the charge made for light is at a fixed rate per lamp installed; the customer pays the same amount, no matter what number of lamps he has alight. As a consequence of this, disputes arise, and finally the use of a meter, which is expensive, is decided upon, this often neither giving satisfaction to the consumer nor to the owner of the generating station. If, for instance, the author states, a consumer can induce the manager of the generating station to instal 20 lamps on his premises and to only charge for 10 lamps—which number, simultaneously alight, is not to be exceeded—the number of consumers supplied at the fixed contract rate per lamp would be numerous. By the use of the maximum automatic controller the guarantee of consumption is real, and the consumer can be supplied with as many lamps as he requires, whatever may be the number for which he will pay the amount agreed upon. An apparatus of this kind would, the author concludes, be taken up by all central-station owners.

A Gas Chairman on the Electric Light. — On Tuesday the half-yearly meeting of the Sheffield United Gas Company was held, at which Sir Frederick Mappin, M.P., who presided, said that the Incandescent Gaslight Company had put a weapon in the hands of gas companies which would enable them to compete in a satisfactory manner with the electric light, for they could supply as good an illuminant as the electric light at a cheaper cost. In his opinion the Welsbach burner rendered the supersession of gas by electric light extremely improbable. He thought that they had no reason to fear the opposition of the electric light experience, for they had had it with them for many years. In his opinion the electric light did not appreciably affect the increase in the consumption of gas in those towns where the public were fairly well satisfied with the gas supply. Passing the new Board school in Bow-street the other day he saw that the electric light company were fixing their apparatus to light the schools. He went inside, and found that it was not only proposed to instruct the children with this expensive light, but that the light was also being placed in the basement where the warming apparatus and other things of that description existed. It struck him that this was not the way in which the ratepayers' money should be spent. This philanthropy is amusing. The gas company presided over by Sir Frederick Mappin has made in the half-year a profit of over £54,000 at the expense of the ratepayers. As regards the wonderful effects claimed for the incandescent gas burner, Sir Frederick would do well to read the note in our last issue headed "German Electrical Trade." Mr. William Johnson, the manager and secretary of the Sheffield Electric Light and Power Company, Limited, has, however, not allowed Sir Frederick Mappin's speech to go unnoticed. He writes: "The effect of the periodical attacks on the electric light by the chairman of the Sheffield Gas Company is to focus more attention on the electric light, and his frequent protestations that the directors are not afraid of the electric light would give the utmost encouragement to electric light companies to proceed with their work, if such encouragement did not otherwise, and for substantial reasons, exist. Electric light companies have no desire to injure gas companies; indeed, the gas companies should be thankful to the electric light companies for having shown them the way to the improvement of their lamps and burners. The extended use of electric lighting should not injure the dividends of gas companies, because there is sufficient use for gas for heating, for cooking, and for power, and where the injurious effects of combustion will not be felt. Gas-engines are already largely used for running small dynamos for electric lighting, and it is an open question whether large gas-engines may not ultimately be introduced into central electric lighting stations as prime motors. . . . The real operations of the Sheffield Electric Light Company began when it received its charter, olny two years ago. At the end of last month there was an increase of electric lamps in use, and about to be put in use, of 108 per cent. since the end of August last year, and experience has shown that if it were not for the initial cost that each consumer must bear before the current can be laid on, the electric light would be taken up in Sheffield more rapidly still. In spite of this difficulty, the extension of the light is extremely satisfactory, and if any fair-minded observer will begin at the post office at the top of Commercial-street, and walk through the main thoroughfares, he cannot but be impressed with the large amount of electric lighting that is increasingly visible. Now, the whole of these consumers must have some reason for the adoption of the electric light. Either the light is no dearer than gas, or it is fulfilling some purpose that cannot be supplied by gas. The gas interests may accept which alternative they like, because it is sufficient for my present object to say that Sheffield people are not in the habit of paying for that which is naught."

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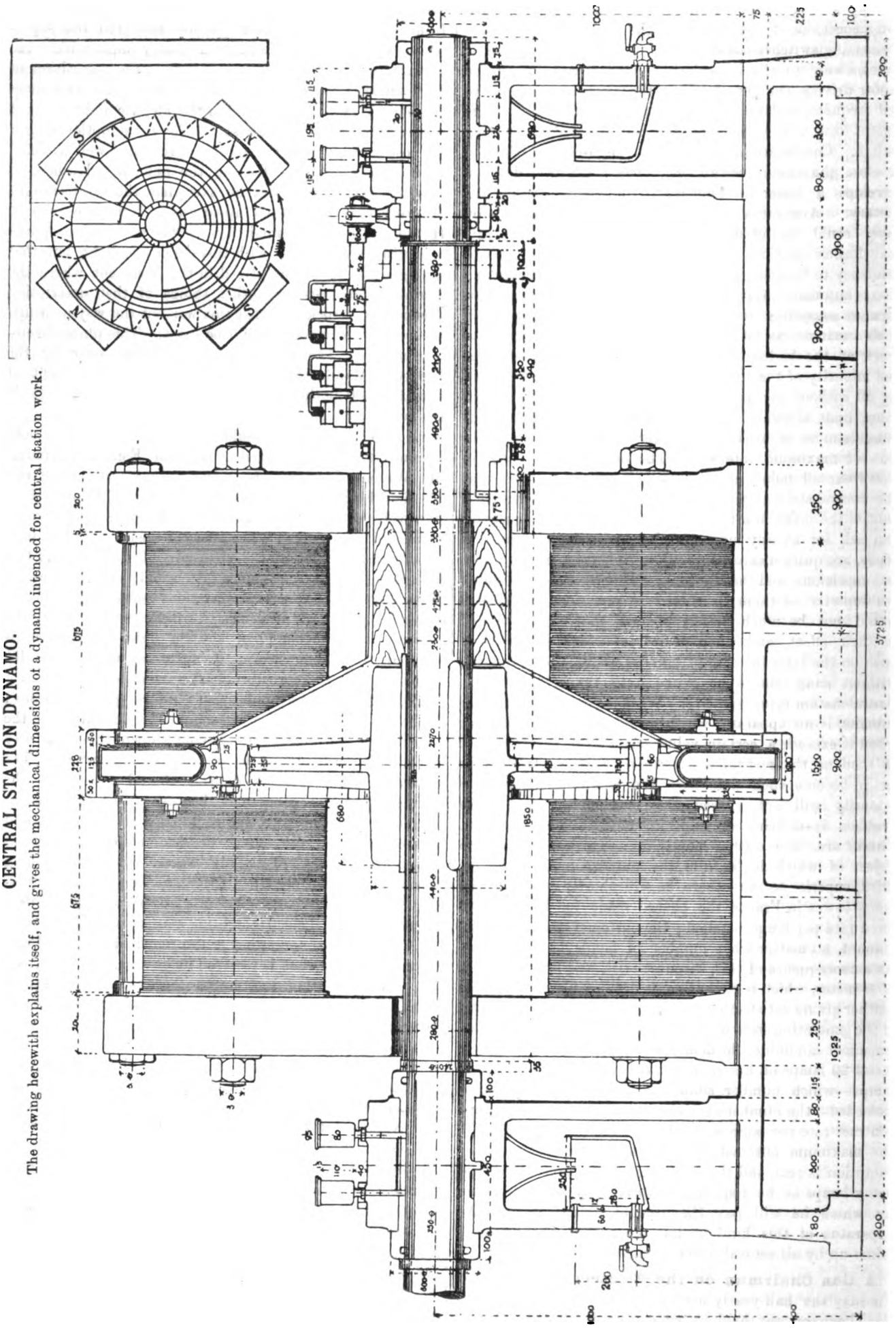
CENTRAL STATION DYNAMO.

The drawing herewith explains itself, and gives the mechanical dimensions of a dynamo intended for central station work.



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MECHANICAL TRACTION FOR TRAMWAYS.

There is little need at this present time to particularise or even discuss the overwhelming importance of better traction methods for use on our tramways than the customary horses or mules: everyone concerned has for a long time realised the wasteful and inconvenient qualities of animal traction, in view of the rapid increase of our requirements in transportation matters; and the only questions now dealt with are such as relate to the most suitable system of mechanical traction to adopt for any particular district or line.

We have yet to chronicle the advent of a comprehensive treatise or book in this country which will take up the whole question of tramway working, and describe in detail the various improvements possible or practicable; but meanwhile there is continually being issued a series of valuable contributions from experts and engineers who each give the results and knowledge that they have gained in transport matters. Amongst these must be included an elaborate paper written by Mons. E. de Marchena and brought before the Société des Ingénieurs Civils of France. As a complete treatise upon mechanical traction, it is thoroughly valuable, including a detailed theoretical account of cable working, electric traction upon all the usual systems, compressed air, steam, ammonia vapour, and gas motors, etc., with a comparative discussion of such points as safety, comfort, economy, working efficiency, etc.

Within the limits and aims of our pages we cannot, of course, attempt to abstract or criticise a tithe of the contents of this paper, and we therefore give an outline only of the matters discussed generally, following this with the substance of Mons. Marchena's remarks concerning electric traction, whether using overhead wires, third rail, a conduit, or accumulators.

In his introduction, the author first examines into the question of the circumstances under which mechanical traction is advisable for tramway purposes, and the main point concerned is the character of the line—whether already worked, or yet to be built. In the former case there are obviously many expenses and a considerable outlay which do not follow on the erection of a new line, and which must be recouped from surplus profits before any benefit from the conversion is obtained. The horses need to be sold—and nearly always at a loss—the depôts altered, stables converted, stores and other buildings replaced or changed very considerably; more often than not it also becomes essential to rebuild the permanent way, since a line which serves for horse-cars will, as a rule, be quite insufficient for the heavier traffic and rolling-stock usually entailed by mechanical systems; and though the importance of economy in first cost may sometimes lead to the patching up of old lines, yet the extra expenses of repairs and renewals will very soon make up for any saving thus effected.

The great outlay required in any case for converting a line has, perhaps, too often proved sufficient to deter tramway companies from due consideration of the matter, except in instances where the advantages accruing from the use of mechanical methods have been obvious at once. Even then an extension of the lease or other powers under which the line is worked ought to be secured, in order to repay the additional charges to capital account.

When, on the other hand, a new line is to be built, great economies are effected by designing beforehand and at leisure the entire road, buildings, and equipment specially for the system to be adopted; and the only comparisons then lie between capital outlays, costs of working, etc.—comparisons which nearly always tell in favour at once of mechanical traction. The question of public favour is naturally an all-important one, since the revenue of the line depends upon it almost entirely; and, speaking generally, mechanical systems are much preferred by those who patronise tramways, because they not only give greater speeds and regularity of service, but may also be employed on heavier grades—just where lifting power is required by wayfarers.

There are also such matters to be considered as the cost of labour, price of fuel, of horses and fodder, etc. These will naturally vary in different places, and may exercise, accordingly, an important influence upon the most suitable type of traction method to adopt. As an instance, we are reminded of the lines in Brazil, Mexico, and the Argentine, where mechanical traction would be excessively dear on account of costly fuel and labour. Horses and mules, on the other hand, are in these places extremely cheap. Native unskilled labour may be hired at a very low rate, and fodder is obtainable for almost nothing. Under such circumstances, animal traction has held its own, and will probably continue to do so until the conditions change. Coming nearer home, however, it may be said practically that for any such continent as Europe—thickly populated, and therefore requiring incessant rapid intercommunication—the low cost of fuel, and the reasonable wages of skilled labour, will ensure the tolerably universal employment of mechanical traction systems.

The final considerations to take up are the conditions of traffic and the service involved. On unimportant lines with but little traffic and no severe grades, the possibilities of mechanical systems do not compare favourably with results achieved by small one-horse cars running at long intervals. When, on the other hand, there are crowded lines to operate on heavy grades with traffic varying between wide limits, the only suitable system to adopt is one of those based on mechanical motive power, which will be able to provide a quick-running and frequent service of cars at small expense. With the best care and attention the actual mortality of tramway horses must be at least from 3 to 4 per cent. per annum; and there is, besides this permanent loss, a temporary waste of power in the shape of 8 or 10 per cent. of the horses on the sick list. The frequent starts and stops required in tramway service cause rapid depreciation in horseflesh, and renewals to the live stock thereby increase the expenses of operation very heavily. Moreover, the limit to dead-weight of car is rather low with horse traction, and this implies less comfortable accommodation for passengers.

Mechanical traction systems overcome all these difficulties: the tractive effort need no longer be limited—on the contrary, heavy loads and severe grades may be encountered with much greater ease, whilst the elasticity of the service may be considered more than double that of a horse line. The average speed is increased, and more work can thus be got out of rolling-stock and staff, with greater satisfaction also to the travelling public, showing itself by increased traffic and higher receipts. It is usually found that the cost per car mile decreases when the traffic and receipts per car mile are correspondingly greater.

The next point which merits discussion—assuming that mechanical motors are decided upon—is the question as to whether single cars of self-moving type should be used or locomotives drawing a small train of several vehicles. It must, of course, be remembered that though the conditions of working tramway lines under Board of Trade regulations in this country are very different from those prevalent in Belgium, France, and Germany, where light railways are abundant and prosperous, yet it is extremely likely that more latitude will in the future be allowed to lines of such character which may be developed in this country, and hence the question is not to be lightly shelved because it assume different conditions to those now enforced.

A decision thereon must, of course, depend upon such points as the importance and volume of the traffic, the frequency of service, and the size or degree of congestion of the streets, etc., through which the line may pass. When, moreover, the average journey is of considerable length the passengers will usually wait some time for a car, knowing that its speed *en route* will make up for the delay; but when the line is a short one, and the average distance travelled but little, a frequent service becomes more desirable, single cars being run at short intervals rather than two or three at longer periods, coupled together in a train. Suburban lines running into crowded cities and towns are best worked by a frequent service of single cars, whilst "local" railways or tram lines joining adjacent towns and suburbs, etc., offer instances where satisfactory use of locomotives may be made. The cost of working is then considerably less per car mile, since one driver and conductor may serve for several vehicles, an important saving in cost of labour being thus effected.

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Moreover, when repairs are necessary to a locomotive or trail-car, only the one or the other is taken off the road, whereas the self-moving car may require attention and its services are lost for the time being. Then the passengers are separated from the motive-power arrangements in the former case—a much better plan on the score of safety and personal convenience. It would, therefore, appear that much can be said for the use of "trains" of tramcars under certain special conditions, and their extended employment is to be strongly advocated when Government restrictions are removed or ameliorated.

After discussing the points thus dealt with, the author sets forth the requirements that help authorities to decide upon the most suitable system to adopt. First comes the question whether the particular method proposed will give the service required with regularity, safety, and continuity. Then follows its safety as regards the passengers as well as those who use the public highways in any manner: the inhabitants along the route followed may also raise objections to any system for this reason or that; but finally, there is the all-important question of working cost and ultimate economy.

For the most part, all mechanical systems possess nearly the same degree of favour in the eyes of the public, so that practically, for the same conditions of service, the economic results will depend on the cost of traction. This is best calculated out at per car mile, though, when all is said and done, a true comparison is extremely difficult to obtain, because the conditions in the different cases vary so enormously. In all such comparisons, moreover, the amortisation of capital outlay upon fixed plant and machinery, rolling-stock, etc., must not be overlooked, and its effect may make some considerable difference in the net financial results of the lines compared.

Starting from this standpoint, the author proceeds to classify mechanical tramway traction systems into two chief kinds, the first of which comprises all those methods wherein the operative energy is produced in a central station and distributed to motors upon the cars without storage in any way; the second includes the self-contained or "automobile" cars, carrying with them a supply of energy material sufficient for a given period of working. These we shall now examine in detail, so far as they are concerned with electrical working.

(To be continued.)

COMPARATIVE EFFICIENCY OF ELECTRIC AND CABLE TRAMWAYS.

BY FRANK B. LEA.

It seems a pity that the least animus or undue preference should be shown by the partisans of either side in advocating the choice of an electric overhead conductor or a wire-rope system for any tramway line irrespective of the special conditions that rule in each case. There is more than room for both. An ample field exists for their respective employment under varying circumstances—a field hardly touched as yet—and it is entirely too soon in the day for anyone to feel jealous. Yet there has been on the part of some an effort (let us hope an unwitting one) to praise the cable at the expense of electricity, and it may be feared that the reverse would also be seen if we had sufficient instances of electric roads to create more attention to their merits and demerits.

The writer's present aim is to show that on points of efficiency and economical working there is not very much to choose between the two systems, and that the only sensible course to adopt is to confine each method to such places and lines as shall be from their nature specially adapted to their respective use.

So far as this country is concerned, we have sadly too few cable roads to enable a definite conclusion to be drawn with respect to their efficiency; and the same want is, of course, apparent also in electric roads. Each year, however, will see an increase, and very soon we may hope to get some really trustworthy figures from which to compare different services. At present, we are obliged to take such "facts" as can be obtained, giving them bare credence until further supported by lengthened experience.

It seems a pity, in this connection, that little or nothing can be learnt with respect to one of the best cable roads—viz., that on Brixton-hill. Whether it be that the trouble of separating out the costs and the calculation of horse-power wasted is too great for consideration, or whether it be not desired for financial reasons to disclose information, cannot, of course, be said; but if cable roads are to multiply, we ought to know the exact results obtained on those already built. Electric roads have a by no means inconsiderable advantage in this respect, inasmuch as the waste of power on the line may be ascertained without much trouble and with great exactness.

Comparing the two systems, the chief losses occur, of course, between the stationary engine shaft and the car axles, and it is quite fair to balance on one side the frictional resistance of engine and toothed gear usually employed in cable work against the engine and dynamo generators of the electric road. If anything, the comparison is in favour of the former, since the efficiency of any type of gear is much less than the 95 per cent. obtainable from any well-made electric dynamo generator. The difference between this and the total waste represents the loss outside the station, being in the one case due to frictional loss in the cable, etc., and in the other to electrical loss from line resistance, underworked motors, motor gears, etc. In a recent number of the *Railroad Gazette* some figures were published to show the losses incurred on certain cable roads outside the station, and these are presumably average instances, seeing that the results are not regarded as extraordinary. If they are wrong or excessive it is the duty of cable tramway engineers to say so, and give reasons or substantiate what they say: and we may hope that this will be done, if possible.

The data given are set forth in the accompanying Table A. They were taken at four different power stations, representing eight different cables, and the observations were made for a period of 20 hours from starting time in the morning until stopping at night. The horse-power necessary to drive each cable was found by subtracting the frictional horse-power of the engine and machinery from the horse-power developed in driving the cable in the morning before the cars were taken out, and therefore with no load on.

TABLE A.—Frictional Resistance on Cable Roads.

Station.	Engines in station.	Horse-power of each.	Cable feet.	Speed miles an hour.	Total curvature.	Horse-power.			
						To drive cable.	Engine and machinery.	Total.	Maximum observed.
No. 1.	2	1,200	26,000 18,500	10 5 10·7	None. None.	98 87	53·32	238·32	1,122·00
No. 2.	2	1,000	20,000 20,000	10·5 12 83	2 of 90deg. 2 of 45deg. 4 of 90deg. 2 of 45deg.	118·100 155 55	72·00	345·65	1,340·00
No. 3.	2	1,500	21,850 12,000 26,430	10 10 12	None. 2 of 90deg. 2 of 45deg. None.	52·15 98·75 22 28	38·32	211·51	556·0
No. 4.	—	1,000	9,475	6·75	10 of 90deg.	171·00	63·00	234·5	821·00

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Taking these results as they stand, we may calculate the percentage of horse-power lost in the cable to the *maximum* horse-power developed; and here, again, the cable is treated as fairly as possible, for obviously the percentage of cable loss to *average* horse-power, or to the *useful* horse-power, would be still higher. For arriving at a standard or maximum of efficiency, we may, however, take the maximum horse-power in both cases as being the average amount. The four roads above would show on this basis the following results:

No. 1. Cable loss, 16·48 per cent. of maximum horse-power.
2. „ 24·21 „ „ „
3. „ 31·14 „ „ „
4. „ 20·82 „ „ „

Of course, these figures would be still higher if we took the horse-power at the cable drum axle, instead of the indicated horse-power of the engines (from which the maximum horse-power observed is calculated). The cable loss is practically constant whatever the load, so that the latter may be disregarded.

It is much to be wished that similar figures could be given for electric roads. The only way to effect a comparison is to use the results obtained in the limited amount of working so far experienced. It may, however, be said with ample safety that an average electric road will give a line efficiency of at least 95 per cent. Higher values than this have been obtained on many lines, and with sufficient constancy to be considered normal. The commercial efficiency of motors and gearing combined is at least 75 per cent., and 82 per cent. is a fairer average. Taking the latter figure, we get a combined efficiency of, say, 78 per cent., or a loss in the line and motors, etc., of 22 per cent. of the horse-power at the dynamo terminals. This percentage would be considerably less when taken with respect to the maximum indicated horse-power of the engine cylinders, as was done above in the case of the cable roads; but even without such an allowance, electric working offers great economy.

As compared with the cable losses above mentioned, this result shows quite as good an efficiency, if, indeed, not much better; but the figures regarded altogether would tend to confirm one very strongly in feeling that both systems stand at present pretty much on a level. They each have qualities which fit them respectively for different work, and for a municipality or tramway company to say "We will equip all our lines with cable"—or electric overhead wires, as the case may be—savours too much of blind prejudice, unless every care has been taken to discuss the adaptability of each method for the various districts involved.

CITY AND GUILDS OF LONDON INSTITUTE.

LECTURE II.—THE PRINCIPLES OF ELECTRIC CIRCUITS, SIMPLE AND BRANCHING.

(Specially contributed.)

It is necessary to know something more about the channel or path of the electric current. Here, again, we may learn something from experiments with water. I have before you a glass cistern with two compartments, A and B (Fig. 1). These compartments are connected by means of the pipe, C, which can be closed or opened by

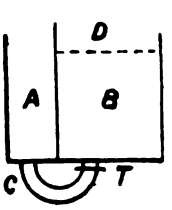

Fig. 1.

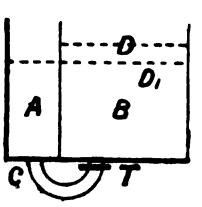

Fig. 2.

means of the tap, T. I fill the compartment B with water to the level D keeping the tap, T, closed. I open the tap, T, and immediately the water flows into A till the level of the water is the same in A and B, Fig. 2. The water then comes to rest. We started with the level of the water in B higher than the level of the water in A, we stop with the water in both compartments level. There was a flow of water, call it a current of water, from B to A, while the level of the water in B was highest. I want to obtain a continuous flow, and to do this introduce a small pump, P (Fig. 3). By continually pumping I keep the level of water

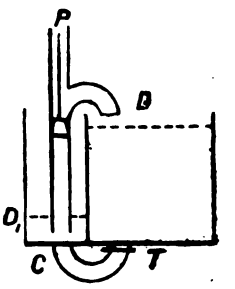

Fig. 3.

in A at D_1, and that in B at D. The water is too clear: you cannot see any water current, though you know it must be there because I am pumping, and yet the level in A gets no higher and no lower, so that what I pump out must be continually replaced from B. I drop a little colouring matter into B, and now you see it passing from B to A, and the coloured water by the pump is brought back to B. I might keep on this little game the whole evening, but shall probably find something better to do. I want you to notice that in this last experiment we have:

1. A piece of apparatus to keep up a difference of level, giving us thereby a difference of pressure.
2. An all-round channel or path.

You will easily see that without some such continuous channel the experiment would soon come to an end. It does not matter if the channel is very roundabout: it must be there. Instead of using a pump, I may let the water run out of B, and keep that in A at a constant level by getting water from the town mains. The continuity, however, can still be traced.

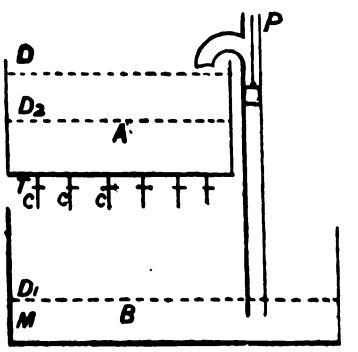

Fig. 4.

I have still another experiment with water to show you. Upon this stand are two more cisterns, Fig. 4. The upper one, A, is furnished with a number of escape-pipes, C, C, C, each with its tap, T. Each pipe is similar in all respects. The water in A stands at the line D, and there is no water in B, the cistern underneath. I open one escape-pipe and let the water flow for one minute. B has now water to the point M. I pour this water back to A, and, replacing B, open two pipes. Watch how long it takes the water in B to rise to M. There it is, and the time is half a minute. We will then assume that under the same head of water—that is, with the same pressure acting, the pipes being similar in all respects—equal currents of water will flow through them in equal times. If we replace the water once more, and instead of B put these two vessels to catch the water, one under each escape-pipe, turning on the water for half a minute, we find equal quantities in the vessels, proving what I have just stated to be correct. I replace the water and open one pipe only, letting it run for half a minute. You see there is practically the same amount of water in it as when both pipes were running. This shows that the opening of a second pipe does not interfere with the current of water flowing through the first. In the experiment this is not absolutely correct, because there has been a little difference in the head of

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water in the two experiments; but you may take it from me, or try it for yourselves, that keeping the head or pressure constant the same quantity of water will flow through pipe No. 1 in equal times whether the other pipes are open or not.

There is just one other experiment I would like to show you. Instead of the level of water at starting in A being at D, suppose it is at D_2. Opening one pipe, and letting the water run for half a minute, we see that less water has run than when the level was higher. Further experiments might be made to show that the higher the level—that is, the greater the pressure—the greater would be the flow in a given time, and the less the pressure the less the flow.

There are other experiments which I might show you, but I think the results will be quite clear if I merely mention them. If I lessen the area of the escape-pipe, the rate of flow with a given pressure will be less than if I increased that area. In fact, by doubling the area—that is, by using the two pipes—I doubled the rate of flow. I can also decrease or increase the rate of flow by largely increasing the length or decreasing the length of pipe, for the pipe offers some resistance to the flow, and increasing the length increases the resistance offered, and so diminishes the rate of flow.

So that doubling area, with length of pipe and pressure constant, means doubling the current flow. We thus say current flow under these conditions is *directly* proportional to area of channel, path, or pipe; while it is *inversely* proportional to length of pipe, which, to repeat, means that the current flow increases or decreases as the area increases or decreases, other things remaining the same, and that that current flow decreases as length increases, and increases as length decreases, other things remaining the same.

It will not hurt to recapitulate what has been shown:

Then, first, to keep up the pressure, if we want a continuous flow we must somehow or other have a piece of apparatus to keep the water at the original level.

Second, we must somehow have an all-round channel, or path, or pipe, to enable us to retain the pressure.

Thirdly, keeping the pressure constant, increasing the number of channels, paths, or pipes, does not interfere with the current flow in any one channel.

Fourthly, the rate of current flow per channel or pipe depends upon the pressure. The total quantity depends also upon the number of channels or pipes.

Unfortunately, I cannot show you a current flow of electricity like I can a current flow of water. In the matter of current flow of electricity we must judge by its effects.

Here is a battery, some binding screws, some coils of wire, and a galvanometer. The battery is a piece of apparatus which serves to produce and, under proper conditions, maintain a difference of electrical level, and thereby we obtain electrical pressure. The galvanometer is an instrument the needle of which is moved under the influence of an electric current flow in the wire wound around it. This other wire is to make a continuous path for the electric current flow (hereafter to be briefly called "current") from one side of the battery to the other. I will throw a shadow of the galvanometer needle upon the screen, so that you can more easily trace its movements. In the diagram (Fig. 5) S_1, S_2, S_3, and S_4 indicate binding screws.

1. I have made all the connections, and you see the

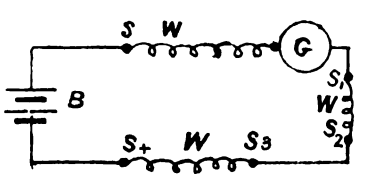

Fig. 5.

needle at once moves as I make the last connection to complete the continuous path. I sever the connection and the needle goes back; I make it again and it moves forward. Thus you will see that as soon as the path is made continuous we have indications of a current, and we cannot get these indications unless the path is continuous. The path of an electric current we call the *circuit*. I have here a coil of wire of the same length as that between S and the galvanometer, but of much larger sectional area. Notice well where the needle stands now.

2. I replace the original wire at S by this of larger area, and note the galvanometer needle swings further than it did before.

3. Putting back the original wire at S, and replacing that at S_1 S_2 by the thick wire, the needle swings to the same position as in the previous experiment—viz., No. 2.

4. Replacing original at S_1 S_2, and putting the thick wire between S_3 S_4, the needle swings to the same point as in 2 and 3.

You see, it does not matter where I alter the circuit. The same effect is obtained so long as the alteration is the same.

5. I now change the original coils for three coils the same length, but of greater sectional area, and you see the needle swings further than ever.

We have said that the needle acts under the influence of the current. The larger the current the further the needle swings, so that experiments 2, 3, and 4 indicate a larger current than experiment 1, and experiment 5 a larger current still. We may assume all through that the pressure has been the same, and that the larger current was obtained by diminishing the resistance of the circuit.

When the circuit consists of one continuous path it is said to be a *simple* circuit.

Let us return once more to experiment No. 1. Note the swing of the needle and the point where it comes to rest, or its deflection.

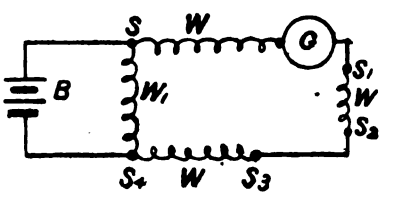

Fig. 6.

6. I have a fourth coil of wire exactly similar to the others, and I insert this between S S_4, Fig. 6. You see there is very little change in the position of the needle.

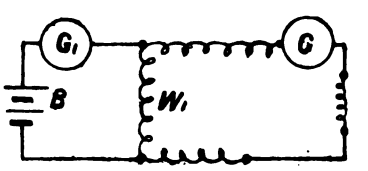

Fig. 7.

7. To find out a little more of what goes on I put a second galvanometer in the circuit, as shown in Fig. 7, and though this galvanometer is similar in all respects to that used all along, we see that the needles of the two galvanometers do not come to rest in the same direction. The galvanometer, G_1, shows a larger deflection than that at G, because the current that goes through both branches acts on G_1, while only the current that goes through one branch acts on G.

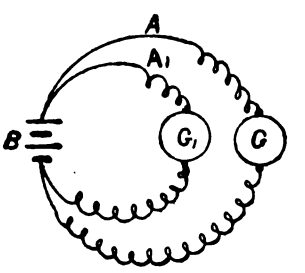

Fig. 8.

8. I now put a galvanometer in each branch circuit, and have made the resistances of the branches, A A_1 (Fig. 8) as nearly similar as possible. You see the needles of each galvanometer swing to the same point, showing that they are influenced by equal currents. The *total* current is double that in either branch.

9. If I alter the resistance of either branch—say, A_1—by putting in a thicker or a thinner piece of wire of equal

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length I increase or decrease the current through that branch, as shown by the swing of the needle, while the current in the other branch, A, remains practically steady.

When the *circuit* consists of two or more branches, it is said to be a *divided* circuit.

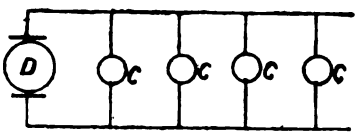

FIG. 9.

Usually incandescent electric lighting is by means of divided circuits, as shown in Diagram 9, where D is the dynamo and C C C the incandescent lamps. Such lamps are said to be in parallel.

CITY AND GUILDS EXAMINATION.

The following were the questions given at the examination last May. The syllabus of these examinations was given in our issue of August 31.

ELECTRIC LIGHTING AND POWER TRANSMISSION.

PRELIMINARY EXAMINATION.

The number of the question must be placed before the answer in the worked paper. Not more than eight questions to be answered. Three hours allowed.

1. Define the terms "in parallel," "in series," "on open circuit," and give sketches in illustration.
2. Describe the Leclanché cell, and add some hints as to how to maintain it in working order.
3. Sketch the connections needful for bells between two places, A and B, so that a person at B can ring the bell at A, and that a person at A can ring the bell at B. One battery (of two or three cells) only to be used, and only one bell to ring at a time.
4. A lamp circuit is supplied at a pressure of 100 volts. There are 42 lamps all in parallel, and the resistance of each lamp is (when hot) 150 ohms. How much current will the circuit take when all the lamps are on?
5. How can you convert a bar of iron into a magnet? If you have a small electromotive force, and no appreciable resistance in the rest of the circuit, would you use thin wires or thick for winding an electromagnet?
6. If electric bells are to be made to ring (by a magneto-ringer) through a line many miles in length, why must fine wire be used both in the coils of the ringer and in the coils of the electromagnet in the bell?
7. Why is there a permanent steel magnet in the bells that are to be used with magneto-ringers?
8. Describe shortly the construction of a glow lamp. Why does the filament become hotter than the platinum leading-in wires? Why does the globe of a bad lamp get very hot?
9. How many horse-power is required to drive a current of 100 amperes through a resistance of 7½ ohms?
10. State the principles on which the Cardew voltmeter is based.
11. Name the principal parts of an arc lamp, and say what is the use of each part.
12. Define "work" and "power." How many foot-pounds of work will be done in 20 minutes by a motor working at 4 h.p.?

ELECTRIC LIGHTING AND POWER DISTRIBUTION.

In the honours grade the student may, during the examination, use an electrical engineering pocket-book, but if he avails himself of this, he must state the title of the book on his answer paper, and in his answers give references to the pages of the book he has consulted. The number of marks obtainable is the same for each question.

ORDINARY GRADE.

(Not more than six of the following questions to be answered.)

1. Describe and sketch some form of ampere-meter of a type which does not depend on the magnetisation of iron.
2. A straight wire carrying a continuous current of 500 amperes lies at right angles to the magnetic flux in a field the intensity of which is 10,000 lines per square centimetre. State the force, in pounds, per foot of the wire tending to produce lateral displacement.
3. Give sketch to one-fourth full size of a switch for breaking an alternate current of 20 amperes at 2,000 volts.
4. State relative advantages and disadvantages of the two following systems of distributing alternate currents: (*a*) transformers in consumers' houses; (*b*) transformers in sub-stations.
5. Give full-size hand sketch of a commutator 6in. diameter, 4in. face, showing in section how the plates are supported and insulated.
6. Current is required along a street 2,000ft. long at the rate of one ampere per 10ft. of frontage. Give sectional area of conductor so that the difference of pressure between any two lamps shall not exceed two volts in the following two cases: (*a*) the current being supplied at one end; (*b*) the current being supplied midway. [N.B.—The resistance of a copper bar 1,000ft. long and one square inch in cross-section may be taken at ·008 ohm.]
7. Explain numerically the relations between the dyne, the erg, the joule, the kilogramme, the British horse-power, and the metric (French) horse-power.
8. Sketch the connections of a Wheatstone's bridge, showing how it is connected to the resistance to be measured.
9. A Gramme armature, intended for a two-pole field, has 120 turns of conductor wound upon it. Give the total flux required through armature core if an electromotive force of 100 volts is to be induced at a speed of 1,000 revolutions per minute.
10. Calculate the number of ampere-turns of excitation required to magnetise, up to 14,000 lines per square centimetre, a soft ring, 20in. in mean diameter, made of round iron 1in. thick. [Assume permeability = 800.]
11. State the circumstances under which it is economical to work glow lamps above their normal voltage.
12. What rules govern the design of motor-generators? Upon what does the speed of them depend?
13. Describe and sketch some form of automatic cut-out for series arc lamps, and explain its working.
14. Give the number of storage cells required for a 100-volt private house installation. Also state maximum charging voltage, and say how many cells must be connected with the regulating switch.

HONOURS GRADE.

Candidates for honours must have passed in the ordinary grade. They may select their questions from one only of the following sections.

SECTION I.—ELECTRICAL INSTRUMENTS, ETC.

Answer questions No. 1 and 3 of ordinary grade, and not more than four of the following questions:

15. Two bars, each five square centimetres in cross-section, have their faced ends touching within a solenoid excited so as to produce a magnetic induction of 15,000 lines per square centimetre through the joint. Give, in pounds, the force requisite to pull them apart.
16. Give a diagram showing connections of a switchboard for three alternators intended to work in parallel four feeders and one exciting dynamo.
17. Why is a closed magnetic circuit not the best form for choking coils?
18. Sketch and describe an instrument for the commercial testing of the permeability of bars of iron of different brands.
19. Describe a method for testing transformer plates for iron losses.
20. What method would you adopt to ascertain very precisely the ratio between the capacities of a very large condenser and a very small one?
21. What do you know of the temperature coefficient of the magnetism of permanent magnets? In what way is it affected by the temper, the mode of magnetisation, the shape, or the prior treatment of the magnet?
22. Describe a modern form of supply meter for continuous currents?

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23. What is meant by the coefficient of damping of a galvanometer? What is the ratio, in an undamped galvanometer, between the angle of the first swing and the angle of the deflection when it has become steady?

24. Describe the arrangements for shunting a galvanometer so that when it is shunted down the total resistance of the circuit in which it is shall not be thereby changed.

25. Describe some form of electrostatic voltmeter suitable for measuring voltages from 50 to 150 volts.

26. Describe a photometer for measuring the illumination given on the pavement by street lamps.

(To be continued.)

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

E.M.F.—WANTED, CORRECT DEFINITION.

SIR,—I read with much interest the article on the City Guilds of London Institute's preliminary examination on "Electric Lighting and Power Transmission," which appeared in your issue of the 7th inst. I am a little uncertain as to the true definition of the term "electromotive force," mentioned as follows: "The difference of electrical potential is the cause of electrical pressure, and, again, this pressure is proportional to the difference of potential, and by increasing or decreasing the latter you increase or decrease the former. Using the electrical terms, what I have called electrical pressure due to difference of electrical potential is technically called electromotive force. I prefer to use the term 'pressure.'"

In "Houston's Electrical Dictionary" I find that the following explanations are given: "Force, Electromotive.—The force starting electricity in motion, or tending to start electricity in motion. The force which moves, or tends to move, electricity. The term is an unfortunate one. Strictly speaking, electromotive force is not a force at all: at least, it is not a force in the Newtonian sense, where force is only that which acts on matter. The term 'electromotive force' is generally written thus: E.M.F. The unit of electromotive force is the volt. When electric induction takes place there results a change in the distribution of the thing called electricity, whereby a movement occurs that results in a positive and a negative charge. The cause which produces this movement is called the 'electromotive force.' There is an unfortunate want of uniformity at present in the use of the term 'electromotive force.' By some, the electromotive force is regarded as something which causes the difference of potential; by others, the electromotive force is regarded as being produced by the difference of potential; and by still others, electromotive force is regarded as the entire electric moving cause produced by any source, while anything less than this is called by them potential difference. Those who regard the electromotive force as the cause which produces the potential difference look on the electromotive force as acting within the source and maintaining a potential difference at its terminals."

Silvanus P. Thompson uses the term electromotive force in his "Elementary Lessons in Electricity and Magnetism" as follows: "The term 'electromotive force' is employed to denote that which moves or tends to move electricity from one place to another. For brevity we sometimes write it E.M.F. In this particular case it is obviously the result of difference of potential and proportional to it; just as in water-pipes a difference in level produces a pressure, and the pressure produces a flow as soon as the tap is turned on, so difference of potential produces electromotive force, and electromotive force sets up a current as soon as a circuit is completed for the electricity to flow through."

Mascart and Joubert, in their work on "Electricity and Magnetism," Vol. I., say: "In all cases, the difference of potential, $V_1 - V_2$, may be considered as producing the motion of electrical masses; it is often called the electromotive force."

Maxwell, in his "Elementary Treatise on Electricity," speaking of the potential differences which may be shown to exist at the terminal of a Daniell voltaic cell when on open circuit, says: "This difference of potential is called the electromotive force of a Daniell cell."

Balfour Stewart, in his "Electricity and Magnetism, says: "This difference of electric level we shall call E, and, indeed, it is merely a manner of expressing the cause of electromotive force."

Prof. Fleming, in his "Short Lectures to Electrical Artisans," says: "The difference of electrical level or potential must be caused by some electromotive force acting in the conductor."

Prof. Anthony, in "A Review of Modern Electrical Theories," regards the potential difference as due to electromotive force. He says: "Difference of potential results from a changed electrical distribution, an electrical strain, and represents the tendency to return to the state of equilibrium. Electromotive force is the something from without that produced the electric strain."

Hering, in his "Principles of Dynamo-Electric Machines," says: "Difference of potential is, as the name implies, the difference of electrical potential between any two points of a circuit, and may, therefore, be applied to that at the poles of a machine, battery, or lamp, or at the ends of leads, or, in general, to any two points in a circuit. The term 'electromotive force,' however, applies only to the maximum difference of potential which exists in the circuit, or, in other words, the total generated difference of potential."

This last paragraph expresses the distinction between the two terms as ordinarily used in connection with dynamos and batteries.

As writers on the subject appear to be so extremely divergent in their opinions as to the definition of the term "electromotive force," I should be glad if any of your readers would give me the definition of the term as recognised by the "examiners," as I am thinking of entering for the above examination, and do not want to fall foul of my examiners.

STUDENT.

PRACTICAL APPLICATIONS OF PORTATIVE ELECTRICITY.

SIR,—I should like to relate an incident that happened to me, and it may be that one of your numerous readers will be duped in the same manner. The other day I visited a friend of mine near Manchester. I arrived by train, and was preparing to leave the station when suddenly I was heartily embraced by a pretty-looking young woman, who exclaimed: "My dear Charlie, you are here!" As my name is not Charles, and as the voice was quite strange to me, I was naturally very surprised. Well, profound apologies followed. She explained that she had mistaken me for her brother, whom she alleged I closely resembled, but later the same evening I missed my scarf pin, which was at least worth £4, and of special value to me as the gift of a friend since dead. A few weeks later I read in the papers of the same trick having been played upon another gentleman. Thus I was bamboozled in an original and daring but ingenious way. To prevent any further "mistake" by these charming thieves, I rigged up a small contact for my scarf pin, bought a tiny and neat electric bell (patented November 9, 1886, and November 27, 1888), made a double pocket accumulator, and now I am ready for any similar emergency. If the fair lady "mistakes" me again for her "brother" I shall at once hear the tell-tale of my pocket bell, and if it tinkles I will embrace (heartily) the "lady" (?) till a policeman releases me of the fair thief. I may add that I since carry about with me occasionally a whole "electric museum." The source of electricity is stored up in the said accumulators. I have made a contact for my watch; thus, if Bill Sykes, Esq. (!), tries to pull it out quietly the tell-tale indicates the fact at once. The third item of my practical equipment is a small incandescent lamp concealed in a well-finished artificial waterproof flower pinned to my coat. The lamp is useful during a performance at a theatre, when the light in the house is usually lowered, and when I may desire to look at the programme, etc. Another piece of apparatus invaluable for the inveterate smoker consists of a very fine platinum coil placed in a

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cavity made of asbestos. By inclining the little tube the mercury in the same closes the circuit of my pocket battery, and I can thus light my cigar regardless of the weather. The entire museum weighs about 22oz., and the only bother is the recharging of the battery. The latest addition to my store is a hollow bamboo cane fitted with a tiny lamp provided with a small silvered reflector concealed in the knob. The hollow cane is sealed at the bottom by a rubber stopper, and the exciting fluid is $CrO_3 + HCl$. The cell consists of an amalgamated zinc rod and a strip of platinum sheet. This type of battery was used for Tissandier's "navigable" balloon. By inclining the cane the lamp is, of course, fed by an electric current, and gives a good light. Any intelligent person can rig up my "portative museum" in a few hours.—Yours, etc.,

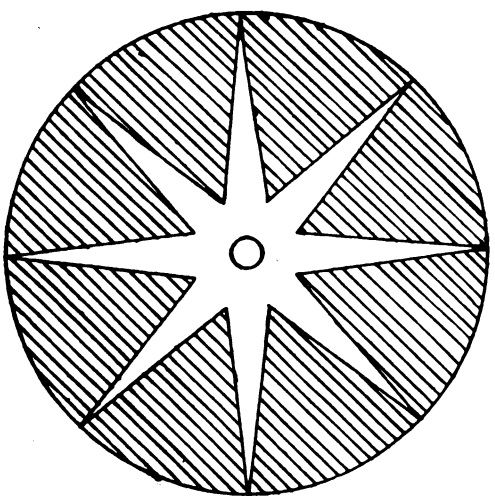
R. W. HILL.

Manchester.

TURNING DOWN ELECTRIC LIGHTS.

SIR,—I send you by this post a copy of the *Birmingham Daily Gazette* with an article in it on the subject of reducing the light emitted by incandescent lamps without resorting to the use of resistance, and trust the subject may be of some slight interest to you.

1. As to the cutting-off principle. I send you a tracing of the revolving disc, the shaded part of which represents the non-conducting part. Of course, the further away from the centre the brush is placed, so the light gets lower and lower.



2. As to the varied series principle. I never have any lights out—that is, not of necessity—and I may here remark that though the designing of the switches in the first instance gave me a great deal of trouble, when once made the copying of them is simple enough.

Of course, any plan which reduces the temperature of the filament reduces the candle-power at a greater rate than it reduces the amperage; but, apart from this inherent principle which is necessarily involved, the arrangements work very nicely, and the convenience and pleasure of being able to lower all the lights uniformly instead of turning some quite out and leaving a few bright points, will, I beg to submit, more than outweigh the unavoidable loss of candle-power in proportion to the power used.

Anyhow, the power consumed for the light given is infinitely less than when the usual resistances are resorted to.—Yours, etc.,

THOMAS BUDWORTH SHARP.

Birmingham, September 11, 1894.

[The enclosure in question is of very considerable length, and the following is an abstract thereof: The value of an easily applied method for lowering incandescent lamps was first brought under the notice of the inventor in a London hotel. On going to his bedroom he found a stocking (whether dirty or clean is not stated) had been carefully tied round the bulb of the electric light, and an investigation of the matter elicited the fact that many visitors, who were loth to sleep in utter darkness and did not want to have the full light, thus shaded it. Mr. Sharp's first idea was to place a make and break arrangement in the circuit. He constructed a small disc of metal conductors isolated by vulcanite, so that when the brush touched the metal a full current would be obtained, and when it came into contact with the vulcanite it would cease. The theory was that if a rapid revolution be made the filament will never get up to its full heat, on the one hand, nor be cooled down very materially, on the other. The disc could be operated by clockwork or otherwise, but as householders would not care to have to set a revolving wheel in motion, the inventor turned to another method. He determined to act on the principle that if the length of a filament of a lamp was increased or reduced, so would the intensity of the light become greater or less. He constructed two clusters of lamps, one of a pair of 16 c.p., and another of six lamps. The lamps are connected both in series and parallel, and switches are arranged so that the current can be run either way or shut off altogether. When the full light is required the current is switched on in parallel, and when a reduced light is required it is switched on in series. It is stated that the invention appears likely to revolutionise electric lighting.]

ALTERNATING-CURRENT DISTRIBUTION.

SIR,—Until Mr. Lowrie publishes the theory of the natural laws which he obeys in his transformer design, he must excuse me taking the same views as most other transformer designers. I must therefore stick to the opinion that the secondary current in his unique switch-transformer is due to an alternating field which will make the pole-pieces attract each other, and that, due to the presence of iron which makes the leakage path on opposite sides of the coils about equal, the repulsion and attraction between current and leakage field will very nearly counterbalance each other. The case is quite different for two solenoids without iron; then there are no pole-pieces to attract each other, and the leakage field on one side of the coil will be stronger than on the other, resulting in a repulsion.

As it is part of my daily work to design transformers and superintend their manufacture and testing, Mr. Lowrie need not inform me what happens when a transformer is short-circuited, but I am glad to see that we hold the same view. He says that "when the conditions require it, the short-circuit can be made through a resistance." I said that the result would be a burn-out "if the resistance of the coils were not high enough to keep the current within safe limits."

As to my letters having a disastrous effect on industrial development, it is my opinion that very much harm has been done, and is still being done, to the electrical trade by patentees receiving support for inventions which afterwards show themselves to be failures. I am, therefore, only too pleased to do my best to reduce the evil when an opportunity is offered, thereby supporting true progress.—Yours, etc.,

S. A. FABER.

September 11, 1894.

RE LARGE ELECTRIC CRANES.

SIR,—The following particulars of a large electric traveller may be of interest to your numerous readers. The crane was constructed for a load of 100 tons, and has three motors—one for each motion, lifting, travelling, and traversing. The girders are 7ft. deep and 74ft. span, and carry two crabs, so that when a finished locomotive, weighing 65 tons, is being lifted, one crab can be used at each end of the crane. A locomotive can be picked up and carried the whole length of the shop and deposited on the track in five minutes. The motors run at 500 revolutions per minute at a voltage of 220.

This crane, which I believe is *the* largest anywhere driven by electricity, is in the Baldwin locomotive works in America.—Yours, etc.,

GILBERT MILLINGTON.

St. Mungo, Belvedere, September 8, 1894.

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TURNING DOWN ELECTRIC LIGHTS.

On Sept. 6 the *Birmingham Daily Gazette* devoted over a column of its space to the discussion of this subject, and the description of apparatus devised by Mr. T. Budworth Sharp for attaining this object. Mr. Sharp has also written to us on the subject, and we have given his letter a place in our columns. Not for one moment do we wish to damp the ardour of inventors. They are necessary in these days and serve a good purpose, but too often their energies are ill-directed. It seems to us that Mr. Sharp has so misdirected his energies, and that though his apparatus may do all that he claims for it, he will find that its commercial value is a vanishing quantity. The energies of inventors may well be directed, broadly, into two directions—to devise something that is really wanted, or to devise something for which a demand may be created. In the matter of turning down electric lights, few even in the largest hotel, and fewer still in ordinary houses, require it. To accommodate these few every lamp in the hotel would have to be furnished with the means for turning down. Assume that half-a-dozen people in the hotel desire a light all night, will it appeal to the proprietors as so important that they will go to the expense of fitting a thousand lamps, say, with the necessary apparatus? We think not. The case is somewhat different in a large house with a nursery. Here a modified light is frequently burnt all night, and as this room is constantly used for one purpose the expense of fitting it up would not be great. By far the larger number of people do not care about lights always burning in bedrooms, and when they do want a light one of the great advantages of the electric light is that it can be turned on in a moment. Usually a switch by the bedside gives command of a lamp. For all ordinary purposes that is enough; the exceptions are more often than not caused by illness. But it is unnecessary to dilate further upon this part of the subject. Every reader can think it out for himself, and we shall be much surprised if the result of such cogitation is not towards our view — that the demand will not be commercially valuable. Nor do we think any demand can be created in this direction while an extra cost over and above the ordinary cost of installation is incurred for the necessary apparatus. Mr. Sharp describes two ways of attaining his object, one of which, the rotating commutator, may be put aside at once. It would involve clockwork, or an electric motor arrangement. In the former, someone would have to look after the clock, and this means wages, not to speak of initial cost. In the latter the current used to drive the motor would probably be more than was saved by the turning down the lamp, so there would be a constant loss, in addition to the initial cost. The other case would increase the initial wiring expenses, as both series and parallel wiring would be required. Therefore, taking into consideration, first, the lack of general demand existing or that can be created, and, secondly, the initial and continuous expenses, we are justified in thinking Mr. Sharp's energies to have been misdirected. We

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must insist upon the fact that only in one bedroom out of fifty or a hundred would the modified light be required; but which room that would be no one could know. It is hardly to be expected that the manager of an hotel will have one wing with rooms where the modified light can be had, and ask his clients when they present themselves if they require a modified lamp at night or not, and give rooms according to their answers. We have made Mr. Sharp's design the text of this article not from any desire to speak well or ill of this particular invention, but to once more point out that inventors multiply inventions to no good purpose. So far as our experience goes, it is only for theatrical purposes that raising and lowering lights is generally required. We have always insisted that one of the greatest advantages of the electric light was that it could be put out and turned on as wanted. It is here where economy comes in, and assists in extending the use of electricity for lighting where, if it was necessary to run continuously at full load or modified candle-power, it would not find favour.

E.M.F.

What is the definition of E.M.F., is the question of a "Student"—that is, the definition to satisfy an examiner. It really does seem peculiar that at this stage of electrical knowledge such a question could be possible; yet the divergent views of authorities are put forward to show that it is not an unwarranted question. In order to see the latest definition, we turn to Vol. I. of a "Laboratory Manual of Physics and Applied Electricity," by Prof. E. L. Nicholls, just received from the publishers, Messrs. Macmillan and Co. On pages 181-2 Prof. Nicholls says: "Any generator of electricity, whether it be a battery, dynamo, or electrical machine, is capable, when energy is supplied to it, of *maintaining* a difference of potential between its terminals, even though they are connected by a conductor. It is to this capability of maintaining a difference of potential that we apply the name *electromotive force*." The italics are the author's. Had we italicised any words, they would have been others, and especially the word *capability*. We asked advice and information from an authority as to what would please examiners and gain full marks. His reply was pertinent and to the point: "First find out if the examiner has written a book. If he has, he wants to sell it; and the examinee should learn up that book, no matter what his private opinions are." The advice is good for the student, but we want to know for other reasons what is the accepted definition of E.M.F.

THE LATE PROF. HELMHOLTZ.

Hermann Ludwig Ferdinand Helmholtz was born August 31, 1821, at Potsdam, where his father was a professor in the gymnasium, his mother, Caroline Penn, being an Englishwoman. The family was not wealthy, and the future man of science was obliged to prosecute his studies as best he might while discharging the duties of an army surgeon. When 27 years old he was appointed assistant in the Anatomical Museum of Berlin, and in the following year he became professor of physiology at Königsberg. In 1856 he went to Bonn as professor of anatomy and physiology, and in 1859 he removed to a similar position in the University of Heidelberg, where he did a large part of his physiological work. Twelve years later he was made professor of natural philosophy in the University of Berlin, a post which he held until his death.

Helmholtz was accustomed to refer to his medical education as having given him valuable insight into natural laws and having laid the foundation for all that he subsequently did. Yet for the possession of a rude and imperfect microscope he was indebted during his career as an army surgeon to an attack of fever, his stay in the hospital permitting the accumulation of his salary. It was while performing the routine duties of this post that he produced his classic work on the "Conservation of Energy," a short essay which has done more than any but scientific workers can fully appreciate to stimulate the researches which have transformed modern science; for it is not only a statement of scientific fact, but a critique of all work in physics. The principle so luminously and forcibly set forth by Helmholtz has made itself felt as a co-ordinating and harmonising force over the entire field of scientific research. That as a matter of strict chronology he was to some extent anticipated by Joule and Mayer hardly detracts from the greatness of his achievement.

Helmholtz brought to his physiological work an unrivalled grasp of physical laws. Indeed, the special note of this great master was that he was an accomplished specialist in many different fields, and possessed the power of combining sciences for the attainment of results not attainable by any other means. His two great works on "Physiological Optics" and the "Sensations of Tones" exhibit him in the character at once of physicist, physiologist, and mathematician. When he turned his attention to optics the knowledge at the disposal of the oculist was extremely limited, at all events on the physical side, nor was its practical application to the complex structure of the eye by any means well understood. By the invention of the ophthalmoscope, Helmholtz substituted direct observation for conjecture, and by his analysis of the physical principles involved he raised observation to the higher level of science. At the same time he threw a new light upon the whole conditions of sensation and of voluntary motion in general. The same comprehensive yet penetrating analysis was brought to bear upon the sensations of tone, while the foundations were laid for the researches into the minute mechanism of the ear, which are among the most intricate and beautiful physiological works of the day. In acoustics as in optics, the work of Helmholtz ranges from mechanics on one side to psychology on the other. In dealing with the vibrations which form the physical basis of sound and light he wielded all the resources of the physical investigator; in working out the operation of these waves upon the sensitive structures of eye and ear the most refined physiological methods were brought into play; while in finally dealing with the translation of these physical and physiological facts into consciousness he showed himself an acute and accomplished metaphysician.

In every department of work at all closely related to his central studies Helmholtz has given evidence of his extraordinary fertility and strenuous energy. His scientific papers upon a wide range of physiological, chemical, physical, mechanical, and mathematical questions are invariably marked by the greatest breadth of view and the most direct insight into what is essential. In the catalogue of the Royal Society he is credited with more than a hundred papers of the highest importance, while of minor work in the form of popular lectures he was also prolific. His more recent researches upon vortices and the mechanical conditions governing the movements and distribution of the atmosphere show his intellectual vigour unimpaired by advancing years. He has long occupied an unquestioned position and enjoyed a European reputation. Recognition of his eminence has been freely accorded from all quarters,

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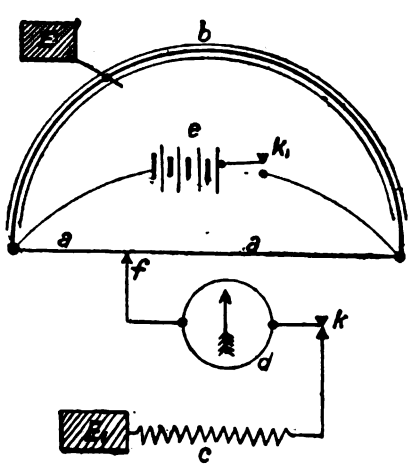
but of the numerous distinctions showered upon him we need mention only the Copley medal of the Royal Society, bestowed in 1873, and the fact that 10 years later the German Emperor raised him to the ranks of the hereditary nobility. Apart from his scientific work the life of Helmholtz has been calm and uneventful. After his marriage he dispensed a gracious hospitality in his official residence at Berlin, and he was all his life a genuine lover of the arts whose physical basis it was his great work to establish. One may without impropriety figure him as occupying in science a position not unlike that of his great countryman, Goethe, in literature. Breadth, universality of comprehension and sympathy, and a certain unmistakable intellectual serenity are characteristic of both.—*The Times.*

A METHOD OF FAULT-CURRENT ELIMINATION.

BY H. D. NORMAN.

The difficulties in the way of an accurate loop test caused by fault or cable currents are well known to everyone who has had much experience in cable work. The method most usually employed is that of neutralising the core under test with a moderately powerful current applied in opposition to that coming from the fault and making the final adjustment on the bridge as quickly as possible—*i.e.*, when the core is in a neutral condition. But it frequently happens, especially in the case of armoured cables,



that there is practically no neutral period, the cable simply passing from + to −, or *vice versâ*, and not stopping at zero at all; and it is with the object of doing away with this objection that the writer has devised the following modification of the loop test: in the diagram, *a* is the stretcher wire of a metre bridge or potentiometer; *b* is the faulty core; *c* is a high resistance, say, one megohm, in series with the galvanometer, *d*; *e* is a battery of well-insulated cells; *k*, the galvanometer key; k_1, the battery key. It will be seen on looking at the figure that the only difference between this and the ordinary loop test connections lies in the 1 Ω between the galvanometer and earth, E_1. The method of taking the test is as follows:

1. Depress *k* and obtain deflection due to fault current, and note: this will be the false zero to which to balance in future.

2. Keeping *k* down, depress key, k_1, and move contact, *f*, of galvanometer until balance is obtained at the false zero, then this point represents by a simple proportion the position of the fault on *b*.

In one experiment an artificial fault was made by means of a No. 2 Leclanché cell zinc rod, which fault gave an E.M.F. of ·67 volt, but the test was made with absolute accuracy.

The chief advantages of the modification are that any length of time can be allowed for accurate adjustment, and that the only path through which the current due to the fault E.M.F. can flow has such a high resistance that no variation takes place.

PRACTICAL NOTES ON DYNAMO CALCULATION.*

XI.

BY ALFRED E. WIENER.

(Continued from page 276.)

25.† *Types of Armature Winding—(a) Closed-Coil Winding and Open-Coil Winding.*—If, in a continuous-current dynamo, the reversal of the current would take place in all the conductors at once, considerable fluctuation of the E.M.F. would be the result. In order to obtain a steady current the armature conductors are therefore to be so arranged, relative to the poles, that a portion of them is in the strongest part of the field, while others are exposed to a weaker field, and some even are in the neutral position.

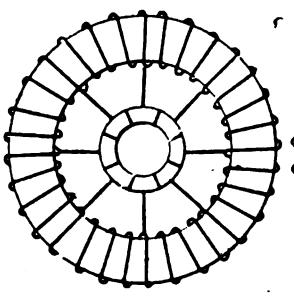


Fig. 32.

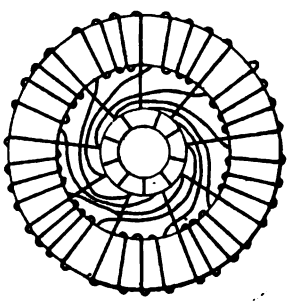


Fig. 33.

After having thus arranged the conductors, their connecting can be effected by one of the following two methods:

(1) All conductors are connected among each other so as to form an endless winding, closed in itself, and consisting of two or more parallel branches, in each of which all the single E.M.F.'s induced have the same direction, and in which the reversal of the current occurs in such conductors only that at the time are in the neutral position. An armature with such connections is called a "closed-coil armature."

(2) The conductors are joined into groups, each group containing all such conductors in series which, relative to the field, have exactly the same position; and the current is taken off from such groups only which at the time have the maximum, or nearly the maximum, E.M.F., all other groups being at that time cut out altogether. An armature wound in this manner is styled an "open-coil armature."

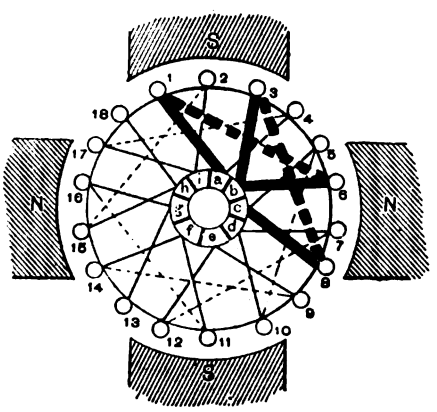


Fig. 34.

(*b*) *Spiral Winding, Lap Winding, and Wave Winding.*—According to the manner in which the connecting of the conductors by the above two methods is performed, the following types of armature windings can be distinguished:

* From the *Electrical World* (New York).

† *Errata.*—In section 24, page 276, of the last issue, the simplified form of the attraction formula in C.G.S. units should read $= G' \times \frac{\mathfrak{N}_1'^2}{16\pi}$; in formula (60) same page, the term $\left(\frac{\mathfrak{N}_1'}{6{\cdot}45}\right)^2$ should be replaced by $\left(\frac{\mathfrak{N}_1}{6{\cdot}45}\right)^2$; Figs. 22 and 24, same page, should be exchanged; Fig. 22 is intended for a horizontal machine and should be in a horizontal position, in place of Fig. 24, and *vice versâ*.

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(1) spiral winding, or ring winding, Figs. 32 and 33; (2) lap winding, or loop winding, Figs. 34 and 45; (3) wave winding, or zigzag winding, Figs. 36 and 37.

In the spiral winding, Figs. 32 and 33, which can be applied in the case of ring armatures only, the connecting conductors are carried through the interior of the ring core, and the winding thus constitutes either one continuous spiral, Fig. 32, from which, at equal intervals, branch connections are led to the commutator, or a set of independent spirals, Fig. 33, which are separately connected to the commutator.

The lap winding, as well as the wave winding, is executed entirely exterior to the core, and can be applied to both drum and ring armatures.

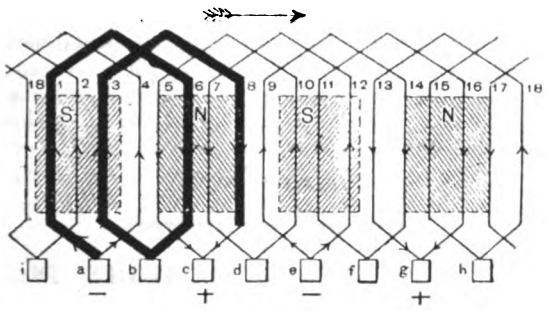

FIG. 35.

In the lap winding, Figs. 34 and 35, the end of each coil, consisting of two or more conductors situated in fields of opposite polarity, is connected through a commutator segment to the beginning of a coil lying within the arc embraced by the former. With reference to the direction of connecting, therefore, the beginning of every following coil lies back of the end of the foregoing, and the winding consequently form a series of loops, which overlap each other. Fig. 34 represents such a lap winding for a four-pole drum armature, the development of which, Fig. 35, more clearly shows the forming of the loops and the manner of their overlapping.

In the wave windings, Figs. 36 and 37, the connecting continually advances in one direction, the end of each coil being connected to the beginning of the one having a corresponding position under the next magnet pole, and the winding, in consequence, represents itself in a zigzag or wave shape. The wave winding is illustrated in Fig. 36, and for better comparison the same four-pole drum armature is chosen—that in Fig. 34 is shown with a lap winding. The development given in Fig. 37 distinctly shows the zigzag form of the wave winding.

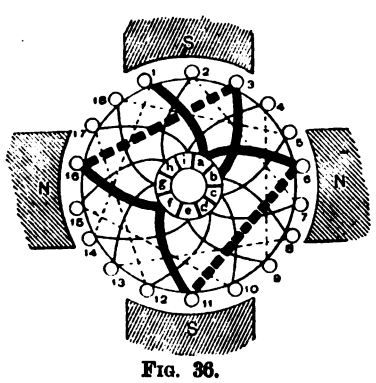

FIG. 36.

In multipolar machines, the wave winding can be used for series as well as for parallel connection; the lap winding, however, for parallel grouping only.

While the lap winding necessitates as many sets of brushes as there are magnet poles, the wave winding for any number of poles invariably needs but two sets of brushes.

For series-parallel connection, either wave winding may be used or lap and wave windings may be combined. Figs. 38 represents the development of such a "mixed winding," the coils partly being connected in the lap and partly in the wave fashion. This winding, like the wave winding, has the peculiarity of requiring but two sets of brushes, independently of the number of magnet poles.

26. *Grouping of Armature Coils.—Formula for Connecting.* A general formula for connecting the conductors of a closed-coil armature has been given by Arnold* as follows:

If K = number of conductors arranged around armature core;
a = number of conductors per commutator segment;
b = number of bifurcations of current in armature;
$b = 1$, single bifurcation, or 2 parallel circuits;
$b = 2$, double „ „ 4 „ „ etc.
P = number of pairs of magnet poles;
y = "pitch," or "spacing" of armature winding—*i.e.*, the numerical step by which is to be advanced in connecting the armature conductors;

then the number of armature conductors can be expressed by

$$K = a \times (P \times y \mp b),$$

from which follows the connecting formula for any armature:

$$y = \frac{1}{P} \times \left(\frac{K}{a} \mp b\right). \quad . \quad . \quad . \quad . \quad (63)$$

The general rule, then, for connecting any armature is:

"Connect the end (beginning) of any coil, x, of the armature to the beginning (end) of the $(x+y)$th coil."

For the various methods of grouping the armature coils the above formula is applied as follows:

(*a*) *Parallel Grouping.*—In this method of connecting there are as many parallel armature branches as there are poles—viz., 2 P circuits, or P bifurcations. Spiral winding, lap winding, and wave winding may be applied.

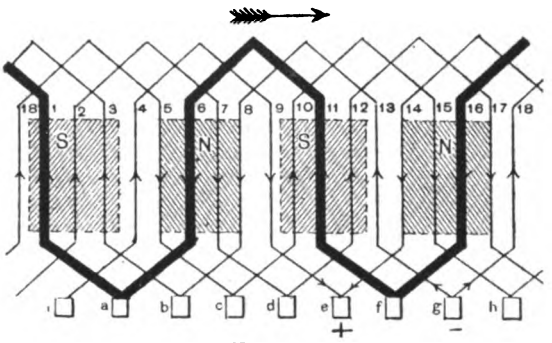

FIG. 37.

(1) *Spiral Winding and Lap Winding.*—In this case the multipolar armature is considered as consisting of P bipolar ones, and independently of the number of poles, P = 1 and $b = 1$ is to be inserted in (63), and the formula applied to a set of conductors lying between two poles of the same polarity.

(2) *Wave Winding.*—Here the actual number of pairs of poles, P, and the actual number of bifurcations, $b = P$, is to be introduced in (63), and the formula applied to the entire number of conductors.

(*b*) *Series Grouping.*—This is characterised by having but two parallel armature circuits, or one bifurcation, no matter what the number of poles may be; for series connecting, therefore, we have $b = 1$.

In the special case of P = 1, bipolar dynamos, the series connecting is identical with the parallel grouping, and the winding may be either a lap winding (spiral winding) or a wave winding; the latter holds good also for P = 2—*i.e.*, for four-pole machines. For dynamos with more than four poles, P > 2, however, series grouping is only possible by means of wave winding.

(*c*) *Series Parallel Grouping.*—In the mixed grouping the number of bifurcations is greater than 1, and must be different from P, hence in the connecting formula we have $b > 1$ and $b \gtrless P$.

In this case there are either several circuits closed in itself, with separate neutral points on the commutator, or one single closed winding with b parallel branches. The latter is the case if y and $\frac{K}{a}$ are prime to each other; the

* E. Arnold, "Die Ankerwicklungen der Gleichstrom Dynamomaschinen," Berlin, 1891.

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former if they have a common factor. This factor, then, indicates the number of independent circuits.

27. *Application of Connecting Formula to Special Cases.*—(*a*) *Bipolar Armatures.*—(1) For any bipolar armature the number of pairs of poles, as well as the number of bifurcations, is = 1. Furthermore, the number of coils per commutator bar is usually = 1. Consequently $a = 1$, if in the connecting formula the number of conductors, K, is replaced by the number of coils, n. For ordinary bipolar armatures, therefore :

$$P = 1, a = 1, b = 1 ; \ldots\ldots y = n \mp 1 \quad . \quad . \quad (64)$$

(2) If the number of commutator segments is half the number of armature coils—*i.e.*, two coils per commutator bar—then

$$P = 1, a = 2, b = 1 ; \ldots\ldots y = \frac{n}{2} \mp 1 \quad . \quad . \quad (65)$$

(*b*) *Multipolar Armatures with Parallel Grouping.*—(1) By multiplying the bipolar method of connecting, we have :

$$P = 1, a = 1, b = 1 ; \ldots\ldots y = n \mp 1 \quad . \quad . \quad (66)$$

This is a spiral winding; beginning and end of neighbouring coils are connected with each other, and a commutator connection made between each two coils. The number of sets of brushes is 2 P.

For multipolar parallel connection and spiral winding with but two sets of brushes, either n divisions may be used in the commutator, and the bars, symmetrically situated with reference to the field, cross-connected into groups of P bars each, or only $\frac{n}{P}$ segments may be employed, and P coils of same relative position to the poles connected to each bar by means of P separate connection wires.

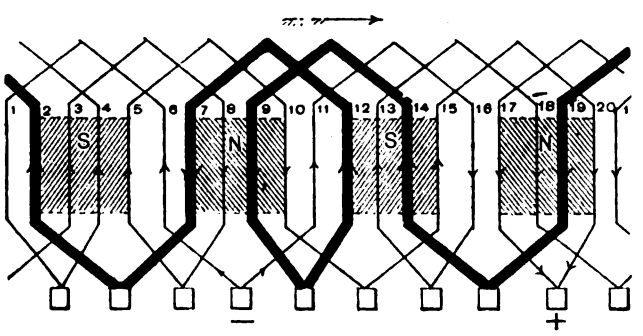

FIG. 38.

(2) In connecting after the wave fashion by joining coils of similar positions in different fields to the same commutator segment, the following formula is obtained :

$$P = P, a = 1, b = P ; \ldots\ldots y = \frac{1}{P}(\mp P) = \frac{n}{P} \mp 1 \quad (67)$$

If y and n have a common factor, this method of connecting furnishes several distinct circuits closed in itself, the common factor indicating their number.

(3) If P similarly situated coils are connected in series between each two consecutive commutator bars, only $\frac{n}{P}$ segments, but 2 P sets of brushes are needed; the winding is of the wave type, and the connecting formula becomes :

$$P = P, a = P, b = P ; \ldots\ldots y = \frac{1}{P}\left(\frac{n}{P} \mp P\right) = \frac{n}{P^2} \mp 1 \quad (68)$$

(*c*) *Multipolar Armatures with Series Grouping.*—(1) If all symmetrically situated coils exposed to the same polarity, by joining the commutator segments into groups of P bars each, are connected to each other, they can be considered as one single coil, and we obtain

$$P = P, a = 1, b = 1 ; \ldots\ldots y = \frac{1}{P}(n \mp 1) \quad (69)$$

Each brush in this case short-circuits P coils simultaneously.

The same formula holds good if beginning and end of every coil are connected to a commutator bar each. The latter can always be done if P is an uneven number; but if P is even, the number of coils, n, must be odd. In the case of P uneven, if n is even, the brushes embrace an angle of 180deg.; but if n is odd, an angle of only $\frac{180\text{deg.}}{P}$ is enclosed by the brushes.

2. Instead of cross connecting the commutator, the winding itself can be so arranged that only $\frac{n}{P}$ bars are required. In this case the connections have to be made by the formula :

$$P = P, a = P, b = 1 ; \ldots\ldots y = \frac{1}{P}\left(\frac{n}{P} \mp 1\right) \quad . \quad (70)$$

Note.—In drum armatures the beginning and end of a coil being situated in different portions of the circumference, they should be numbered alike, and yet marked differently, in order to facilitate the application of the above connecting formulæ. By designating the beginnings of the coils by 1, 2, 3, ..., and the ends by 1', 2', 3', ..., this distinction is attained.

(To be continued.)

THE USE OF STORAGE BATTERIES IN THE TROLLEY RAILWAY PLANT AT ZURICH, SWITZERLAND.*

The total length of this line is 4·6 kilometres (2·36 miles). The grades are quite severe, the maximum of 6·48 per cent. extending a distance of 378ft. The average grade is 1·1 per cent. The line is a single-track road, with the exception of eight turn-outs about 30 metres in length, as well as a short section of the track upon which the cars of the Central Zurich Berg road run. The gauge is less than that of the Zurich Street Railway Company, which operates with horses—namely, one metre (39·4in.) instead of 4ft. 8½in. The gauge of one metre is that generally adopted for new tramways, on account of its advantages over the other in narrow streets and on curves of short radius.

The type of rail used is the Phœnix 7 A, which has a weight of 77 kilogrammes per running metre of complete track (78lb. per yard). It is laid on a stone foundation without using the usual ties.

The cars are from the works of the Swiss Industrial Company, of Neuhausen. They have a capacity for seating 12 passengers and standing place for from 12 to 14 others without overcrowding. Each car is equipped with one four-pole Oerlikon electric motor of 18 h.p., which is mounted on the truck in the usual way well known in America. The gears run in grease. The speed and direction of the car are controlled by a controller on each platform operated by means of a lever and gears. The two controllers have a common resistance-box. The great disadvantage of the usual controlling apparatus consists in the fact that the arc, which in electric railways is usually caused upon the breaking of the current, acts very disastrously on the contact-pieces, and in a short time occasions their destruction. This is remedied by making the apparatus in such way that the sparking occurs only at one place, where it is "blown out" by a small electro-magnet specially provided and arranged for the purpose. The equipment includes the usual fuses and cut-out switches.

The total weight of the car, empty, with electrical equipment is about 4·10 (short) tons, or, including passengers, about 6·19 tons (of 2,000lb.).

With nine cars it is possible to operate on a headway of six minutes. This requires an average speed of 10·6 kilometres (6·57 miles) per hour, including stops. The trolley wire is of copper of seven millimetres (0·276in., about No. 1½ B. & S.) diameter, and is supported at a height of about 5½ metres (18ft.) above the street, so that it does not interfere with even the highest vehicles. Span wire (steel) or bracket construction is employed, the use of each depending upon local conditions.

The trolley wire serves for the outgoing circuit, the

* Abstracted from the *Street Railway Journal.*

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rails being used for the return. The joints are bonded with copper bonds. A copper supplementary return of seven millimetres is laid between the rails and connected from time to time with the rail bonds, making a continuous return circuit. The outgoing circuit is divided into four insulated sections of about the same length, each supplied from the central station through a feeder of 60 square millimetres (about No. 00 B. & S.) cross-section. Guard wires are also employed to protect the trolley wires from falling telephone or telegraph wires. Most of the telephone wires are run underground.

The current is supplied by a generator and a battery of accumulators working in parallel, the batteries being placed between the engine and boiler rooms.

To understand the arrangement of the storage batteries it must be noted that the current load in stations of such small capacity undergoes uncommonly severe and quick fluctuations. It might happen that for a moment—namely, when perchance all the nine cars stop at one time—the current may fall down to zero, and possibly in the next moment it may jump to the maximum of 200 amperes. On the average, the current required is around 80 to 90 amperes. It is evident that such a variable load, without the help of storage batteries, must have the most deleterious influence on the efficiency of the dynamo and engine. On the other hand, by using storage batteries one can obtain the great advantage that the engine and dynamo load remain almost uniform. If the power consumption on the line rises above the capacity of the generating plant, then the storage battery assists the plant; if, on the contrary, the consumption falls below the capacity of the latter, the surplus of the current produced by the dynamo flows into the storage battery and charges it. The plant, therefore, runs at its normal capacity—that is to say, under the most favourable conditions possible.

In regard to the advantages of using storage batteries in parallel with the generator, the Oerlikon Works Company submits the following computation: "The average grade on the Zurich electric railway amounts to 1·1 per cent. The load of the car, including electrical equipment, amounts to about 3·8 (metric) tons. If we consider that the cars carry, besides the conductor and motor-man, on an average one-third of their total carrying capacity, which is not estimating it too high, the average total weight per car reaches 4·4 (metric) tons. Assuming the traction coefficient to be 12 kilogrammes per (metric) ton (24lb. per ton of 2,000lb.), the total round trip therefore requires $2 \times 4{,}600 \times 4{\cdot}4\ (11+12) = 931{,}000$ kilogrammetres. No account is taken of the reduced consumption on down grades.

"The complete trip, with all stops on the way and at the end, requires 52 minutes; therefore, with the allowance of 25 per cent. increase for starts and curves, this corresponds to an average output of $1{\cdot}25 \times \frac{931{,}000}{54 \times 60 \times 75} = 4{\cdot}75$ effective horse-power per car measured at the car axle.

"The average loss from the steam-engine to the car wheel can be taken at 35 per cent., and therefore the efficiency comes out 65 per cent.

"For a 12-minute run (five cars) we have therefore $\frac{5 \times 4{\cdot}79}{0{\cdot}65} = 36{\cdot}8$ h.p.; and for a six-minute run (nine cars) $\frac{9 \times 4{\cdot}79}{0{\cdot}65} = 66{\cdot}3$ h.p., which is the power required at the engine flywheel; or, per day, $36{\cdot}8 \times 1{\cdot}9 + 66{\cdot}3 \times 12{\cdot}9 = 925$ horse-power hours, for which a daily consumption of 1,350 kilogrammes (2,975lb.) of coal, or 1·46 kilos (3·22lb.), per horse-power hour is required.

"Power stations for electric railways without storage batteries consume for this output, as demonstrated by experience, 2·5 kilos (5·51lb.) of coal and more (per horse-power hour). In fact, there will be not less than 440 tons of coal saved per annum, while the cost for the maintenance of the battery scarcely exceeds one-seventh part of this amount saved."

The power station is equipped with the following apparatus: two vertical compound steam-engines, each of 90 h.p., operating at 240 revolutions per minute; two Oerlikon shunt generators of 66 kilowatts capacity (550 volts), operating at 450 revolutions per minute, belted to the engines. Of these two pairs, one only is usually in service, the other being held as a reserve. The idle pair can be put in service to relieve the other without interrupting the service of the station. It is, however, apparent that in case repairs to the storage batteries should be necessary the battery must be disconnected for a given time; in which case the reserve plant takes the place of the battery, and both machines, by switching in the compound coil, work as compound-wound dynamos. The storage battery is located in a special room, and consists of 300 Tudor elements No. 110, of 245 ampere-hours, and having a maximum current rate of 81 amperes. It is, however, possible, without shortening the life of the batteries, to double this current for a shorter time. The regulation of the charge or discharge of the batteries is effected by switching cells in and out of circuit by an automatic arrangement. In order to recharge these regulating cells and bring them up to the proper condition and make them uniform with the rest, a small direct-coupled generating unit is used, having a capacity of about three kilowatts, or 20 amperes at 150 and 30 amperes at 100 volts. It is found by experience that this small unit need not be operated continuously, but is only required to operate for an hour or two each day.

THE EQUIPMENT FOR ELECTRICAL ENGINEERING LABORATORIES.*

BY D. C. JACKSON.

When this subject was assigned to me by your secretary it was suggested that a discussion of the ideal equipment for the electrical engineering laboratories of engineering schools was not wanted. The discussion should be limited to the special electrical equipment that is necessary for use in engineering schools having a course in electrical engineering, in order that proper instruction may be given in their specialty to the undergraduate electrical engineering students. This seems to be a reasonable limitation, and, in fact, an essential one, if the discussion is to be of value. I doubt if anyone is able, with our present knowledge of the requirements, to outline the true ideal equipment for electrical engineering laboratories. We can all tell what we now consider an ideal equipment, but in a few years it may be far from ideal. We are, however, faced by a positive condition which demands a first class working equipment in the electrical engineering laboratories. How can the electrical laboratory equipment be made most effective, is a question for solution; how much and what equipment is required to fulfil the demand in the instruction, is another question which confronts us.

As we are are dealing with electrical engineering laboratories, we will presume that they are attached to the engineering department over which a professor of electrical engineering presides. The electrical engineering department is therefore separated entirely from the physics department, and is co-ordinate with the other departments of engineering. The practice at present common in many colleges of placing the electrical engineering course with its classroom and laboratory instruction under the direction of the professor of physics, is just as absurd as it would be to devolve upon that professor the instruction in advanced thermo-dynamics and the design and construction of steam-engines. It is equally absurd for the professor of electrical engineering to attempt to teach physics. Proper instruction in physics is essential to the student who is pursuing a course in electrical engineering, and the physics department must be well controlled and supplied with an excellent independent laboratory equipment. In addition to the ordinary general course in physics, the electrical engineering student should gain, during his course in physics, a common-sense grasp of the elementary notions of electricity and magnetism, and of the "all-pervading law of Ohm." The latter can be properly enforced in the laboratory by placing in the student's hands ordinary electrical instruments—such as galvanometers, bridges, voltmeters, ampere-meters, etc.

* Paper read before the Society for the Promotion of Engineering Education, at Brooklyn, N.Y., August, 1894.

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Before beginning his work in electrical engineering, the student's knowledge of Ohm's law and its common results should have become almost instinctive. The student should also become acquainted with the theory and practice of photometry. This should all be done in the physics department, and the equipment required for the instruction should be controlled by that department. Much of this equipment is quite different from that required by the electrical engineering department, but some of it is useful to both departments, and where students are not too numerous may be used to some degree in common.

With due regard for his preparation, it seems best to arrange the professional electrical studies for the average electrical engineering student in four divisions, in three of which laboratory work must be made an integral part of the instruction in a satisfactory course. The divisions are: (1) electromagnetism and its applications to special uses, with special reference to dynamos and motors; (2) electrochemistry, including primary and secondary batteries, and electro-metallurgy; (3) alternating currents and alternating-current machinery, including alternators, transformers, motors, condensers, etc.; (4) the special application of the preceding divisions in electric light, power, railway, mining, telegraph, telephone, and other types of plants. These divisions are of about equal real moment, but the last must be allotted more time in the lecture-room than either of the others, but little or no laboratory time or equipment need be directly allotted to it. The laboratory equipment for the first three divisions only need therefore be discussed. The equipment that can be made useful in the fourth division is usually of an illustrative nature, and must be a matter of slow growth and collection as the electrical industries progress rather than immediate selection.

While higher mathematics is a useful aid in each of the divisions, its limitations as an agent must be carefully shown in the classroom and laboratory. For the purpose of educating the judgment of a student, and fully defining the limitations of theories and mathematical deductions, the laboratory is indispensable, and the equipment should be selected with this object in continual view. The equipment should be so selected and be of sufficient amount that as much as one-half of the total time spent by the student under the direct instruction of the professors of electrical engineering may be profitably devoted to the laboratory. The equipment, moreover, should be such that the work may as far as possible deal with fixed commercial instruments and machinery, and actually follow the methods of testing and research used in practice. The first three divisions should each be properly represented by a commercial laboratory equipment, in which every principle and operation is illustrated and made useful in every-day instruction under the direction of a man who has had experience in similar commercial work after having had a thorough theoretical training in preparation for his work. The laboratory work must always go hand in hand with the classroom work, illustrating and strengthening the latter. In this way the equipment may be made most effective in the work for which it is designed.

We will call the laboratory equipments for the three divisions, the dynamo equipment, the electrolysis equipment, the alternating-current equipment, and consider the essential equipment of each separately in the consecutive order given, since that is probably the best order for the student to take them up. It is well to remember at this point that engineering measurements are almost invariably quantitative, and that the results from an engineering investigation which bear fruit are also nearly always quantitative. It is seldom that purely qualitative results may be accepted as satisfactory in engineering work. Therefore the laboratory equipment must be capable of doing quantitative work which is, in general, of satisfactory commercial accuracy, and which may be made rigorously exact for purposes of exact investigation.

The first work that a student should take up upon entering the dynamo laboratory is a study of the methods of testing the magnetic qualities of iron. In this work, testing by magnetometer, ballistic galvanometer, and traction should be used. The apparatus for the magnetometric method is very simple and is generally at hand, as almost any reflecting galvanometer may be used for the magnetometer. For the ballistic method, a magnetising yoke and proper test-pieces should be supplied as well as a satisfactory galvanometer. Arrangements for determining the constant of the galvanometer and proper current-measuring instruments must be supplied. For the latter, Weston ampere-meters with proper scales and in good condition are entirely satisfactory. To determine the constant of the galvanometer, several methods requiring their own special but simple apparatus should be used. The special apparatus for the traction method of testing iron consists simply of a magnetising yoke with its test-pieces. Here, again, an ampere-meter is required. Indeed, a good supply of first-class ampere-meters and voltmeters is of the utmost importance in the electrical laboratory. These should be selected so that various types are represented, but for general use with continuous currents the Weston instruments are most satisfactory, and should therefore be in a majority. Ampere-meters, with scales from 0 to 1, 0 to 5, 0 to 15, and 0 to 50; voltmeters, with scales from 0 to 5, 0 to 60, 0 to 150, 0 to 600; and milliampere-meters and millivoltmeters are indispensable. The actual number of instruments required for use must depend, of course, upon the number of students who work in the laboratory.

In addition to the standard methods of testing iron which have been mentioned, there are several special devices constructed by different instrument makers which are of some advantage in instruction, but which should not be purchased until the essential equipment is supplied. Such are the iron tester using a bismuth spiral made by Hartmann and Braun, the Siemens and Halske device, and magnetic bridge arrangements.

It is not a bad plan to have various test-pieces for use with the ballistic method made from cast and wrought iron and cast steel of known chemical composition and degrees of annealing. These may be most conveniently in the form of bars to be used with the magnetising yoke, or may be rings. By using various specimens for the class testing a very good idea of the differences to be found in different bars is given to the students. In this work the students should always be required to plot both the curve of magnetisation and the permeability curve of his specimen, as well as to fully report his process.

After the testing for simple magnetic quality comes the measurement of the hysteresis loss and its companion—coercive force. For this purpose apparatus for the magnetometric method, with slowly varied continuous currents, should be provided. This may be similar to the apparatus for the magnetometric method of testing the magnetic quality of iron. If a sufficiently small number of students work in the laboratory, the same apparatus may be used. In addition to the magnetometric apparatus a couple of devices for testing hysteresis loss by alternating currents should be supplied. These methods are being improved so rapidly that it is almost impossible to say which are the best for fixed use in laboratory instruction, and much must be left to individual choice. Here, again there are various excellent illustrative but unessential pieces of apparatus, such as the Ewing curve tracer, which should only be purchased after the essential apparatus is fully supplied, or which really belong in the field of the department of physics.

The writer makes all his laboratory work follow quite closely to his classroom instruction, and therefore makes the work in the dynamo laboratory follow the plan of his text-book on "Electromagnetism and Continuous-Current Dynamos." Consequently, after the students have completed their work in magnetic testing, they begin a study of the dynamo. The dynamo-room must fulfil two objects: (1) to furnish current for experimental work which cannot be conveniently furnished from the laboratory lighting circuits; (2) to supply machines for laboratory testing. For the first purpose dynamos of various pressures driven by a steady power must be arranged so that they may be operated upon laboratory circuits as desired. This requires that a good automatic engine, which is used for no other purpose, be used to drive the dynamos, and that the machines be systematically wired to suitable distributing switchboards. A good storage battery of 60 or 70 cells is a most useful adjunct in this connection. For the second purpose it is

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desirable to have continuous-current machines of comparatively small size—from 2 to 10 kilowatts capacity. Such machines are readily handled, are not readily injured, when injured are inexpensive to repair, and laboratory testing with the machines under load is always possible, when it would frequently not be so with larger machines. A dynamo laboratory in which a fair number of students work needs a number of such machines, which should be carefully chosen to represent the widest range of types and styles of construction. All these machines should be so arranged that they may be operated either as dynamos driven from a constant-speed prime mover, or as an electric motor.

Upon entering the dynamo-room for work the student receives systematic instruction in handling the dynamos so that his work may proceed without danger to himself or to the machines. Determinations of the strength of the fields of dynamos when the armature windings are known are then made from measured speeds and pressures. This requires no instruments except voltmeters and ordinary speed counters. Following this comes the measurement of leakage by ballistic methods, and a comparison of the measured results with results calculated from the dimensions of the machines. This gives the student an idea of the large percentage of guess which must enter into such calculations. Tests of the magnetic circuits of dynamos, the regulation of dynamos and motors with different forms of field windings, effect of load on lead, characteristic curves, etc., all require the all-useful ampere-meters, voltmeters, and speed counters, which, as already said, must be on hand in sufficient number and with a sufficient variety of range.

Efficiency testing requires a more varied equipment, yet in this the ampere-meter and voltmeter hold prominent places. In stray-power tests and determinations of the losses by hysteresis and Foucault currents in armature cores, ampere-meters, voltmeters, and speed counters supply all the information that is needed. Efficiency tests should always be made by stray power, live-load and dead-load methods. For the latter, convenient variable liquid, wire, and lamp loads should be liberally supplied. One or more first class bridges must be at hand for measuring resistances and standard instruments, such as Kelvin balances or Weston laboratory instruments, should be conveniently arranged for the calibration of the portable instruments. Stationary devices for the measurements of currents, such as a good calorimeter and a galvanometer arranged for use in the so-called Vienna method, should be properly mounted.

Recapitulating, the essential apparatus for the dynamo laboratory is: Appliances for testing the magnetic and hysteretic qualities of irons, together with the necessary test-pieces, galvanometers (plain and ballistic), standard solenoids, earth coil, condenser, etc. Set of small continuous-current dynamos and motors representing various types for laboratory testing. Goodly supply of first-class ampere-meters and voltmeters, of various types, with standards for use in calibration. Instruments for measuring currents by different methods, bridges, and special instruments for measuring resistances. Various arrangements for loading dynamos and motors, and testing their speed. A number of portable storage cells to furnish steady currents which cannot be conveniently supplied from the lighting circuits and the dynamo-room.

The electrolysis and alternating-current equipments will not be taken up in so great detail. The former requires for the fundamental work a number of standard cells, silver and copper voltameters, fine galvanometers, balances for weighing, accurate resistance boxes, devices for measuring the resistance and specific inductive capacity of electrolytes. For the advanced work is required a goodly supply of primary and secondary cells of various types which may be used in examination and testing, and a well-equipped set of two or three good sized electro-deposition vats and arrangements for heating by the arc, with low-pressure dynamos, and the ampere-meters, voltmeters, and hydrometers which are necessary to carry out work on a considerable scale in electro-deposition and electro-metallurgy. The electrolysis laboratory has received comparatively little attention in American engineering schools, but its importance makes it deserve an allotment of its full share of equipment and instructional force. There seems to be a time coming when the electrolysis equipment will be made equal in importance to the dynamo equipment in all first-class engineering schools.

The alternating current is receiving a preponderating amount of attention in many colleges, sometimes on account of the numerous striking and beautiful experiments which may be performed by the alternating current, and sometimes because of the attractive field of speculation which is opened by the use of polyphase currents in power transmission. It is not belittling the enormous power value of the alternating current to say that the equipment of each of the divisions should be given equal consideration, and no one should be given undue prominence to the injury of the others.

The effects of self-inductance, mutual inductance, and capacity are at the root of a large proportion of alternating-current phenomena, and the fundamental alternating-current equipment should be arranged for the study and measurement of inductances. It would be a long step in advance if electrical engineering graduates were given as lively and practical a working conception of inductance and reactance as that usually given them of Ohm's law and its results. For studying inductances in the laboratory, various coreless solenoids are needed, which may be used for experimental and mathematical determinations of the coefficients. The methods of measuring the inductances of solenoids should include the direct measurement of self-inductances by ampere-meter and voltmeter using an alternating current of known frequency, the comparison of self-inductances with each other and with mutual inductances, the direct measurement of mutual inductances by ampere-meter and ballistic galvanometer, the comparison of self and mutual inductances with capacities, etc. After these measurements have been carried out by the student, using the simplest known methods, the measurements should be extended to include circuits with iron cores. These measurements require comparatively simple apparatus, but it should be on hand in sufficient amount. Carefully-wound long and short solenoids of known constants, condensers of known capacity, bridges, alternating-current ampere-meters and voltmeters, a sensitive ballistic galvanometer, and a secohm-meter are essential for the work. A very convenient instrument for use in this branch of the work is a variable standard inductance, but its place may be filled by solenoids of known constants.

After inductances, the alternator and single-phase currents are in logical line. One or more small alternators are needed for this work, which may be carried out in much the same way as that relating to continuous current dynamos. The work, however, requires the introduction of two new instruments, the wattmeter and a device for taking alternating-current curves. Wattmeters are difficult instruments to get in satisfactory form, but probably the Weston form is the best for general laboratory use, though a split dynamometer is a good instrument to have at hand. There is a considerable number of schemes for the tracing of alternating current and pressure curves, and more than one should be put into use. The relations of the current and pressure waves in circuits should be studied from the curves, as well as from measurements of the true and apparent energy in the circuits. This study is finally applied to transformers, a number of which, representing various types of construction, should be in the equipment.

The laboratory equipment to be supplied for the study of polyphase current effects is as yet an open question. It seems desirable to have at hand polyphase currents of variable frequency and induction motors representing the different types of construction. The variable frequency polyphase currents may be most readily gained by means of a rotary converter.

The equipment which has been enumerated, or is necessary to carry out the experiments that have been mentioned, covers the essential requirements of any first-class undergraduate course in electrical engineering. There is much more work which must be carried out in the laboratory, such as testing the insulation resistance of wires, measuring the earth's magnetic force, accurately comparing standard resistances by divided wire bridge, etc., but the equipment for this is found in that already enumerated, or has its

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place among the apparatus of a well-equipped physics department. There is much apparatus which is entirely unnecessary for both the physics and electrical engineering departments to possess. In fact, the work just mentioned, with the exception of insulation testing, really belongs in the instruction given by the professor of physics, and, as intimated earlier, it is well for the laboratories to be quite independent of each other. There is a vast amount of work carried on by undergraduates in the preparation of theses which is often in the nature of excellent investigation. Some of this requires special apparatus, and the extent to which it should be supplied from laboratory funds is an open question. Where the investigation does not require special apparatus, or where the work is in the nature of a test of commercial apparatus or an operating plant, the equipment that is required will nearly always be found among that supplied for the regular course, if the latter has been properly designed.

In determining the course of study to be pursued by the electrical engineering undergraduate, upon which the course of laboratory work must depend, it must, unfortunately, be remembered that he cannot confine his attention to electrical engineering during the whole time given to professional work in his course. He must gain an elementary but practical knowledge of thermodynamics and hydraulics, with an efficient knowledge of their application in steam and water power plants. He must also get a common-sense knowledge of the principles underlying the design, manufacture, and selection of machinery. In fact, he must receive a good working knowledge of the problems of the mechanical engineer. Laboratory courses are likely to fail when not properly balanced on account of a failure to educate the common-sense or judgment of students, and the students leave the college without having gained an all-round capacity for practical work and research which is necessary to put them in a fair way to become useful engineers. The knowledge of the electrical engineer must be based on the honest, well-tried mechanical laws, and he must go into a study of all that will aid most in putting him in a way to make a thorough electrical engineer.

THE "UNIQUE" SWITCHES.

We illustrate herewith some of the latest improvements in the "Unique" switches manufactured by Mr. A. P. Lundberg, Bradbury-street, Kingsland, N. The switch shown in Fig. 1 is now made in four sizes up to 20-ampere capacity. In the smallest size of switch the key is of

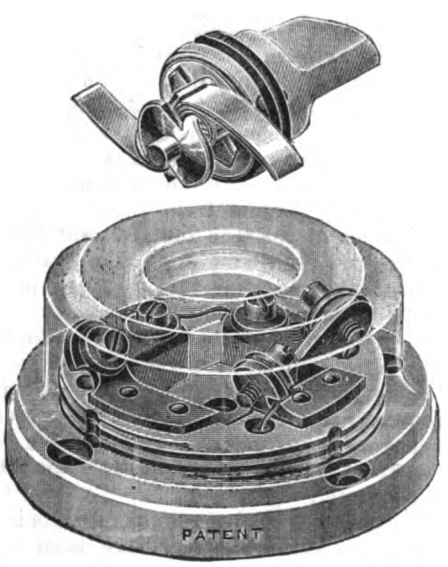

FIG. 1.

special construction, and persons, whether wilfully or ignorantly, turning the key against the springs can do no mischief through buckling them, the key undoing, but not detaching, a rubber ring taking all strain against the roof of the cover. The brasswork of the key is fixed to it by an improved patented method which has superseded the use of tapped porcelain. The brass cradle-piece to which the springs are attached is now made out of stampings only, the start of the spring being clamped between lugs attached to the two parts forming the complete cradle. In

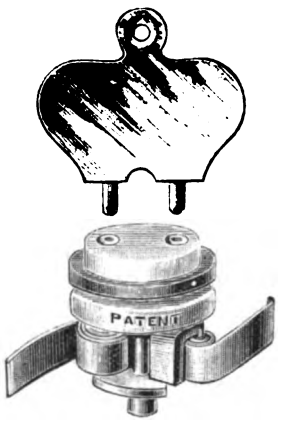

FIG. 2.

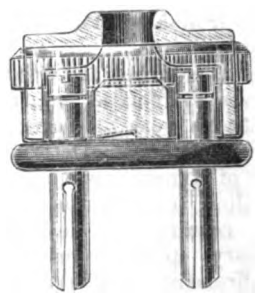

FIG. 3.

this manner the split pins previously used for this purpose are done away with. Improved terminals are also used in all sizes, the method adopted in the smallest size being shown in Fig. 1, the leading wires being drawn into the slot of the lug on the contact plate and clamped under the screw, the slot preventing it slipping out and allowing the wire practically a full turn under the screw. In the

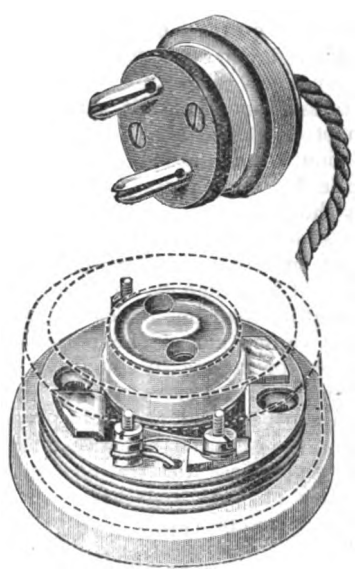

FIG. 4.

larger sizes, use is made of a screw-eye terminal, the leading wires passing through the screw-eye and being clamped against the upright lug of the contact plate, through which the screw-eye passes, by means of a hollow nut. The three-ampere and six-ampere sizes can be fitted, if desired, with porcelain centres for use with removable

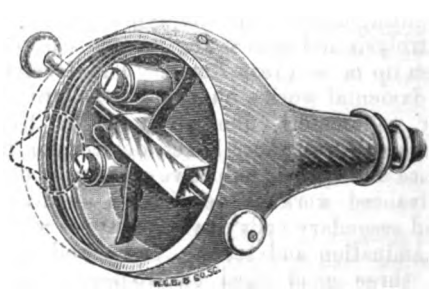

FIG. 5.

keys, which are shown in Fig. 2. A three-ampere damp and dust proof pattern, with brass cover, is now on the market, and is intended for use in exposed positions.

Fig. 3 shows an improved two-pin ratchet plug for use in the Unique combination switch and wall socket (which

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is represented in Fig. 4), which prevents the springs being damaged if turned backwards, the spring tongue of the ratchet only engaging when turning to the right. The construction and operation of the plug can be readily understood from the illustration.

Fig. 5 shows an improved form of bowspring pear switch.

COMPANIES' MEETINGS.

ELECTRIC CONSTRUCTION COMPANY, LIMITED.

The first annual general meeting of this Company was held at Cannon-street Hotel yesterday afternoon to receive the report of the directors and the accounts, which we printed in our last issue. Sir Daniel Cooper, Bart., G.C.M.G., occupied the chair.

The Chairman, in moving the adoption of the accounts and report, stated that before the shareholders could form a sound opinion on the accounts it was necessary that he should briefly give some idea of the troubles and difficulties the directors had had to deal with and overcome in the past year. They were aware that the old company was successfully reconstructed last year, but besides the work of reconstruction the Board and the managing director had to deal with several entanglements that had to be taken over as a legacy from the old corporation. These matters had been dealt with and, if not completely straightened out, were now in a comparatively narrow compass. At the end of December the heads of three important departments at Bushbury resigned on one month's notice, without any intelligible cause, and would not be induced to stay a short time longer till their places could be conveniently filled by others. At the same time, Mr. Parker, the works director, intimated to the Board that he would not renew his engagement, which was to expire in the coming May. The Board had no desire to retain him as works director, but they were willing to keep up his connection with the Company, and offered him a very liberal retaining fee as consulting engineer. This Mr. Parker declined to accept. About this time rumours became very prevalent that rival works were about to be built at Wolverhampton, but Mr. Parker strenuously denied that he had anything to do with them. Under these circumstances immediate steps had to be taken to reorganise the establishment, and in April it was found expedient to anticipate the termination of Mr. Parker's engagement by dispensing with his services. Now that the staff had been reorganised the Board were not sorry that the changes had been made, because they had secured a chief engineer and a technical staff at Bushbury in whose ability and loyalty they had full confidence; but it would be understood that such extensive changes could not be made without seriously interrupting the work in hand and the continuous flow of new orders, and that these explanations were necessary before a just conclusion could be come to respecting the accounts. He was happy to think that the accounts did not seem to require much explanation. And first, as respects the profit and loss account, he could not say that he was satisfied, although it was quite as good as could be expected under the circumstances already explained. A good deal owing to depression in business, but perhaps more to the reasons to which he had referred, the profits at Bushbury were too small and the general expenses too large. He hoped the directors would be able to show next year an improvement in both respects. The item of profit—£15,764. 10s.—on sales of shares and debentures of other companies, required some explanation. If the shareholders would refer to the balance-sheet they would observe an asset under the head of shares and debentures of other companies—£147,872. 6s. 7d. These interests in other companies were valued by the directors, when taken over from the old company, according to the best of their judgment. They had great difficulty in arriving at what they considered a fair valuation, because none of the securities had market quotations. After much deliberation the prices fixed were such as were considered safe, but at the same time they could not then have been realised in the market. The values depended on the development of the undertakings. As it happened, the interests in certain of these properties matured more quickly than was anticipated, and the directors found an opportunity of realising them before the end of the financial year, with a profit of £15,764. 10s.; this profit, less a proportion for general expenses, it was proposed to apply in reducing the amount at debit of this account, which would thus be strengthened by £12,500 to meet any unfavourable realisations, should such arise. Beyond the account—shares and debentures of other companies—he did not think there was any other item in the balance-sheet requiring explanation. During the past year there had been extreme depression in business generally, and very keen competition in electric manufactures, but, as would be seen from the report and accounts, the Company could fairly say that they had held their own. As to the future, he believed they had at Bushbury the finest electric works in the kingdom, and they were situated in a locality where work could be executed quite as economically as anywhere. Mr. Blackburn, the recently appointed chief engineer at Bushbury, had had wide experience in all kinds of electrical engineering, and was supported by a technical staff and a body of artisans at least equal to any other in the United Kingdom. All were determined to maintain the high character of the work hitherto turned out by the establishment, and the directors believed this could be done with greater economy that heretofore. The future, of course, depended to a large extent on the business activity, not only in this, but in other countries which they supplied with their manufactures. All he could say was that they expected to obtain a fair share of what work was going and to carry it out with reasonable profit to the shareholders. The business was never in so stable a position as it was to-day, and he not think there was any cause to be apprehensive of the future. Before moving the formal resolution, he would add that a moderate increase of capital would be of advantage to the Company. There remained of the £100,000 preference capital £74,010 unissued. The rate of dividend—7 per cent.—they thought too high, considering the improved position in which the Company now stood, but there were various difficulties in the way of reducing the rate. A quotation on the Stock Exchange for the preference shares had been obtained, and, as they could not redeem the portion issued, it would probably be impracticable to obtain another quotation for a new issue at a lower figure. The directors had come to no conclusion on the subject, but it was probable that they might resolve to offer the balance of the present preferred shares to the shareholders, giving ample time to pay up the calls, and thus the existing shareholders would receive, as they were well entitled to, the benefit of the high dividend payable on these preference shares.

Mr. Emile Garcke, in seconding the motion, said he would only add an expression of confidence in the staff. The success of such a company depended largely on the loyalty and capacity of the staff and of the body of artisans, and the directors had every desire to enlist the confidence of their workmen.

Mr. Williams considered that the expenses were unduly heavy, and wanted to know how Mr. Parker's secession would affect the Company.

Mr. Cook said that there was plenty of capital in the concern, but it was mainly lost. They had only £8,753 cash in hand, and about £32,000 due from debtors.

Mr. Hancock stated that affairs were very dispiriting. Patents were running out, and yet only £3,000 were allowed for depreciation, or only 1 per cent. That should be increased, or else someday there would be a dead loss. When the shareholders came in they were induced to do so by the stress which had been laid on the talents and connection of Mr. Parker, and his departure was a great loss to the Company. During the last four years about £500,000 had virtually been lost. Much of that loss had been due to the two sources from which the directors had been drawn—the Balfour set and the Irving Courtenay set. Some directors should be drawn from outside sources.

Sir D. Cooper stated that the present directorate were not responsible for the doings of their predecessors.

Mr. E. Garcke, on behalf of the directors, explained that the meeting must remember that the Board had only had one year's trial. With respect to Mr. Parker, he was building works at Wolverhampton. As regarded depreciation, the directors thought that if they kept the works in their present condition, and put in new tools, the sum provided was sufficient. He thought that as regarded Mr. Parker they had made a satisfactory change. He hoped that they would be able to show better results, and as good as any going.

The motion having been carried, Sir D. Cooper was re-elected a director, and Messrs. James Meston and Co. were reappointed auditors.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Portsmouth.—The Corporation want tenders by the 22nd inst. for the purchase of second-hand electrical plant.

Edinburgh.—The last date for the delivery of tenders for the arc lamp-posts required by the Corporation is the 17th inst.

Cheltenham.—The Town Council want a seven-ton hand-power overhead crane for their electric lighting station. Particulars are obtainable from the borough surveyor. Tenders are to be sent in by the 18th inst.

Bristol.—Tenders are invited for the construction of transformer chambers in certain streets in Clifton, for the Electrical Committee. Specification and plan of the arrangements required may be inspected on application to Mr. H. Faraday Proctor, M.I.E.E., city electrical engineer, Temple-back. Tenders must be delivered by noon on 18th inst., addressed to the Electrical Committee, Temple-back, Bristol, and endorsed "Tender for Transformer Chambers."

South Shields.—The following tenders are invited for the supply and erection of the following plant, for the Corporation: Section A—boiler-house plant, including boilers (marine type), fittings, pipes, chimneys, etc. Section B—pump-house plant, including double-acting, slow-speed, circulating and feed pumps, cast-iron tank, pipes, and fittings in connection therewith. Section C—engine-house and sub-station plant, including 100 and 25 kilowatt steam alternators, with double or triple compound engines, steam exciter, circulating pipes, switchboard and instruments, sub-stations, and transformers. Section D—underground work, including rubber-covered cables, cast-iron pipes, boxes, switches, and trenching. Section E—arc lamps, lamp-posts, switches, and transformers. Section F—meters. Firms tendering are at liberty to tender for any section or sections, or for the whole of the sections, but not for part of a section. Copies of specification, including plans, conditions of tender, and contract, can be obtained at the Borough Electrical Engineer's Office, South Shields, on and after 17th inst., on payment of £3. 3s., which sum will be returned on receipt of a *bond*

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fide tender. Tenders, sealed and marked "Tender for Electric Lighting," to be delivered to Mr. J. Moore Hayton, town clerk, Court Buildings, South Shields, by October 31.

RESULTS OF TENDERS.

Wolverhampton.—The School Board have accepted the tender of Messrs. T. W. Scott and Co., electrical engineers, etc., of Birmingham, amounting to £233. 10s., for an installation of the electric light at the Walsall-street new school, in accordance with the plans and specifications prepared by the architect of the Board.

BUSINESS NOTES.

Bacup.—The Liberal Club is to be lighted electrically.

Eastbourne—The electric light company are extending their mains.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,887.

Blackburn.—Provisional arrangements have been made for lighting the free library by electricity.

Commercial Cable Company.—A quarterly dividend of 1¾ per cent. has been declared, payable on October 1.

The Temple.—Preparations are being made for the installation of the electric light in the Middle Temple Library and Hall.

Direct Spanish Telegraph Company.—The Board recommends a dividend of 1s. 8d per share for the half-year ended June 30.

Ayr.—The Secretary for Scotland approves of the Ayr Town Council borrowing £15,000 for the installation of the electric light.

Southampton.—The Town Council are to hold a special meeting to consider the suggested purchase of the electric light undertaking.

Hove.—The new baths and laundry were opened on Wednesday. The buildings are lighted throughout by electricity, generated on the premises.

National and International Exhibitions, Limited.—This Company has been registered to promote, or assist in promoting, exhibitions, etc.

Llandudno.—The grounds of Rivière's concert hall have been lighted by Mr. Kingsland with arc lamps. Motor power is supplied by a gas-engine.

Liverpool.—The Duke of York on Monday laid a foundation-stone of new post office buildings at Liverpool. They are to be lighted by electricity.

Dover.—Notice of intention to lay electric light mains in Stroud-street and Wood-street has been received by the Town Council from the Dover Company.

Fareham.—Major Cardew, R.E., has held an enquiry in connection with the proposed transfer to the Local Board of the electric light undertaking.

Bristol.—A case of nuisance at the electric lighting works, owing to a smoky chimney, has been reported to the Sanitary Committee of the Town Council.

Manchester.—The lighting of Mudie's Library, Manchester, has been placed with Messrs. Drake and Gorham, of London, and the number of lights will equal about 100 of 8 c.p.

Queensbury.—Plans have been passed by the Local Board for a channel on the road to carry the electric supply conductor for Prospect House, for Messrs. J. Foster and Son.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending 9th inst. amounted to £1,054, as compared with £724 in the corresponding week of last year.

Reading.—An arcade of 20 shops has been opened in Friar-street, Reading. Sixteen of them are furnished with the electric light. The central part of the arcade is lighted by six electroliers, which give a brilliant illumination.

Hampstead General Electric Fitting Company, Limited.—This Company has been registered, with a capital of £1,000 in £1 shares, to carry on business as electrical and general engineers, iron and brass founders, wire-drawers, etc.

Streatham.—The Greyhound Inn has been lighted electrically, the work having been carried out by Mr. George Stegman, Clapham Junction. The installation comprises 80 16-c.p. lamps, and power is obtained from a Stockport gas-engine.

Taunton.—The Electric Light Committee of the Town Council have presented an estimate for further extension, amounting to £5,000, and they recommend that application be made to the Local Government Board for their sanction to borrow that sum.

Southport.—The Electricity Works and Plant Sub-Committee of the Town Council have recommended that a low-tension main be laid down on the Promenade, from Bold-street to Seabank-road, along Seabank-road, and in Lord-street from Seabank-road to Bold-street.

London.—Messrs. Drake and Gorham have obtained the contract for the lighting of the Royal Geographical Society's building by means of about 120 lights. The current is to be supplied from the central station, and it has been decided to do away with the gas altogether and to rely on the electric light alone.

City and South London Railway.—The receipts of the Company for the week ended September 9 were £840, against £754 for the corresponding week of 1893, or an increase of £86. The total receipts for the current period of the present half-year amount to £8,576, as against £8,148 in the corresponding period of 1893.

Northampton.—The annual report of the Northampton borough surveyor has been printed. It is incidentally stated that a considerable amount of work has been caused by the electric light company disturbing the footways in laying their mains, and a large amount of supervision has been necessary in consequence.

Stafford.—The work at the central station of the Town Council is going on satisfactorily, and the foundations are now put in. Six tenders have been received for the supply of cables, and have been submitted to the consulting engineer, Dr. Hopkinson, for him to report upon. It is intended to lay the memorial stone on October 17.

Middlesbrough.—The deputation appointed by the Middlesbrough Electric Lighting Committee to make enquiries relative to electric lighting in towns, have arrived at the conclusion that it would be in the interests of the borough to proceed forthwith with the laying down of an electric installation at a cost not exceeding £25,000.

Nelson.—The minutes of the Gas Committee of the Town Council state that the charges for electric light supply and the rent of meters had been reduced, and that the committee had resolved that all electric power for motor purposes be supplied to consumers at 4d. per unit, and the ordinary discount, and that the borough accountant arrange accordingly.

Gateshead.—The Town Improvement Committee have reported to the Town Council that their sub-committee to whom they had delegated the question of the advisability or otherwise of introducing a system of electric lighting into the borough, had before them a report from the town surveyor on the subject, and that they would report thereon at a future meeting.

Wells.—The Town Council is about to seriously consider the subject of adopting electricity for the public lighting of the city. The majority are decidedly favourable to it if it can be done at a reasonable cost. In the meantime Mr. Councillor Sheldon is laying down machinery and dynamos with a view to lighting his engineering works and his residence with electricity.

Halifax—The laying of the street cable has been completed, and the work of connecting with the business and other premises to be supplied is now in progress. At the works the stone beds for the engines, which Messrs. Pollit and Wigzell, of Sowerby Bridge, have now got ready for removal, are being prepared with every despatch. Fresh applications for the electric light continue to be received.

Devonport.—Intimations received by the Town Council from the County of London and Brush Provincial Electric Lighting Company, Limited, and the Great Western Electric Light and Power Company, Limited, of their intention to apply to the Board of Trade for provisional orders to supply electricity within the district of the Urban Sanitary Authority of Devonport, have been referred to the Streets Committee.

Luton.—Mr. Wilkinson, a member of the Town Council, has given notice that he will move the following resolution: "That the Highways and Lighting or a specially appointed committee do consider and bring up a report upon the question of applying for and ultimately obtaining a provisional order for the supply of electricity for public and private purposes within the borough of Luton, and that the Highways Committee do consider and report upon the probable cost of obtaining such order."

Sunderland.—Another official report has been prepared on the proposal to light the Town Hall by electricity. It is estimated that 312 lamps and sockets will be required inside the building, the cost of which is put at £450. An extra £70 would be required to adapt the Fawcett-street front, the plant and necessary alterations costing altogether about £600. The average cost of lighting by gas and maintenance, for three years past, has been £88 per annum, whereas electricity would cost £136 per annum.

Folkestone.—The following appear on the agenda of the Town Council: "To consider the question of the scheme for lighting the borough by electricity, proposed by Mr. Daniel Baker, at a cost of £12,000, and matters incidental thereto, and to make orders and to pass resolutions with reference thereto," and "to reconsider the subject of the report of the Special Committee as to electric lighting, which has been received by the Corporation, and the scheme and matters connected with that report and incident thereto, and to make orders and to pass resolutions with reference thereto."

Cheltenham.—The Town Council have received a certificate from the borough surveyor to the effect that Messrs. Malvern and Sons, the contractors, were entitled to £400 on account of the work done at the electric lighting station, and the same was passed. The town clerk read a correspondence between the Brush Electrical Engineering Company and himself upon the subject of the contract for transformers, and the town clerk's letters were approved and he was directed to forward them the draft contract for approval. The regulations relating to the supply of electric energy were approved.

Hastings.—The Public Lighting Committee of the Town Council have had their attention called to the dark state of that part of East-parade, etc., in the vicinity of the lifeboat-house after one-half of the electric lamps had been turned out at midnight, and in order to obviate this defect they had caused instructions to be given to the electric lighting company, by virtue of the terms of the contract with the company, to keep the lamp to the west of the Cutter Hotel (which was one of those turned out at midnight) alight all night in future, which would make the number of lamps to be lighted all night one in excess of half the total number of the lamps, and they recommended that their action in the matter be confirmed. This was carried.

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Hertford.—A public meeting of the ratepayers has been held for the purpose of considering the electric lighting scheme now before the Town Council. The chair was occupied by Mr. A. Hawks, and Mr. G. A. Munnings, a gas shareholder moved, "That this meeting having considered the proposed electric lighting scheme of the Town Council is of opinion that it is not desirable for the Council to proceed with it." This motion having been seconded, Mr. G. R. Durrant moved as an amendment, "That this meeting of burgesses desires to express its confidence in its elected representatives in the Town Council, and leaves the question of the introduction of electric light into Hertford to their discretion," which was seconded. On a show of hands the resolution was carried.

Bath.—The Bath Electric Light Company are using at their works in Dorchester-street a mixture of tar and creosote for firing the boilers. It is ejected by steam pressure in two small jets from a reservoir, itself heated also by steam, on to the furnace fire. The amount of coal or coke required is reduced to a minimum. It is stated that the experiments, which have resulted in the present application of the system, have been several months in progress under the supervision of Mr. G. F. Metzger, the engineer and manager, and involved much trouble to overcome. At the station powerful new engines and dynamos, making with those already in use 11 in number (the former being of some 900 h p. in the aggregate) are being erected, as well as a new switchboard.

Bradford.—The gas and electricity accounts were presented to the Bradford Town Council on Tuesday. Alderman W. Moulson, chairman of the Gas and Electricity Supply Committee, moved the adoption of the minutes of that body, and said that with regard to the electricity supply he had a favourable report to make. The laying of the three-wire system had involved an extra expenditure of about £700 on account of salaries and wages, but notwithstanding this there was a net profit on the past half-year of £336, as compared with £625 in the corresponding half of 1893. The £700 comes out of revenue. The total expenses of the electricity department were £3,221. 7s. 5d., and the gross income £5,418. 7s. 10d., as compared with £4,543. 8s. 3d. for the corresponding period of last year. The gross profit was £2,293. 15s. 1d., as against £2,189.

Yarmouth.—The borough surveyor has asked for instructions as to the gas lamps to be turned out when the permanent plant should be ready for work. He stated that along the line of the electric lamps there were about 120 gas lamps which would not be required, and he recommended that a joint committee of the Electric Light Committee and of the Lamp Committee should consider this question, as also that of the number of hours during which the arc lamps should be kept lighted. The committee recommended the Council to instruct the town clerk to give the gas company notice that about 120 lamps would not be required after November 1 next, the borough surveyor to prepare a list of the lamps which would not be required, and that the joint committee inspect the districts affected as soon as the borough surveyor had effected the alteration. The report was adopted.

Yeadon.—The Local Board on Monday night discussed the electric lighting question. The Board have obtained a provisional order giving them power to manufacture and supply electricity for public and private lighting purposes, and have obtained from several firms tenders as to the sum at which the plant could be put down; but the lowest of these is somewhat higher than the estimate which was submitted to the ratepayers' meeting that sanctioned the Board going on with the scheme. Some of the members of the Board are now in favour of deferring the question until after the election in November next, whilst others argue that as a mandate was received from the ratepayers to go on with the scheme, the Board are in duty bound to do so. Ultimately, after considerable discussion, the meeting decided to call in an electrical expert to advise the Board on the tenders and samples of materials sent in.

Dundee.—Messrs. William Ramsay and Co., electrical engineers, 254, Argyle-street, Glasgow, have secured an important contract from ex-Bailie Taylor for the illumination by electricity of his business premises in Yeaman's Shore and his steamer "Alice Taylor." By means of a private dynamo, and utilising the power of a steam-engine at present embraced in his stock, Mr. Taylor is to light all his offices, stores, stables, and workshops. Four powerful arc lamps, each of 2,000 c.p., are to be provided for the yards, two of these being placed in the railway yard and the other two in his English coal yard. An interesting fact is that the electric light will be introduced into Mr. Taylor's foreman's house, this being probably the first workman's house in the city thus treated. In resolving to have the "Alice Taylor" electrically lighted a new departure will be made in the coal trade, this being the first local steamer thus exclusively employed to be lighted in this manner.

Grange.—The following letter has been read at a meeting of the Local Board from Mr. C. W. Dean, clerk to the Rural Sanitary Authority: "The R.S.A. have received formal notice of the intention of the Windermere and District Electricity Supply Company, Limited, to make application to the Board of Trade for an order authorising the company to supply electrical energy within the area of the jurisdiction of the Authority, and the matter has been referred to a committee for consideration and report. I am instructed by the committee to enquire if your Authority has had the matter under their consideration, and what action (if any) has been determined upon. I am also directed to enquire if your Authority would be willing to appoint a small committee to join with this and other local authorities in the district in conference, with the view to combined opposition to the application in question." It was agreed that the clerk and Messrs. Midgley, Booth, and Westwood be appointed to confer with the committee of the Rural Sanitary Authority.

Private Telephony.—The new building in Salisbury-square, E.C., recently erected for Messrs. Lloyd, Limited, has been fitted throughout with telephones, on the intercommunication system, by the Private Wire and Telephone Installation Company, of 110, Cannon-street. The instruments, which are all of the magneto pattern, have been specially made in light oak to match the wainscoting and furniture of the rooms, and are eight in number—five of them desk sets and three wall sets. By this system all parts are enabled to have instant and direct communication with each other, which is not only more expeditious, but saves the services of an attendant, which would be necessary on the central exchange system. It is claimed that one of the advantages of the system as installed here is that when conversation is ended it is only necessary to withdraw the plug, it not being necessary to insert it in a "home" socket. All the instruments are fitted with Hunnings's transmitters, and the whole installation is worked by dry batteries, as also are the electric bells which have been fitted throughout the building by the same company.

Sheffield.—The proprietors of the *Sheffield Telegraph* are at present putting in the foundations of a new electric light plant, consisting of an engine and dynamo, which will form a duplicate to the existing plant now in use at the office for lighting and electric motive power. At present the electric lighting plant consists of a small dynamo by Messrs. Scott, Mountain, and Co., of Newcastle, capable of supplying 100 16-c.p. lights. This is used during the daytime. When the light is needed in quantity the larger plant is switched on, consisting of one of Messrs. Marshall's 45-i.h.p. high-speed engines, coupled by belt to a Wilson Hartnell 500-light dynamo. The new installation, which will be a duplicate of the above large plant, will consist of a Willans compound high-speed engine running at 500 revolutions per minute, and coupled direct to a Wilson Hartnell dynamo capable of supplying 500 16-c.p. lamps The Free Libraries and Museum Committee think it desirable to postpone the proposed cleaning, painting, and decoration of the Weston Museum until next spring, in view of the introduction of the electric light into the building in the meantime. Information and detailed particulars of electric lighting are to be obtained.

Newport (Mon.).—The Electric Lighting Sub-Committee of the Town Council have reported that the Corporation would be in a position to supply electricity in the month of October. The engine plant, which was being made by the Uskside Company, had been inspected by the engineer, and was progressing satisfactorily. The committee had also themselves inspected the electric lighting station and the progress of the buildings. The Uskside Company wrote asking for a payment on account, but the committee recommended that the terms of the contract be adhered to as to payment on delivery. None of the engine plant had as yet been delivered. Mr. Clifford Phillips asked whether the attention of the Traffic and Lighting Committee had been drawn to the bad lighting of Church-road Alderman Bear enquired whether, in view of the electric lighting of the borough, it was intended to continue to erect lamps. Mr. Brown (chairman of the Lighting and Traffic Committee) said that the spots where the electric lights were to be erected had been already fixed. No complaint had been made about the lighting of Church-road, and therefore the matter had not been taken into consideration. The Works Committee have reported in favour of erecting a refuge with an arc lamp at the cross-roads at the head of Newport Bridge.

Burton.—George-street Chapel has been renovated, and the electric light installed throughout. At a meeting of the Town Council, Councillor Rugg asked the chairman of the committee (Alderman Lowe) whether it was a fact that there was an enormous waste of electricity going on at the works when the electric lighting engines were running of an evening, and whether it was necessary to buy accumulators to enable them to store such wasted electricity so that it might be used in some of the public streets, and for electrical fans for ventilating public buildings. Alderman Lowe said perhaps Mr. Ramsden would be better able to reply to the electric light question than he (Alderman Lowe) was. But as he understood it, the system of electric lighting adopted in Burton was not one in which the storage arrangements could be adopted. The storage system could be carried out if there was only a small area to be dealt with, but over a scattered area like that at Burton it was not only unnecessary, but would be very expensive That, at least, was Mr. Ramsden's opinion. Councillor Rugg: You don't answer the question with regard to the waste of electricity. Mr. Ramsden (gas and electrical engineer): There is no waste. Alderman Lowe: That is a complete answer. Are you satisfied? Councillor Rugg: I will bring the matter forward again.

Cardiff.—The preparations connected with the lighting of Cardiff by electricity are now nearly completed. All the machinery and boilers are in position, the steam and exhaust pipes are being fixed, and final tests will shortly be run on the lamps, etc., to ascertain that everything is in a proper condition for starting. Fires have also been for some time in the boilers to make sure that everything is dry, and to prevent any possibility of cracking. Everything in the town is complete. The gas lamps are to be replaced by electric lamps. The Corporation insist that the new light shall immediately follow upon the old, so that the streets may not for a single night be improperly lighted. This will necessitate certain extra work and occasion some delay, though very little according to present arrangements. The prices for consumers have been fixed by the Cardiff Corporation at 6d. per Board of Trade unit for the

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current for lighting purposes, and 4d. per unit for supplying motive power for machinery. At Monday's meeting of the Town Council an intimation was made by Alderman Carey that the electric light would be started by the end of this month, or at the beginning of October. This he made, he said, on the authority of Mr. Massey, consulting electrical engineer to the Corporation. Tradesmen who intended taking advantage of the light were asked to take immediate steps for getting it laid on, inasmuch as the wiring would occupy some time. There would be a preliminary trial of the light, after which the new illuminant would be formally inaugurated.

Brighton.—The Theatre Royal has been reopened after renovation, and has been lighted electrically. The installation has been carried out by Messrs. F. Geere Howard and E S. Dashwood, of 10, Berners-street, London, W., under the personal superintendence of Mr. Dashwood. The installation comprises about 600 16-c.p. incandescent lamps, and extends from the stage to the colonnade in the front, which is illuminated by a series of incandescent lamps. It includes the entrance halls, the lobbies, corridors, staircases, and every part of the auditorium from the gallery to the stalls; and it is manifest that this has an exceedingly beneficial effect upon the ventilation of the building. About 400 of the lamps are on the stage. The battens, bearing variously-coloured lamps, are patent fireproof split steel tubes, and these, with the footlights and other portions of the installation, are controlled by a switchboard on the prompt side of the stage, the switches being so arranged as to permit of the lighting being dealt with in sections or as a whole. There are also separate switches in the front of the house which may be used independently of the main switches; and, as a precaution against any failure in the lighting arrangements, gas is laid on all over the house in such a manner that the whole may be controlled from two or three taps The electric lighting installation is on the three-wire system, and the current is obtained from the Corporation mains. The Town Council have decided to raise the salary of Mr. W. H. Everett, meter superintendent at the electric generating station.

Londonderry.—At a quarterly meeting of the Corporation a report has been submitted from the resident electrical engineer (Mr. Christie) to the effect that between August 22 and September 4 seven failures took place, placing about one-fourth of the portion of the city lighted by electricity in darkness for a night on each occasion. Six of the failures were due to bursts in the cable at different parts of the circuits. In the seventh case the failure, which extinguished 22 lamps, was caused by a faulty contact in one of the lamps. The failures, Mr. Christie added were not at all attributable to any action of himself or his staff. Councillor Hastings, chairman of the Lighting Committee, said he had asked for a full statement of the facts from Mr. Christie. They had been kept in the dark too long. A letter was read from Messrs. Siemens Bros. declining to admit that the repeated failures in the cables were due to defective manufacture or to careless handling on the part of their men. As, however, they were greatly interested in the success of the installation, they would consider the question of defraying the expense to which the Corporation had been put in reopening and closing the streets to reach the defective parts of the cables. A question was asked regarding any suggestions for preventing these failures in the future, but Councillor Hastings said such questions could not be answered. Messrs. Siemens Bros. were responsible for the working until May 29, 1895, when their period of maintenance would terminate. It transpired that Mr. Blake, the electrical engineer, under whom the installation was introduced, had gone to London to consult Dr. John Hopkinson, the consulting electrical engineer, who had already passed the specifications. The consultation took place with reference to the failures in the cable. Dr. Hopkinson's opinion had not yet arrived. A letter had come from him which, however, the chairman declined to make public at present.

Portsmouth.—The Electric Light Committee of the Town Council have reported that it would be necessary to enlarge the generating plant at a further cost of £6,000, and recommended that the Local Government Board should be requested to sanction the borrowing of £20,000 to cover any further extension that might be required, so as to obviate the necessity of making repeated applications. Alderman Ellis, in moving the adoption of the report, said that at the present time they were supplying 4,140 16-c.p. lamps and 725 were waiting to be wired, making a total of 4,865, which meant an income of nearly £5,000 a year. To that they must add the increase for Corporation street-lighting. Assuming that the inhabitants went on applying for the light to the same extent as heretofore, the Corporation would have an income from that source of from £12,000 to £14,000. Mr. Kimber seconded. Alderman Sir W. Pink said that he feared they were going too fast. He should like to know what the real income up to the present time had been, and what the real prospects of the light were. Mr. Evans also opposed the recommendation of the committee, saying that he thought £6,000 enough for one time. They had no right to invest so large a sum unless they could see a fair return for it. He moved that the £6,000 only be granted. Sir W. Pink seconded the amendment. Alderman Scott Foster said that it seemed to him to be a great mistake to refuse the money necessary for the extensions which were rendered necessary by the demands of the public. After further discussion the resolution was passed by a large majority. The President of the Chamber of Commerce has pointed out at a meeting of that body that after the electric light had been turned on there was such a buzzing in the telephone instruments that it was impossible to communicate a message. The Secretary said he had written to the company and had received a reply that they were dealing with the matter.

Ulverston.—The clerk to the Local Board has read the minutes of a committee meeting at which the following resolution was passed: "That the clerk write to the Board of Trade stating that having considered the report of the deputation which waited upon the Board of Trade, and fully considered the question of electric lighting of the town, and ascertained that at the present time the inhabitants within the restricted area of supply would not take the light in the place of gas, this Board are of opinion that looking to the great expense they have had to incur in making provision for an efficient supply of gas, they should not be called upon to lay down an electric light plant until the owners and ratepayers within the Board's district signify their desire that such should be afforded, but as soon as such desire is expressed the Board will be prepared to meet the same, and the Board trust that this decision may be satisfactory to the Board of Trade, and that the Board of Trade will not entertain any application by outside parties to supply electricity within the Board's district." The Gas and Water Committee received a letter from the clerk to the Ulverston Rural Sanitary Authority, asking if the Local Board would appoint a committee to meet a committee appointed by the Authority to consider the question of opposing the provisional order of which the Windermere District Electricity Supply Company have given notice to the Board and other authorities within North Lonsdale. It was recommended that the Board should appoint a committee. Mr. Tosh moved, and Mr. Case seconded, the adoption of the report. Mr. Birkett asked whether the appointment of the committee proposed would involve any expense, and whether it was not in contradiction of the letter sent to the Board of Trade. The Clerk said it was really intended to strengthen the opposition, and the committee would have to report to the Board before any expense was incurred. Mr. Tosh said the object was that the various authorities should co-operate to oppose the proposed invasion of this district by an outside company. The report was approved, and it was resolved that the committee consist of the chairman of the Board and the chairman of each standing committee.

Bury.—A long discussion has taken place at a meeting of the Town Council as to the letting of the contract for the installation of electric lighting. The tender of Messrs. Storrs and Sons, Stalybridge, had been accepted after revised tenders had been sent by that firm and Messrs. Thompson and Brierley, of Bury. Mr. Spencer said that the tender accepted was only about £70 to £80 less than that of a local firm, amounting to only about 1 per cent. more, and he contended that Messrs. Thompson and Brierley ought to have the contract, as the money would be spent in the town, and would thus circulate to the benefit of all. Dr. Greenhalgh seconded an amendment to this effect. The Mayor said everything had been done that could be done to give a local firm the preference, and the real difference in the tenders was about £160. Messrs. Storrs would have to pay the same wages, and perhaps employ a number of local men. Besides, if the local tender was accepted the difference would not go to the ratepayers, but to the local firm. Mr. W. Sykes said he looked upon the question as one of principle. If Mr. Spencer wanted an article, and a Heywood firm would supply it for £99 and a Bury firm would not supply it at less than £101, he would employ the Heywood firm. And what he would do privately he ought to do on the Council—spend the ratepayers' money to the best advantage. Members of that Council such as Mr. Bryon did work in other towns; and if Bury set up to be a close Corporation, and employed only local firms, they would want a wall built round. He found that every shop in Bury sold foreign goods such as he manufactured, but he did not go whining about and saying that they should buy of his firm. Mr. Collinge said that Messrs. Thompson and Brierley were heavy ratepayers, and the difference was so small that it would pay to give them the contract. Mr. Bryon said he had been employed by the Manchester Corporation for four or five years, and had at present a heavy contract with them. If only local tenders were to be accepted outside firms would cease to tender, and the work now done from outside districts would not be given to him and others. Alderman Brierley had a large contract on at Prestwich, and Prestwich and Manchester might object if such a rule as that suggested were to obtain. The amendment was defeated by 15 to 10.

Birmingham.—The installation of the electric light at the Market Hall is nearly complete, and the new illuminating appliances will be brought into use in about a fortnight. At present the hall is lighted by a central ring of gas-jets and by standards and naked burners connected with the various stalls. Altogether there are 550 burners to illuminate a building 350ft. long and 100ft. wide. Enquiries and experiments were made by the Markets Committee as to an improved method of gas lighting, and it was found that electric arc lights would be more economical. The new installation consists of 33 arc lights, some of which are outside the building. The electric energy will be taken from the electric supply company's mains in Bell-street. The light from the arc lamps will be between three and four times that derived from the present gas lighting, even after allowing for the loss of half the total light on account of the use of opaline globes. The cost of running the electric lamps will be £507 for energy and £25 for carbons, as compared with £522 for gas. It is proposed, however, to pay off the capital outlay of £900 in 10 years, making an addition for interest and sinking fund of £100 per annum for the period named. The Markets Committee considered the desirability of establishing their own generating plant This would have still further reduced the annual cost, but it was thought the difference was not worth the inconvenience of introducing new machinery. The new installation has been designed by Messrs. Henry Lea and Thornbery, civil engineers, of Birmingham, under

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whom it is being carried out by the Walsall Electrical Company as contractors. Messrs. Lea and Thornbery also have in hand the introduction of electric lighting for the new meat market, the municipal school, and the botanical gardens. The arc lamps are of the Brockie-Pell pattern, and the ornamental ironwork is by Messrs. Hart, Son, and Peard.

Whitehaven.—The chairman of the trustees for the town and harbour of Whitehaven, Mr. J. G. Dees, in proposing the confirmation of the minutes of the Electric Lighting Committee, stated that they had a deputation from the Eccles Corporation, who are considering the advisability of adopting electricity as a means of public and private lighting. They expressed themselves highly gratified with the light and with the manner in which they had been entertained. Applications for the electric light at Whitehaven continued to come in in almost too satisfactory a manner. They had now applications nearly up to their present requirements, and there were several more applications coming in. With regard to the application to the Local Government Board for power to borrow £5,000 more on electric lighting account, they had expected that the result of the former enquiry and the evidence then given would have been sufficient for the Local Government Board's purposes, but a letter had been received pointing out that it would be necessary to hold another enquiry, also that it would be necessary to apply to borrow £6,304. He moved that application be made to the Local Government Board to borrow this amount, and the motion was agreed to. Mr. Cant asked that some statement should be prepared showing the financial aspect of electricity in connection with the town before they spent a large sum of money upon it. When the subject was first brought up, Mr. Brodie, then engineer, submitted a creeping scheme, then they had a walking scheme, and now it appeared to him they were going in for a flying scheme. The chairman pointed out that he had recently shown that up to March 25 there had been a saving to the ratepayers on the electric lighting as against gas. They had only had the electric light from September 2 to March 25 on which to base their calculations, but even in that period, when the expenditure was extraordinarily heavy, the result of the working was a saving as against the price of gas in the previous year, and the estimate of the surveyor and the Electric Lighting Committee was that there should be a very considerable saving this year. There would be no difficulty in furnishing a statement showing the result of the working of the electric light up to the present time, and he promised that such a statement would be supplied.

Salisbury.—At a meeting of the New Sarum Town Council a letter has been received from Mr. Hammond to the Council stating that he had sent a copy of the following letter to the Board of Trade: "To the Assistant-Secretary, Board of Trade, Whitehall, S.W. Sir,—In reference to the license applied for under the Electric Lighting Acts, 1882 and 1888, by the Salisbury Electric Light and Supply Company, Limited, in respect of the city of Salisbury, in the county of Wilts, I beg to hand you, on behalf of the Corporation of Salisbury, acting as the local authority, a draft of the said license, with some slight alterations and additions thereto, and beg to express the desire of the Corporation that the amendments indicated shall be made by the Board of Trade in granting the license. I beg to make the following observations thereon: Section 3—The date filled in is deemed to be the most suitable one from which the license shall date. Section 4—The additional clause becomes necessary in the event of the possibility of the local authority becoming the purchasers of the undertaking. New Section 8—The local authority consider that the audit of the accounts which is usually provided for in the provisional orders shall not apply in the case of this license. Section 23—It is felt that the local authority should have power to make representations and objections. Section 31—The addition is rendered necessary by the possibility of the local authority becoming the purchasers. Section 65—The local authority feel that in the event of revocation, the power of purchase, which usually is inserted in provisional orders, should also apply in the case of a license. Sections 66, 67, 68—The same remarks apply. Section 70—As this section replaces the ordinary penalty sections, it is desired to make it as full as possible, and not to limit the duties by the words 'in relation to the supply of energy.' Fourth schedule—The local authority desire that 8d. should be the maximum price permitted." In the second letter from Mr. Hammond he said, "I believe I am right in saying that Sir Thomas Blomefield has explained to the company the disinclination of the Board of Trade to issue any licenses, and that in view of the application of a provisional order the period would be limited to two years, and that they were contented to accept the license on this basis." Mr. Watson: Then we get for our £50 absolutely nothing. Mr. Nodder: That is just what I anticipated. Mr. Watson: So did I. Mr. Nodder: We have the reputation of being a rich Corporation. Mr. Waters: We came to a wise decision.

Colliery Plant.—In the course of a recent visit of the Federated Association of Colliery Managers to the Forest of Dean, a visit was paid to the Trafalgar Colliery, the directors of which have for some time felt that it was necessary, on account of the increasing distance from the shaft at which the workings were being carried on, to place a good system of haulage in operation, and guided by the previous successful applications of electric power, and on the advice of Mr. F. Brain, it was decided to instal a "main and tail rope" system, operated from the bank at top by electricity. Specifications having been prepared by the consulting engineer to the company, Mr. Le Neve Foster, of London, tenders were invited, and eventually a contract signed with Messrs. Easton, Anderson, and Goolden, Limited, for the supply of the whole plant, comprising a double-cylinder horizontal engine, driving the generating dynamos by means of rope gearing. The engine (which has been built by the firm of Messrs. T. and R. Lees, Hollingwood, Manchester), as at present arranged, is intended to develop 150 h.p. at 85 revolutions when driven by steam at 50lb. pressure, but is specified to develop 264 h.p. at the same speed when driven at 80lb. pressure, which it is intended eventually to adopt. For this reason only one dynamo (if the exciter is omitted from consideration) is at present installed, but the driving ropes are sufficient, and couplings are provided for a second dynamo of equal power to be eventually added. In addition to this a smaller dynamo is in operation, used for exciting the magnets of the generating dynamo and driving some lamps, and capable also of supplying current for the electric pumps already installed. The large generating dynamo has an output of 600 volts and 150 amperes, at 500 revolutions. From the dynamo the current is led to the switchboard, of which all parts carrying the high-tension currents are so enclosed as to be inaccessible while the current is "on," so that accidental shocks are impossible, and then down the shaft by cable insulated with vulcanised indiarubber, being carried in iron pipes, with junction or test boxes at intervals. At the bottom of the shaft the cables are carried on insulators till the haulage engine is reached. This consists of a pair of 5ft. drums, each 3ft. wide, carried loose on the main shaft, to which are keyed friction clutches, enabling either drum alternatively to be driven, the other running free. The present arrangement of the plant has been laid out by Mr. Ll. B. Atkinson, of Messrs. Easton, Anderson, and Goolden, Limited, under the superintendence of Mr. F. Brain and Mr. Le Neve Foster.

Southport.—The Electricity Works and Plant Sub-Committee have recommended the Town Council that a low-tension main be laid down on the promenade from Bold-street to Seabank-road, along Seabank-road, and in Lord-street from Seabank-road to Bold-street. Alderman Hacking, in moving the adoption of the minutes on Wednesday last, said no doubt the members would want to know what they were going to do with respect to the electricity arrangements. They would see from the minutes the committee had decided to lay down a low-tension main on the promenade from Bold-street to Seabank-road, along Seabank-road, and in Lord-street from Seabank-road to Bold-street. They had had an application for electrical energy from the Queen's Hotel, and they thought it possible that they might also have a similar application from the Convalescent Hospital. The reason they decided to do this work at the present time was that they had some hundreds of yards cable over and above what they required for the streets which had been scheduled; they thought that was the proper time to do the work, and that the cables would be more likely to do good when laid than lying in coils in the yard. The building at Crowlands was roofed in, and the stone beds for five of the engines and dynamos were fixed, and they were assured that the others would be completed that week. Councillor Hesford seconded the motion. Councillor Boocock said he had been asked several times when they were to have the electric light. They were told they were within measurable distance of the completion of the work, but he should like to have an official statement on the point. Alderman Hacking said last month it was said the installation would be complete by the end of September, but he would rather they would allow the committee a little more latitude, for they could never be certain what the chapter of accidents might bring about. He would say this year, and he hoped long before the year was out. Councillor Hatch asked if the work of laying the main referred to by Alderman Hacking had been let by tender, and if it had been approved by the Council. Alderman Hacking said the cable had been contracted for, and the tender had been accepted by the Council. They required no tender for what they had in stock. The cable would be laid by their own men. Councillor Holland asked if it was the intention of the committee to introduce the electric light on the promenade. Blackpool had the electric light on the promenade; other towns were ahead of them in that respect, and with a beautiful promenade like theirs its lighting by electricity ought to have consideration before the lighting of the shops. Alderman Hacking said he did not think that was the business of the committee, but rather of the Council. They had not reached that stage yet, and the Council might do whatever it pleased. The Mayor: At present it is not included in the work contemplated. Alderman Hacking: No street-lighting is contemplated yet. The minutes were adopted.

Monmouth.—In our issue of the 31st ult. we gave some particulars of the report presented to the Town Council by Messrs. Bramwell and Harris on the electric lighting of the town. The subject has since been before the Town Council, when the Mayor observed that at their last Council meeting authority was given to himself to form a special committee to attend to the details of the electric lighting and sewage scheme. He would suggest that this committee remain in power until the work was completed. Afterwards it could be naturally divided and the drainage portion would go, as a matter of course, over to the Sanitary Committee, and then no doubt they would form a permanent committee to attend to the lighting portion of the scheme. That committee they could form when the scheme was completed. It was important to his mind that the engineers should be selected without further delay. There had been a great deal of preliminary work done, and the engineers would not proceed further without the Corporation signing the usual agreement with them. Their agreement with Messrs. Bramwell and Harris, as consulting engineers, whom he had recently seen, as well as Mr. Lailey, was

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practically at an end. He had not known whether Messrs. Bramwell and Harris extended their work beyond that of consultation, and he had accordingly enquired on the subject, eliciting the reply that they were prepared to superintend the carrying out of the work at a commission of 5 per cent., plus out-of-pocket expenses. Mr. Wilson asked how they stood with regard to the Brush Company. The Mayor said they owed them 10 guineas for work they had already done. There was nothing more. He pointed out that the appointment of the Brush Company would prevent Messrs. Bramwell and Harris arranging and being associated with their own water power. Mr. Wilson said the Brush Company were prepared to look after the water power when the proposal applied to the water in the Wye. The Mayor: Personally I don't object to your suggestion, though I give the preference to Bramwell and Harris under the circumstances. Mr. Wilson: It is just possible the Brush Company may do it cheaper. Alderman Hyam: We shall not throw the Brush Company over. Mr. Morgan: Then we shall have three of them on the job. The Mayor: No, the Brush Company will come in as contractors The Mayor pointed out that Mr. Lailey had not the option of selecting his own site, and it was to the pumping station only that exception was taken by the Local Government Board. Mr. Wilson persisted that there was no idea before of having engineers to superintend the Brush Company. Before they were to have been engineers, contractors, and everything. The Mayor: We should have to put somebody on our behalf to look over them—an independent consulting engineer to superintend the fixing of the work. Now it is proposed that Messrs. Bramwell and Harris shall take that position. That is all. Mr. Wilson: I see. Messrs. Bramwell and Harris will occupy the position of architects, so to speak, and the Brush Company that of working contractors. The Mayor: Precisely. On Tuesday a special meeting of the Town Council was held to appoint an engineer to prepare plans and specifications for the combined scheme for drainage and electric light in the borough. After a protracted discussion it was decided, by seven votes to six, that Mr. Lailey, C.E., Westminster, be employed. The whole of the work connected with the electric installation, as well as the conveyance of the sewage from the pumping station to the purifying-tanks, is to be entrusted to Messrs. Bramwell and Harris. The minority wished to employ Messrs. Bramwell and Harris alone.

PROVISIONAL PATENTS, 1894.

SEPTEMBER 3.

16774. **Improvements in the construction and working of voltaic batteries.** Desmond Gerald FitzGerald, 53, Chancery-lane, London.

16775. **Improvements in voltaic batteries and electrolytic cells or tanks.** Desmond Gerald FitzGerald, 53, Chancery-lane, London.

SEPTEMBER 4.

16825. **Electromagnetic car brake and traction device.** Robert Thomas Murray and Charles Milton Allen, 60, Queen Victoria-street, London. (Complete specification.)

16851. **Improvements in or relating to underground electric railways.** William Phillips Thompson, 6, Lord-street, Liverpool. (Oscar Axel Enholm, United States.) (Complete specification.)

16854. **Improvements in continuous-current dynamo-electric machines without commutators.** Sydney Hopwood Blake, 70, Chancery-lane, London.

16857. **Improvements in telegraphy and in the means employed for perforating tapes used for this purpose.** Patrick Bernard Delaney, 24, Southampton-buildings, Chancery-lane, London.

16859. **Improvements in systems of electrical distribution.** Thomas Cornell Coykendall, 53, Chancery-lane, London. (Complete specification.)

SEPTEMBER 5.

16887. **Improvements in or connected with ships' telegraphic apparatus.** Hedley Oliver, 15, Water-street, Liverpool.

16912. **Improvements in electrical insulating compounds.** George Edward Heyl, 37, Chancery-lane, London.

16916. **An improved apparatus for manipulating lime and electric lights, and the boxes used therewith.** Henry Taylor, 106, Priory-park-road, Kilburn, London.

16918. **Improvements in access and junction boxes for electric conductors.** Alfred Fox, 46, Lincoln's-inn-fields, London

16939. **Improvements in apparatus for recording electric currents.** Hermann Aron, 6, Lord-street, Liverpool.

16943. **A new or improved portable ladder platform for the use of telephone or telegraph linesmen or the like.** Thomas Langlois, jun., 22, Glasshouse-street, Regent-street, London.

SEPTEMBER 6.

17000. **Improvements in electric arc lamps.** James William Rogers, 24, Southampton-buildings, Chancery-lane, London.

SEPTEMBER 7.

17047. **An improvement in electrical lock and block apparatus for railway points and signals.** Edward Tyer, 28, Southampton-buildings, Chancery-lane, London.

17065. **Improvements in or relating to electric cables, wires, or conductors for conveying electricity to vehicles or travelling motors.** Sebastian Ziani de Ferranti, 6, Lord-street, Liverpool.

17066. **Improvements in electric cables.** Sebastian Ziani de Ferranti, 6, Lord-street, Liverpool.

17077. **Improvements in lenses and electric lamps, more especially intended for use for theatrical stage purposes** Walter Pfeffer Dando and James Eglinton Anderson Gwynne, 47, Lincoln's inn-fields, London.

SEPTEMBER 8.

17129. **Improvements in electrically-heated soldering irons.** Paul Stotz and Friedrich Wilhelm Schindler-Jenny, 89, Chancery-lane, London.

17130. **An improved apparatus for electrically heating liquids.** Paul Stotz and Friedrich Wilhelm Schindler-Jenny, 89, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1889.

9571. **Telephonic communication.** Kingsbury. (Welles.) (Second edition.)

1893.

13610. **Dynamo-electric machines.** Gravier.

15577. **Electric furnaces.** Chaplet.

17603. **Arc lamp.** Atwater.

18173. **Electrolysis of chlorides, etc.** Hargreaves and Bird.

19183. **Transmitting signals through submarine, etc., cables.** Muirhead.

22184. **Regulating electromotors.** Abel. (Berliner Maschinenbau Aktien Gesellschaft vorm. L. Schwartzkopff.)

13723. **Electrolytic production of bleaching liquid.** Kellner. (Second edition.)

1894.

12605. **Telephones.** Nikolajczuk.

13523. **Reflectors for electric arc lamps.** Coerper.

13762. **Electric railways.** Jenny.

13765. **Electric railways.** Johnson and Lundell.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	5	5½-5⅝
Bournemouth Electric Company	—	—
Brighton and Hove Company Original	100	210-215
—— "A" Ordinary	—	162-166
Brush Company, Ordinary	3	2⅝-3⅛
—— Nom. Cum., 6 per cent. Pref.	2	2⅛-2⅜
—— 4½ Debenture Stock	100	109-112
Charing Cross and Strand	5	4½-5⅛
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	12½-13½
—— 6 per cent. Cumulative Pref.	10	14½-14⅝
—— 5 per cent. Debenture Stock	115	129-132
City and South London Railway, Consolidated Ordinary	100	36-38
—— Debenture Stock	100	121-123
—— 5 per cent. Pref. Shares	10	12½-13½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1⅞-2⅛
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	95-100
Electric Construction, Limited	2	⅛-¼
—— 6 per cent. Debentures	—	87-92
—— 7 per cent. Cumulative Pref.	2	1⅞-2⅛
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1⅛-1⅜
Elmore's French Company	2	⅛-⅜
Elmore's Wire Company	2	1⅛-1⅜
Fowler-Waring Cables	5	⅛-1⅛
W. T. Henley's Telegraph Works, Ordinary	10	7⅛-8⅛
House-to-House Company, Ordinary	5	1-1⅛
—— 7 per cent. Preference	5	5⅛-5⅝
India Rubber and Gutta Percha Works	10	23½-24½
—— 4½ per cent. Debentures	100	104-106
International Okonite, Ordinary	—	—
Kensington and Knightsbridge	5	4⅜-5⅛
—— 6 per cent. Pref.	—	6⅛-6⅜
Liverpool Electric Supply, Ordinary	5	6⅞-7
—— Pref.	—	—
Liverpool Overhead Railway	10	7⅞-8⅛
—— Pref.	10	12¾-13
—— 4 per cent. Mortgage Debentures of £100	100	111-113
London Electric	5	⅞-1⅛
Metropolitan Electric Supply	10	9⅛-9⅞
—— 5 per cent. Reg. Debentures, 1-10,000 in Bonds of £10, £20, and £40	—	—
National Telephone, Ordinary	5	4⅞-5⅛
—— 6 per cent. Cum. First Pref.	10	14-15
—— 6 per cent. Cum. Second Pref.	10	13½-14⅛
—— 5 per cent. Nom. Cum. Third Pref.	5	5⅛-5⅜
—— 4½ per cent. Deb. Stock	—	109-111
Notting Hill Company	10	4⅛-5⅛
Oriental and Electric Company, £1 shares	1	1-1⅛
—— £5 Shares	—	6⅞-7⅛
—— £4½ shares	—	5⅛-6⅛
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	6⅞-7⅛
—— 7 per cent. Pref.	5	8¾-9
Swan United	—	—
Telegraph Construction and Maintenance	12	40-42
—— 5 per cent. Bonds	100	102-105
Westminster Electric Supply, Ordinary	5	6⅛-6⅜
Yorkshire House-to-House	4½	4⅛-4⅜

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NOTES.

Electricity in India.—Rs. 18,000 has been sanctioned for lighting the Arkonam railway station with electricity.

Telegraphy in India.—The project for a telegraph line from Tavoy to Mergui has been abandoned for the present.

Institution of Civil Engineers.—The premises of this body in Great George-street, Westminster, are being reconstructed. The theatre is, however, to be left intact.

Telephony in Austria.—It is stated in Belgian newspapers that when the Austrian Government buys up the telephone lines it will issue a loan to provide the money.

International Exhibition at Bordeaux.—An international exhibition of arts and industry is to be held next year at Bordeaux. There are 10 classes, of which the ninth deals with electricity.

Telephony in Germany.—The Pforzheim Chamber of Commerce is in communication with the postal authorities for the establishment of direct telephonic communication between Pforzheim and Mayence.

A New Cape Steamer.—The "Guelph" is the latest addition to the fleet of the Union Steamship Company. She has been built by Messrs. Harland and Wolff, of Belfast, and is lighted electrically.

Electric Fans.—At the new Birmingham hospital there are two large revolving fans which propel the cleansed air and which are driven by electromotors. The premises are also lighted by electricity.

The Electro-Harmonic Society.—The next smoking concert of this society will be held on Friday evening next at the Banquet-room, St. James's Hall, Regent-street, W. We printed the programme in our last issue.

Exhibition at Stuttgart.—A proposal has been made that in connection with next year's opening of the Stuttgart central electric supply station there should be held an industrial exhibition, with electricity as a special feature.

Franklin Institute.—We have received the September issue of the *Journal* of the Franklin Institute of Philadelphia, which, among other matters, contains a paper by Mr. Thomas Commerford Martin on "Electricity in the Modern City."

The Heilmann Company.—The "Société Anonyme Traction Electrique, Système J. J. Heilmann," have held an extraordinary meeting of shareholders, at which it was decided to double the capital, which now stands at 1,000,000f. (£40,000).

The Houses of Parliament.—It is stated that during the present recess further progress is to be made with the scheme of electric lighting at the Houses of Parliament. There are many members who are much in need of enlightenment.

Electricity in South Australia.—The cost of lighting Parliament House, in South Australia, with electricity, formed the subject of a return laid before members by the Minister for Education. The total cost since its installation, including all costs of lighting during the 1891 session, amounted to £2,153. 18s. 10d.

An Electric Dairy.—At Blythwood, Stanstead, on Wednesday, Mr. and Mrs. James Blyth entertained upwards of 700 guests on the occasion of the visit of the British Dairy Farmers' Association to their electric dairy. The buildings are lighted electrically, and the cream separators and churns are worked by electromotors.

The Economy of the Electric Light.—Mr. William Whiteley, the "universal provider," of Westbourne-grove, states that he is saving £500 per annum in whitewashing alone by having adopted the electric light in his establishment. He adds that "there are many other advantages attaching to this system of lighting." Quite so.

Long-Distance Telephones.—A petition is being signed at Cardiff with a view of inducing the National Telephone Company to place that town in direct telephonic communication with the Metropolis. A similar movement in connection with the Post Office telephone system has been initiated by the Cardiff Chamber of Commerce.

Gas and Electricity Profits.—The Bradford Corporation in the last half-year made a profit of nearly £6,000 on their gasworks, and £336 on their electricity works. In the corresponding half-year the gasworks had a loss of £1,100. This indicates that the supply of the electric light is inducing gas consumers to burn more gas.

Electric Power in Germany.—The sugar refinery at Itzehoe, which is partly lighted electrically, is to receive a power transmission plant, comprising a 250-i.h.p. steam-engine, and 200 effective horse-power primary dynamo, and six electromotors of a total of 190 h.p. The work will be carried out by Messrs. W. Lahmeyer and Co., of Frankfort-on-the-Maine.

The British Museum.—The annual report relating to the British Museum states that the artificial lighting of the reading-room has been greatly improved by the installation of incandescent electric lights fitted to the reading desks. The old system of arc lamps is, however, still retained for the general lighting of the room, but at a lower power.

Cable-Laying in Scotland.—H.M.'s telegraph steamer "Monarch" arrived in Kirkwall Bay on Saturday. The vessel has been engaged laying cables on the west coast, and is engaged lifting the old cable in Ring Sound, replacing it with a new one. This cable crosses from the mainland to Shapinshay, and has been a private one, but is now expected to be made public and taken on to the Post Office.

Technical School at Bury.—Lord Derby has opened the technical schools at Bury. A fan driven electrically is used for taking off the fumes from the chemical laboratory combustion chambers. The closets are lighted by an automatic switch light, which switches the electric light on and off as the door opens or closes. The lighting throughout is by electricity, there being 211 lights in all, including two arc lights outside.

Heriot-Watt College. — We have received the calendar for the session 1894-95 of the Heriot-Watt College, Edinburgh. Although Edinburgh cannot be called an engineering centre, the classes connected with engineering subjects are very largely attended. In electrical engineering and applied physics the professor is Mr. R. Mullineux Walmsley, D.Sc., London, and the assistant professor is Mr. James A. Wilson, M.A., B.Sc.

Personal.—Mr. F. F. Bennett, M.I.E.E., of the firm of Bennett and Druce, Preston, has been appointed by the Radcliffe Local Board as their consulting and electrical engineer. He is also retained to prepare plans, specifications, etc., for the lighting of the town and district of Radcliffe, and to superintend the carrying out of the same. Mr. Hubert P. Marsh has been appointed teacher of electricity by the Rochester Town Council in connection with the local technical education scheme.

New Publications.—Messrs. Whittaker will issue shortly a new and mostly rewritten edition of Mr. Gisbert Kapp's "Electric Transmission of Energy" (as we have

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already announced); "Model Engine Construction," by Mr. J. Alexander, with working drawings; "Steelworks Analysis," by Prof. J. O. Arnold, of the Sheffield Technical School; "Steam Power and Mill Work," by Mr. G. W. Sutcliffe, M.I.C.E.; and "The Manufacture of Modern Explosives," by Mr. Oscar Guthmann, A.M.I.C.E., F.I.C., etc.

Change of Address.—Messrs. Jeffery, Taylor, and Co. inform us that they have changed their address from Tidal Basin, E., to 11, Queen Victoria-street, E.C., where they will continue to carry on the business of electrical engineers, their speciality being house and ship lighting. They have recently completed installations at the Royal Albert Music Hall, Canning Town, E., where there are outside Jeffery arc lamps; at 159, Fleet-street, 303, Holborn, 151, Bishopsgate-street, and 160, Fleet-street, and have rewired several Royal Mail steamers.

Electric Lighting at Warsaw.—Offers have been received for lighting Warsaw electrically from Mr. Podobiedow, Mr. Paszkowski, and Mr. Timaszäjew, all of St. Petersburg; Mr. Ratner, of Warsaw; Messrs. Siemens and Halske, and the Allgemeine Elektricitäts-Gesellschaft, of Berlin; Messrs. Ganz and Co., of Budapest; the Oerlikon Works, of Switzerland; Mr. Waldeck, of Antwerp; and Mr. Berthol, of Paris. Further tenders are expected from other firms. The electric light is to be introduced in 1896, when the contract with the Continental Gas Company of Warsaw expires.

Telescopic Scaffolds.—As time passes on it is well we should find improvements effected in means for fixing and attending to arc lamps with greater facility and convenience, and Mr. Heathman, of Endell-street, is always striving to meet the requirements of electric lighting in the way of ladders. He is now constructing portable telescopic scaffolds, with his recent improvements, for the Norwich Castle Museum; the London and North-Western Railway Company, Crewe Station; the Great Northern Railway Company, King's Cross Station; the Bedson Wire Company, at Middlesbrough; Spitalfields Market; and Aberdeen railway station.

Electrical Accidents.—Somebody or other once referred to alliteration's artful aid, but it can be reduced to absurdity. The "dangerous dynamo" is the expression used by a juvenile sub. on a Tudor-street evening paper in connection with an accident which occurred at Leicester, on Monday, at the electric light station at the Midland Railway Company's station. If you want alliteration it sounds very well to refer to the "silly *Sun*," for it was not a shock from a dynamo, which killed the youth. He fell on to a flywheel and was knocked about, with the result of death. But such a death is not to be put down to electricity. You can get it in any works.

Union of Continental Incandescent Lamp Manufacturers.—Mr. G. Straus announces that the members of the union held their quarterly meeting from September 10 to 13 at Frankfort-on-the-Maine. Every member was present, and unanimously confirmed the resolution carried at the previous meeting. It was officially announced by the president of the meeting that communications had been received from several makers who had hitherto kept aloof from the association that they would like to join, and instructions were given for the management to make arrangements to meet these gentlemen and to arrange for them to join the union forthwith.

Yet Another Electric Launch.—The new electric launch "Maggie" ran her trial trip on Monday from the Barry Graving Dock and Engineering Company's works at Barry Docks, where she was wholly built, the run proving in every respect a successful one. There was a good company on board at the time, and the working of the new craft by means of electricity was much admired. This is the first electric launch built and fully equipped in South Wales. The electrical machinery was constructed under the supervision of Mr. D. Lowdon, M.I.C.E., A.I.E.E., for the Barry Graving Dock Company, the general manager of which, Mr. J. Lowdon, J.P., accompanied the boat on her trial trip on Monday.

What Are They About?—The Local Board of Sutton-in-Ashfield have extended the gasworks. They almost do not seem to know that the electric light is knocking about, although it is mentioned that the development of the electric light, and its application to several of the large factories in the town, has reduced the quantity of gas made, and for some considerable time the output from the gasworks has shown a falling off. The difficulty of supplying these factories previous to their adoption of the electric light was not so great as might at first sight appear, because the consumption by these works was mainly at night, when the shops in the town were closed, and when there was not such a strain upon the supply.

A Funny Notion.—The *Yarmouth Independent* says: "The Trinity Brethren can surely not be in earnest in their suggestion that the electric lights on the parade should be screened seawards. How can they possibly be any danger to ships at sea? We should think they would be a safeguard rather than a delusion, and would intimate to them their position. One single bright light might perhaps cause a little confusion until masters became acquainted with its position, but a line of lights along a parade can surely have no element of danger to the shipping. One of the advantages of the electric light on the Drive is that it lights up the beach, and if it were shaded on the sea side much of its utility and value would be gone. The electric light is used under similar circumstances in other places, and we hope no obstacle will be put in the way of its continuance here."

City of London School for Girls.—This school, which is situated in Carmelite-street, Thames-embankment, was opened on Thursday night last week. It owes its origin to Mr. William Ward, of Brixton, who left £20,000 to the Corporation for the purpose. The school is lighted electrically. On the occasion of the opening ceremony there was a display of electrical appliances illustrating the progress of telegraphy. The instruments, which were under the charge of Mr. J. W. Curra, included some curious old apparatus designed by Messrs. Cooke and Wheatstone, one of them having been in use in Buckingham Palace so far back as 1850. Another singular relic was a piece of wood containing fine laid wires which, in 1837, formed a portion of the telegraphic communication between Euston Station and Camden Town. Telegrams were dispatched from room to room by Wheatstone's A B C machine transmitting over 300 words a minute.

Electric Production of Sulphuric Acid.—Mr. R. W. Hill, of Manchester, writes that he has invented an electric apparatus for the production of sulphuric acid. The apparatus works quite automatically, and requires no manual assistance. If a leakage of acid somewhere takes place, an electric bell rings. The replacement of carboys (filled with ready-made concentric sulphuric acid, H_2SO_4, 66deg. Beaumé) takes place only once a week or fortnight, depending on the number of carboys, which vary from six to forty-eight or more as required. An electrical automatic hydrometer regulates the density of acid, thus any density of acid can be obtained. Sulphuric anhydride is produced direct

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from sulphur dioxide (oxygen) by means of an electric current of low pressure. No platinised asbestos "chambers" or chimney are required for this new electro-chemical process. As soon as the empty carboys are full with ready-made acid an electric bell rings at the offices, thus signalling the fact that the filled carboys should be replaced by empty ones.

Electric Lighting in France.—It appears that the use of gas-engines for electric lighting purposes is making headway in France, and that this fact may lead to an understanding between the owners of gasworks and electric lighting concerns in cases where the former are unwilling to themselves undertake the supply of current. The *Génie Civil* draws attention to the installation at Rheims, which has been carried out under the direction of Mr. Théodore Vautier, of the group of gasworks which have their head-quarters in Lyons, and who was assisted at Rheims by Mr. André Coze, the manager of the local gasworks, one of the group in question. The central electric lighting station at Rheims at first comprised two 50-h.p. gas-engines, to which there have been added this year two 80-h.p. Niel two-cylinder gas-engines and a 45 h.p. Niel gas-engine. This is the most important electric station in France depending upon gas for motive power. There are two continuous-current C. E. L. Brown dynamos made by Messrs. Weyher and Richemont, of Paulin, running at 500 revolutions, and furnishing a current of 165 amperes at a variable pressure of from 240 to 300 volts. The efficiency of the dynamos is 88 per cent.

Electrolytic Works in Sweden.—A large electrical installation has been erected at Mansbo, Dalecarlien, Sweden, in connection with a chemical works where electrolytic processes are to be employed. The power station has been erected at the side of a waterfall in the neighbourhood, and 4,000 h.p. is available. At present there are eight turbines erected, each of 220 h.p. They have horizontal shafts, and run at 280 revolutions per minute, each being coupled direct to a dynamo. The dynamos are arranged in a row against a wall, which forms a dam to the upper part of the water. On the opposite side of the chamber in which the dynamos are placed there is a switch-board opposite each dynamo. The dynamos work independently, but in order to have a kind of reserve an arrangement has been made whereby each neighbouring pair of switchboards can be connected by means of a reserve cable. The dynamos have six poles and drum armatures, and have a normal output of 115 volts and 1,200 amperes, at which they have to be able to work day and night without interruption, though for a short time they can be considerably overloaded. The installation has proved most satisfactory, and it is proposed to increase it by 10 similar sets of turbines and dynamos. The electric portion of the plant was carried out by the General Swedish Electricity Company, of Vesteras.

Electricity at the Belgian Arms Factory.—We have on previous occasions given particulars respecting the electrical arrangements at the Belgian National Arms Factory at Herstal, near Liège. Some additions have been made to the plant, and the latest information appears in the *Times*, which says: "A very striking feature in connection with the Herstal works is the fact that the whole of the machinery is driven by electricity, the same agency being employed in lighting the factory and the yards. There were originally 13 electrical motors, having a total of 260 h.p., and a combined engine and dynamo of 500 h.p. These have been recently supplemented by an additional 300-h.p. plant. From the main generating dynamo the current is distributed to the various departments. In each department it drives a motor, which in its turn drives, through belting, a given length of main shafting. One great advantage of this arrangement is that each principal transmission shaft is under the control of its own electro motor, and is independent of the others. The particular characteristic of the main dynamo is that not only is it driven direct by the steam-engine, but the armature itself forms the flywheel of the engine. The first installation was put down three years ago, and it has been running continuously ever since most successfully and with marked economy. The supplementary installation is equally successful, and combines with the other machinery to make the Herstal works one of the most perfect of its kind."

Associated Chambers of Commerce.—At last week's meeting of the Associated Chambers of Commerce at Huddersfield, Mr. Plummer (London) proposed, and Mr. Thompson seconded, and it was resolved: "That this association expresses its hearty approval of the resolutions adopted by the inter-colonial congress recently held at Ottawa in favour of inter-Imperial postal and telegraph routes between this country and the colonies, and between the colonies themselves respectively, without such routes passing through other countries; and this meeting would urge on the postal and other governmental departments the importance of aiding, as far as possible, the proposals of the congress, and that memorials be sent to the Prime Minister, the Chancellor of the Exchequer, and the Postmaster-General." Mr. Eldridge (Wakefield) moved, "That in the opinion of this association, it is unfair to the public that the telegraphic department of the Post Office should for financial purposes be treated as a separate establishment, thereby causing unwarrantable delay in carrying out urgent and much-needed reforms: that, inasmuch as the postal establishment and its various departments are in their entirety a financial success, the time has arrived when the address of not exceeding four words should be allowed free of charge in all telegrams, and that telegraphic communication should be extended to rural districts where practicable; that a deputation wait upon the Postmaster-General to urge upon him the desirability of adopting this suggestion." Mr. W. Lester-Jones (Cardiff) seconded the resolution, which was passed. Mr. Walker (Huddersfield) moved, "That this association reaffirms the desirability of the law relating to the rating of machinery being settled in accordance with the principles in the Bill which was introduced into Parliament, and that her Majesty's Government be requested to give facilities during the next session for the passing of an Act to settle the law upon the subject." Mr. Slater (Leeds) seconded the resolution, and it was passed.

Rectifiers.—We referred last week in a note to the fact that Mr. Sidney F. Walker had again been on the war-path in the Welsh papers on the subject of rectifiers, which he described as "a laboratory toy." This has raised the ire of Mr. S. Z. de Ferranti, who writes in reply: "As a sub-contractor for a portion of the arc lighting work at Cardiff, you will perhaps allow me to say a few words on this subject. I cannot for a moment regard what Mr. Walker says in a serious light, but I must point out that what he says with regard to the arc lighting is without any foundation whatever. In the first place, the arc lighting by means of rectifiers in Cardiff has not been abandoned, and his kind congratulations on the subject are, therefore, quite superfluous. Mr. Walker goes on to say that he has persistently said that the use of rectifiers in Portsmouth has spelt trouble to all concerned. In doing this he has simply written that which is untrue, as the arc lighting by means of rectifiers at Portsmouth has proved the most complete success. The fact of being able to light the con-

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tinuous-current arc lamps by means of rectifiers instead of by separate plant has greatly added to the economy and satisfaction of arc lighting, and therefore the system is is being largely adopted. Rectifiers and arc lamps working off them have been ordered by the Islington Vestry for the lighting of the main thoroughfares of this most important parish. Rectifiers have also been ordered, according to the specifications of Mr. W. H. Preece, chief engineer to the Post Office, for the lighting of Tunbridge Wells. Again, they have been ordered by Prof. Kennedy for lighting the principal streets of Edinburgh with arc lamps, and rectifiers have also been ordered for the extension lighting for the streets and sea-front of Blackpool by Mr. R. Hammond. There is not now a consulting engineer of any importance who has not got rectifiers on order for the arc lighting of the streets in the different towns of this country. I think that the above will be sufficient to prove how completely satisfactory this system of arc lighting has proved to be. The delays which have occurred in getting the station to work are simply what one may expect with any new enterprise, and if the Cardiff installation had been ready as quickly as many people would have liked, it is quite certain that it would have been the first case on record where the people were satisfied in this respect. It is very evident that there is not much left to be done before before a start can be made, and Mr. Massey's wise judgment in the matter will then be fully demonstrated. I consider that it is very unfortunate that Mr. Walker, who from the address at the foot of his letter—namely, Cardiff Electrical Works—might be considered to be officially employed by the Corporation, should be allowed to make rambling and false statements. Fair criticism is always desirable in the conduct of public enterprise, but criticism which is wholly without truth or reason can be nothing but bad."

Leeds Corporation and Electric Lighting.—The question of how, and by whom, the Leeds Town Hall and Municipal Buildings shall in future be lighted, has been discussed at a meeting of a special sub-committee of the Leeds Corporation. For a long time past the electrical plant in the basement of the Municipal Buildings has been a nuisance, the noise and the vibration caused by it being a source of considerable discomfort to those engaged in clerical work in the building. The matter first came before the committee in February last, when the city engineer was instructed to prepare a report upon "the question of the removal of the electric lighting station to one of the refuse destructors," it being thought that the waste energy at one of those places could be utilised. This report has been submitted to the committee. It appears that there are at present in and around the Town Hall and Municipal Buildings 3,131 incandescent lamps of 16 c.p., and 10 arc lamps of 2,000 c.p. The total cost for the year ended March last was £3,729. 6s. This included £1,022. 14s. 2d. for lamps, renewals, and attendance; £1,506. 12s. 4d. for mechanical power, and £1,200 interest and sinking fund. It was estimated that the cost of lighting by the present plant was 6·70d. per unit. The estimated cost, if the current were supplied by the House-to-House Electricity Company, was £3,383. 9s. 6d., or 6·57d. per unit. The estimated cost of electric lighting, supposing the current to be generated at the Kidacre-street destructor and led to the Town Hall, was 7·21 pence per unit. It seems rather singular at first glance that the cost at the Kidacre-street destructor should be the greatest, notwithstanding that the steam for the generation of power at that place would cost nothing. "This arises," says the report, "from the fact that £11,300 additional capital (inclusive of £3,000 for stand-by plant, absolutely necessary, though not provided in present plant) is required for that place, and that this £11,300, added to the capital of leads, lamps, etc., in the buildings, has to be met with an annual payment of 12 per cent. The result of this speedy repayment would be that in 10 years the debt would have been cleared off, the annual cost would be reduced some £1,100, or 2·15d. per unit, making the cost at Kidacre-street thereafter 5·06d. per unit as compared with 6·57d., the cost if the supply is taken from the House-to-House Company. Another feature in favour of the Corporation generating the electricity at Kidacre-street, or, indeed, anywhere, is the fact that should the Corporation in the future buy out the electricity company, it would not have to buy out the profits on its own custom, which on the present consumption of electricity would amount to about £3,300. After a lengthy discussion, the committee resolved to recommend the Council to accept their electrical supply from the House-to-House Electricity Company for a period of two years at a price to be agreed upon. If the Council carry out this recommendation, the present plant will remain in the Municipal Buildings in case it may at any time be required.

First Aid in Electric Accidents.—Dr. W. S. Hedley, of Brighton, writes to the *Lancet* as follows: "For the information of those who are not medical men and electricians, the article on the pathology and treatment of electric accidents in the *Lancet* of August 25 may be suitably supplemented by briefly adverting to the question of first aid in such cases, and to certain risks attendant thereon. It is obvious that the first thing to do is to detach the body of the victim from the circuit with which it is contact; but it is equally obvious that, as that body is forming part of the circuit, it would be dangerous to touch the skin with bare hands, inasmuch as anyone doing so would thereby 'shunt' a portion of the current through his own body. The clothing, if dry, would afford a considerable, but not quite adequate, protection; it is therefore necessary to improvise some kind of insulation for the hands of the rescuer. Further, as is well known, the muscles of a body traversed by an alternating current of high tension remain in a state of tonic contraction. In other words, a hand grasping a cable remains tightly clenched (the condition of 'fixation'), and detachment is not always easy. Such accidents generally occur by the completion of a circuit between the cable and the earth, but sometimes contact is made simultaneously with both poles of a circuit. The time seems to have arrived for the publication of some carefully considered authoritative code of instructions for the management of such accidents as well as for their prevention; in the meantime, however, such considerations as the foregoing would appear to point to the following: Rules for guidance in electric accidents—(1) Break the circuit at once if there be an interrupter close at hand and you know how to use it; if not, lose no time, but proceed to Rule 2. (2) Do not touch the man's body with your bare hands, but if indiarubber gloves are not at hand, pull him off the cable by his coat-tail, or fold your coat or some such dry article into two or three thicknesses, and, using this as a pad to take hold of the body, pull it away from the circuit and resort to Rule 5. (3) If unable to get him off, raise with covered hands that part of the body which is touching the earth, or one of the poles of the circuit. This will break the circuit, and it will usually be thus possible to get him easily away, and, if so, proceed to Rule 5. (4) If still unsuccessful, make another pad, and, placing it between the ground and that part of the body in contact with the ground, continue your efforts to detach him. (5) Having pulled him away from the cable, free his neck from clothing, and treat the case as one of

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drowning, one method being as follows. (6) Open his mouth, and, taking hold of the front part of the tongue with your fingers—covered with a handkerchief if you have one—draw the tongue forwards, and gradually let it go back 16 times a minute. Be sure that the root of the tongue is acted upon and drawn forward. If the teeth are clenched and you cannot get them apart with your fingers, gently separate them with the handle of a pocket-knife or by a small piece of wood, cork, etc. (7) Resist the efforts of the bystanders to pour stimulants down his throat until a medical man arrives and 'takes over' the case."

The Effects of Lightning.—Mr. T. W. Carmalt Jones writes as follows to the *Lancet*: "By the same post I am sending you the skin of a rabbit, which has simply been rubbed over inside with table salt. When we, a party of five, were at lunch in the keeper's cottage in Kingswood, near Woodstock, this afternoon, there was some thunder about. About a quarter past two there was a tremendous crash with a blaze of light—the light reddish, certainly not blue—and we all felt more or less shaken, and were certain that the lightning had struck somewhere very near us. We soon found that a tree 35 yards from the cottage had been struck. The bark had been ripped off the tree in two streaks between 2in. and 3in. wide, and some of it was hanging in strips from the tree, and pieces of bark in small pieces and in strips were lying for a distance of at least 10 yards all round the tree. The tree was a larch, and the tallest near us, and was estimated by an architect and a builder, who were of our party, to be at from 55ft. to 60ft. in height. At the foot of the tree, about 1ft. from its base, we found a rabbit lying dead. It is the skin of this rabbit that I am sending you. You will see where the electricity has scorched off the fur, and we all noticed that there was a distinct smell of burning about the rabbit. The latter was quite warm and limp, and lying on its side, the eyes being open and quite bright." The following is the editorial comment on this subject: "The letter of Mr. Carmalt Jones, which is printed in another column, though it does not seem to present any absolutely new feature in connection with occurrences of the kind in question, is interesting in more ways than one—chiefly, perhaps, from the point of view of the rabbit. The 'skin' sent to us shows a space of about 6in. in length and about 1in. in width denuded of fur. The bare skin is slightly desiccated, but not discoloured, vesicated, or charred. It is presumed that there was no further sign of injury or disorganisation of tissue in the rest of the body of the animal. This is consistent with the known fact that electric discharges, even when fatal, do not necessarily kill by producing any gross change in the tissue and organs, or even, so far as is known, by altering the histological elements of a structure. The damage to the tree is simply the disruptive effect of the lightning flash striking an imperfect conductor. The men 'felt more or less shaken.' In other words, they experienced a shock due to induction. Owing to the presence of a 'charged conductor' in their neighbourhood a charge of opposite sign had been induced in them. When the flash occurred—*i.e.*, when the conductor was discharged—the induced charge in their bodies was also suddenly discharged. This is known as 'return shock.' The distance recorded in this case is not too great for such effects to be experienced. It was very different in the recent balloon accident at Aldershot, where four men holding a captive balloon by a wire rope were 'struck' and seriously injured. In this case the unfortunate men had by means of their balloon simply angled for the lightning, and, having captured it, offered it a ready route to earth through their own bodies. It is a source of astonishment as well as of regret that, in the light of historic experiments with lightning and kites, such an accident as this should not have been foreseen and provided against."

The Pacific Cable.—Sir Adolphe Caron, Postmaster-General of the Dominion of Canada, is at present in this country, and has been interviewed by the *Daily Chronicle*. He was asked what progress was being made in carrying out the recommendations of the inter-colonial conference, of which he was vice-president. It was evident from his replies that material progress is being made. The Dominion Government has called for tenders for the proposed cable across the Pacific, and the Postmaster-General has, while in London, seen Mr. Alexander Siemens, who expresses himself confident that there is nothing standing in the way of the immediate construction of the Pacific line, at a cost of £2,000,000, if three years be allowed for construction, or £2,030,000 if a shorter time is given. Mr. Siemens does not even admit that a prior survey of the route is necessary. "He knows the Pacific along the line where the cable would run as well as he knows his own bedroom," said Sir Adolphe. "These are not his precise words, but they convey what he meant. Electrical science has, he says, made such progress in recent years that there is now no difficulty in laying cables even at great depths." Sir Adolphe was reminded of the tale published in American journals that the provisional Government of Hawaii had managed, upon a premature statement by Mr. Reid, the Victorian Minister, to frustrate the alleged intentions of her Majesty's Government to acquire Neckar Island as a landing-place for the cable, and had dispatched a steamer to annex the island to Honolulu territory. But Sir Adolphe was not to be drawn. He could not, he said, make any public statement. Evidently, however, he did not feel much disconcerted by the alleged action of the Honolulu authorities, and thought it most probable that now Hawaii was politically at rest, the advantages of direct cable communication with the American continent would make the Hawaiian Government sympathetic towards the proposal. It was also to be inferred that the matter is engaging the close attention of Lord Kimberley. As for the other recommendation of the conference, Canada was charged by the assembled delegates to push them forward, and Sir Adolphe declared that she would not be slow to fulfil this mission. It was, he thought, quite among the possibilities of the future that events would be rife for another inter-colonial conference perhaps next year, and the meeting-place might then very well be in one of the Australasian colonies. These matters move so fast when the initiative lies in colonial hands. The *Chronicle* yesterday stated: "The New South Wales Government has, it is announced, decided to co-operate with other Australasian Governments in protesting to the Imperial authorities against the annexation of Neckar Island by Hawaii, and combined action on the part of the Agents-General is talked of. We fancy Mr. Reid and his colleagues will find that their protest comes too late. If Neckar Island does not belong to Hawaii by natural right, to whom does it belong? It certainly does not belong to us, and, barren rock land that it is, we never thought of claiming it until a resting place was needed for the proposed trans-Pacific cable. As a matter of fact, the merchants and Government of Hawaii are themselves as eager for the Pacific cable as are the Australians, and those who should know do not think any serious difficulty will be raised when it becomes a question of seeking a neutral landing place for the cable within the Hawaiian territory. Whatever is done must, however, be the outcome of friendly communications; to talk of protests seems out of place."

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MECHANICAL TRACTION FOR TRAMWAYS.

(Continued from page 300.)

In dealing with mechanical tramway traction systems, it has been stated that the author classifies these according as the operative energy is produced at a central point and distributed in various ways to motors upon the cars as they travel along the road; or, secondly, the cars themselves are made to carry sufficient raw energy material or stored energy to run continually between terminal points for some length of time.

Taking the former into consideration first, so far as they include electric working, it may be said that the general principle of action upon which they are based is the following: motive power is produced at some fixed point, and is caused to operate electric dynamo generators. The energy of the latter is transmitted along conductors fixed over the entire length of tramway to electric motors carried on the cars, to the axles of which they communicate a rotary movement. Such a plan obviously differs from a cable or wire-rope system in so far as it involves a transformation of energy, and does not use the latter in its primary form as derived from the motive-power station; but since this transformation is highly efficient and offers great advantages of distribution, it does not actually involve more waste, expense, or trouble than that which follows from using an endless wire rope for traction purposes.

There are obviously three distinct parts or characteristic features in an electric traction system of this kind:

1. The production of energy in a central station.
2. Its utilisation by electric motors upon the cars.
3. The connecting link between these two—*i.e.*, the line of conductors along the route serving to connect the fixed generators with the travelling motors.

The author then proceeds to consider the latter section, and shows that an initial difficulty presents itself at once. The electric motors are in actual motion along the line—that is, are continually moved from point to point with the cars on which they are fixed. This necessitates also a moving contact or point of communication between each car and the fixed conductor along the way, and great care must be exerted to make this contact as good as possible. This line conductor must be separated or isolated from surrounding bodies. There are conceivably three different positions for such a conductor: it may be above the ground level, at the same level as the rails, or, finally, underground. The first and third evidently form the only two methods which are practically suitable for tramways whose permanent way or road bed is not specially constructed or fenced off. Each system or arrangement of line conductor is described and discussed briefly by the author, but he states nothing in any way novel or of striking interest, beyond what is now well known to all our readers, both historically and technically.

For overhead conductors he takes as the typical arrangement that of the Thomson-Houston Company, so largely employed in the United States, and to an increasing extent at the present time upon the European Continent, but does not forget to trace the development of this system from the early electric tramways of Messrs. Siemens and Halske, dating about 13 years back, and based upon the use of two overhead channel conductors, positive and negative, or lead and return.

The Portrush and City and South London lines are cited as instances of the second method of fixing the line conductor, whilst Blackpool and Budapest provide examples of the third, involving the use of an underground conduit, along which the conductor is placed upon insulators.

Turning from the line and permanent way to the central station, where the necessary energy is produced for operating the cars, the author recognises three constituent parts or features of special importance. These are:

1. The boilers and engines, water motors, or other prime movers used to actuate the electric energy-developing machines.

2. The dynamo-electric generators which transform mechanical energy into electric energy.

3. The apparatus used for regulating and controlling the current of electric energy passing outwards to the line conductors.

On a line with considerable grades, the work absorbed by the cars varies enormously from instant to instant, the resistance on a grade of 6 per cent. being seven times that of the level with an ordinary track: and a corresponding amount of power must be provided at the central station. With a small number of cars on the line—each one pulling up, stopping, and restarting irrespective of the others—the variation in output from the central source of power is very high; for instance, with less than eight cars at work on a somewhat uneven road, the maximum output will often be twice as much as the average. The prime movers and electric generators must therefore be calculated to withstand these sudden variations in the power required on the line.

As a rule, the current is distributed along the line in such fashion that the different car motors are all connected in parallel with the line conductor at a potential as constant as possible. The amount of current therefore varies within limits corresponding to the changes in output from the station, and it rises by no means infrequently from zero to the maximum in a few seconds. This leads to the adoption of special arrangements in the electric generator in order to secure a tolerably constant E.M.F., these machines being what is called "over-compounded." The usual E.M.F. employed averages 500 volts, and with a maximum 10 per cent. loss in the line, the terminal E.M.F. is therefore 500 volts at no load and 550 volts at full load.

The speed of the dynamo must also be kept as constant as possible, whatever the load; and this implies the use of engines or prime movers with very sensitive and quick-acting governors, not allowing a variation in speed of more than 2 to 3 per cent. In cases of great differences in the output—when, *e.g.*, the maximum reaches double the average—it is often preferable to use high-speed engines or other motors, provided with heavy flywheels, either coupled direct to the dynamos or driving them by means of belting. For more regular work engines of a slow speed and more economical type may be employed.

It is usual to keep the brushes on the electric generators in a constant position: sparking at the commutators is avoided by using carbon brushes, and by varying the generator magnetic field in accordance with the output.

Each car, of a capacity equal to 50 passengers, and weighing loaded about 10 tons, may be said to absorb from 6,500 to 7,000 watts on a well-built level road at a speed of from 6¼ to 7½ miles an hour. With moderate grades, this corresponds to an output of 11 h.p. to 12 h.p. at the central station; the capacity of the latter ought, however, to be sufficient for a possible demand of double this amount at least. The Thomson-Houston Company, says the author, calculate upon using one 60-kilowatt dynamo when four cars are on the line, and one 100-kilowatt machine for seven cars at work—that is, from 13,000 to 15,000 watts per car. Boiler capacity is reckoned at about 120 square feet of total heating surface per car on line.

When the network of lines covers only a small area, the current is, as a rule, sent out from the station along the trolley wire, but as the tramway system extends, other wires are carried along also to act as "feeders," thereby keeping down the waste of energy due to line resistance, and at the same time avoiding the necessity of a larger trolley wire. The latter is thus maintained at a diameter of some eight or nine millimetres (equal to, say, No. 0 S.W.G.): the feeders are run direct from the central station to different points of the lines best calculated to maintain a uniform potential over the whole network. In cases where large currents are required, the feeders are supplemented by an underground conductor carried along parallel with the line conductor, to which it is joined at proper intervals. The generators at the station are usually connected in parallel, and any one of them may, on emergency, supply current to any isolated section of the network.

In some instances the supply of current along the line is provided by a central station, already in existence, for the purpose of lighting adjacent districts: and a combination of this kind obviously offers great advantages, because it gives a practically continuous load for the generating machinery for at least two-thirds of the day and night.

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The working cost per unit of energy is thus very considerably reduced, and the expenses of operating both the lighting and traction systems are correspondingly less. The usual E.M.F. of dynamo generators for electric lighting purposes on a low-pressure system is, however, insufficient for the higher potential employed on an electric tramway, and this necessitates the use of continuous-current transformers, which raise the voltage from that of the lighting circuits (125 to 250 volts) to that of the tramway line conductor (500 to 600 volts). Such transformers need not necessarily be placed in the central station, but can be fixed at any convenient point whence distribution over the tramway network is the easiest and most economical.

Passing from the development of electric energy in the central station to its use in the motors on the cars, the author discusses the question of motor winding in its effect upon the tractive force or motive couple. The amount of the latter developed in a motor armature rotating in a magnetic field of strength H under the application of a current having an intensity equal to c is proportional to the product of these two, or $C = K \times H c$. Also, if E represents the line E.M.F., e the counter E.M.F. developed in the motor, and R the resistance of the circuit, we have the following relation between them:

$$e = E - R c.$$

Again, e is proportional to the value of the magnetic field, H, and the angular speed of rotation in the motor, ω; or

$$e = k \times H \omega.$$

Obviously it is advisable that the speed of rotation in the armature should vary as little as possible with the resistance to be overcome—that is, the car speed should be kept up whether travelling up or down, or on the level.

In the case of shunt-wound motors, the magnetic field is practically constant, especially when the magnets are near saturation, because then the armature reaction has only a very small effect. The counter E.M.F. is diminished in proportion as the current rises: but if the internal resistance of the motor is kept purposely small, the diminution in e is also less in comparison with E, the line E.M.F.

Under these conditions the speed of rotation is kept almost constant, and the car will travel at practically the same velocity whatever the grade may be. The current, on the other hand, will increase in proportion to the work to be done, and on very steep grades may attain an excessive value in regard to the safety of the motor, unless the latter is constructed of a size and weight far beyond what is required for the average output.

This system of winding is therefore seldom employed. Preferably means are used for increasing the value of magnetic field and current upon which the static effort depends, in order to develop a large power at starting for heavy loads or steep grades without necessitating dangerously large currents in the motor armature. Moreover, with the comparatively high voltages employed, a shunt winding implies field magnets of too delicate and costly a type for continuous working.

It may be remarked, incidentally, that such obstacles to the use of shunt-wound motors do not possess the same importance for lines where the resistance is more uniform; say, for instance, on ordinary railroads. In these cases the magnetic field may with advantage be kept constant either by a shunt winding or separate source of excitation. This latter method is used, it will be remembered, on the Heilmann locomotive.

With series-wound motors the couple, $C = K \times H c$, reaches its maximum value, thereby giving an easy and powerful starting effort upon steep grades. To prevent excessive variations in the car speed under normal conditions, and to reduce the amount of armature reaction, the winding upon the field magnets is designed to give a very powerful magnetic field, almost saturated, when the average current passes. The lead of the brushes may then be reduced to nothing without any sparks at the commutator. This arrangement also makes the counter E.M.F. developed in the armature much less sensitive to the current variations.

The speed of rotation depends upon the current value. When the latter increases, the counter E.M.F. is less, whilst the magnetic field is more powerful. The speed will accordingly continue to fall in proportion as the current increases—that is, in proportion as an increasing resistance in the line calls for a greater tractive effort. The variations thus noted may be effected artificially by changing the internal resistance, interposing, for instance, a rheostat in the circuit.

In going down hill the magnetic field becomes weaker, and the speed of rotation increases out of all proportion. The use of a resistance in the circuit, however, checks this increase in speed by reducing the E.M.F. at the motor terminals; but this procedure, of course, involves a considerable loss, which reduces the general efficiency to no small degree.

The efficiency of the motor depends upon the relation of e to E—that is, of $k \times H\omega$ to E. It depends principally upon the speed of rotation, ω, for the magnetic field, H, cannot increase beyond certain limits; it has, indeed, a certain maximum value, however great should be the current strength. Consequently, at starting (when the speed of rotation stands at zero) and at points on the line where the requirements of traffic cause the car speed to materially decrease, the efficiency is very small. There is accordingly a loss at every stoppage or reduction of speed, independently of the energy taken up by the brakes, and the sum of these losses will attain a considerable amount on tramway lines where frequent stops are the rule.

(To be continued.)

A GENERAL THEORY OF THE GLOW LAMP.*—I.

BY H. S. WEBER.

The phenomena of the glow lamp are perhaps the simplest in the domain of radiation. The lamp consists of a conductor in a nearly complete vacuum, traversed by an electric current, under the action of which it is heated to a stationary temperature such that the radiation from its surface consists in considerable part of visible rays. The simplicity of the conditions lead to the supposition that between the size and the temperature of the radiating surface, the wave-length and intensity of radiation, and the quantities by means of which the electrical energy developed in the filament are determined, there exist relations which are capable of expression in some simple form.

Up to the present time only purely empirical attempts have been made to determine the relation between the amount of light emitted by the glow lamp and its electrical constants. Jamieson and Preece believed the brightness of the glow lamp to be proportional to the sixth power of the strength of the current. Voit concluded from the observations of Jamieson, and from numerous measurements made at the electrical exhibition of Munich upon many varieties of lamps, that the light was approximately proportional to the third power of the energy expended. Hess has shown that whenever the range of intensities becomes considerable, a member must be added to Voit's expression which is proportional to the energy. Finally, Slotte has drawn the conclusion from simultaneous measurements of the strength of the current and the intensity, that the light of the lamp is closely related to the fourth power of the current strength.

These experimental investigations could lead to no final result, since the most important element—viz., the temperature of the glowing filament—was left altogether out of account. Finding that the means of determining this temperature were lacking, only the most unreliable estimates concerning it, running from 2,250deg. to 1,200deg., being attainable, I have spent several years in an attempt to establish an exact physical theory of the electrical incandescent lamp which should cover all the observed facts, and have for this purpose made exact measurements upon more than 30 types of lamp, in order to determine the characteristic properties and to obtain the values of such constants of radiation for carbon as are necessary to a completion of the theory. I believe that I have now reached a point in these attempts where all the phenomena

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of the incandescent lamp may be expressed by means of a few formulæ. Permit me to report briefly in the following pages the results of my investigations.

I.

The starting point of my work was the establishment of a general expression by means of which the intensity of homogeneous radiation of a given wave-length emitted by a solid body at a given temperature might be expressed in terms of the wave-length and temperature, and of the size and nature of the radiating surface. No such general formula existed in the realm of radiation.

In 1888 I showed that the result of a great variety of observations could be expressed in this form :

$$d^2 s = \frac{d\,\mathrm{F} \,.\, d\,\mathrm{F}_1 \,.\, \cos w \,.\, \cos w_1}{r^2} \cdot \frac{c}{\lambda^2} \cdot e^{a\,\mathrm{T}} \quad \frac{1}{b^2 \lambda^2 \mathrm{T}^2} \quad (1)$$

in which $d\,\mathrm{F}$ is an element of surface of the radiating body, $d\,\mathrm{F}_1$ an element receiving this radiation, r the distance between the two elements of surface, w and w_1 the angles between the elements of these normals and the direction of the line joining them, r. This equation expresses the amount of energy of homogeneous radiation of the wave-length which is sent out from the surfaces of the element $d\,\mathrm{F}$ at the absolute temperature, T, to the surface of the element $d\,\mathrm{F}_1$ in the unit of time. In this equation e has the usual signification; a is a constant common to all solids—viz., the value 0·0043; b^2 is a constant which should have the same, or nearly the same, value for various bodies; and, finally, c is a constant which varies from substance to substance. To distinguish them, I have named these three respectively constants of temperature, a, the illuminating power, b^2, and the constant of emissivity, c.

From equation (1) it follows, in the first place, that the amount of energy radiated from the entire surface, F, in all directions in the unit of time is

$$s = c \,.\, \pi \,.\, \mathrm{F} \,.\, e^{a\,\mathrm{T}} \quad \frac{1}{b^2 \lambda^2 \mathrm{T}^2} \quad . \quad . \quad (2)$$

This quantity is to be called the intensity of homogeneous radiation.

It follows, further, that the sum of the intensity of all the homogeneous rays which are emitted at the temperature, T (the total radiation of the body) is expressed by the equation—

$$\mathrm{S} = \int_{\lambda=0}^{\lambda=\infty} s \,.\, d\,\lambda = c \,.\, \pi \,.\, \mathrm{F} \,.\, \frac{\sqrt{\pi}}{2} \,.\, b \,.\, \mathrm{T} \,.\, e^{a\mathrm{T}} = \mathrm{C} \,.\, \mathrm{F} \,.\, \mathrm{T} \,.\, e^{a\mathrm{T}} \quad (3)$$

The quantity $\mathrm{C} = \frac{1}{2}\pi\sqrt{\pi c \,.\, b}$ is to be called the constant of total radiation.

If the radiating body, k, is placed in an enclosed space, the walls of which have the common temperature, T_0, the total loss of energy which k suffers in consequence of the radiation in the unit of time is given by the formula

$$\Delta\,\mathrm{S}_{\mathrm{T},\,\mathrm{T}_0} = \mathrm{C} \,.\, \mathrm{F}\,(\mathrm{T} \,.\, e^{a\,\mathrm{T}} - \mathrm{T} \,.\, e^{a\,\mathrm{T}_0}), \quad . \quad (4)$$

it being assumed that the surface, F, of the radiating body is very small as compared with the surfaces of the surrounding walls, an assumption which is admissible for all incandescent lamps. I have assured myself that equation (2) expresses the result of all trustworthy measurements hitherto made upon the relation between wave-length and temperature of homogeneous rays. And it can be shown also that equation (4) agrees completely with the carefully determined results of Schleiermacher upon the total radiation of platinum, and the oxide of copper for temperatures between 273deg. and 1,173deg. Measurements of my own upon the total radiation of carbon between 300deg. and 700deg. were also capable of being expressed by formula (4).

II.

Equation (4) affords a simple method for the determination of the temperature of the glow lamp. After the temperature of the filament under the action of the current has become stationary, the amount of energy developed by the current in each unit of time plus the energy which the filament receives from the surrounding walls is equal to the energy which it gives out, so that for every such time-interval the equation—

$$\Delta\,\mathrm{S}_{\mathrm{T},\,\mathrm{T}_0} = \mathrm{C} \,.\, \mathrm{F}\,(\mathrm{T} \,.\, e^{a\mathrm{T}} - \mathrm{T}_0 \,.\, e^{a\mathrm{T}_0}) = i \,.\, \Delta\,\mathrm{P}$$

holds true, where i and $\Delta\,\mathrm{P}$ are the current intensity which is regarded as constant, and the difference of potential between the terminals of the filament, respectively.

In the case here assumed, where $\Delta\,\mathrm{S}_{\mathrm{T},\,\mathrm{T}_0}$ is given in heat units, the equation takes the following form :

$$\Delta\,\mathrm{S}_{\mathrm{T},\,\mathrm{T}_0} = \mathrm{C} \,.\, \mathrm{F}\,(\mathrm{T} \,.\, e^{a\,\mathrm{T}} - \mathrm{T}_0 \,.\, e^{a\mathrm{T}_0}) = \frac{i \,.\, \Delta\,\mathrm{P}}{\mathrm{J}},$$

in which J is the mechanical equivalent of the calorie. It follows from this equation that by means of measurements of the quantities i, $\Delta\,\mathrm{P}$, T, and F, the temperature of the filament can be determined, provided the constant, C, is known. This can be found by the estimation of the stationary temperatures which the filament attains under the action of known currents and potential differences. The value of these temperatures is given from the resistance of the filament, provided the dependence of resistance upon temperature has been determined by a series of experiments for the intervals of temperatures not given. The following table gives an example of the determination of the constant, C, the total radiation of the filament of a specimen of the new Cruto lamp, the surface of which had been found by the length of the carbon and its cross-section at 11 points distributed along the filament at equal distances. This surface was found to be 0·647 square centimetre. The resisting value of C = 0·0000171 refers to gramme-calories, centimetres, and seconds.

NEW CRUTO LAMP.

F = 0·647 square centimetre.

T	W	T	W
290°·0	332·08Ω	440°·4	318·09Ω
340°·3	327·68	490°·0	313·03
390°·3	323·01	540°·5	307·88

T_0 in the beginning = 290°·0; at the end = 290°·1.

i	$\Delta\,\mathrm{P}$	W	E	$\Delta\mathrm{S}_{\mathrm{T},\,\mathrm{T}_0}$	T	$\frac{\mathrm{T}}{\mathrm{T}_0} e^{a(\mathrm{T}-\mathrm{T}_0)} - 1$	C
A.	V.	Ω.	W.	cal.			
·006526	2·1472	329·02	·01401	·003344	325°·0	0·3027	$169·2 \times 10^{-7}$
·010051	3 2729	225 62	·03289	007850	362°·5	0·7096	171·0
·13176	4·2449	322·17	·05593	·013349	398°·9	1·1971	172·4
·16542	5·2655	318·31	·08710	·020740	438°·2	1·8577	171·0
·19986	6·2863	314·53	·12564	·029983	475°·3	2·6399	173·9
·23358	7·2637	310 97	·16966	·040451	510°·2	3·5315	175·4
·26690	8·2022	307·31	·21892	·052248	546°·1	4·6677	171·4

$\mathrm{M} = 171·8 \times 10^{-7}$.

Following this plan, I have in the course of years determined the constant of total radiation for 33 varieties of glow lamp. The summary of the results obtained shows that these 33 filaments belong to two groups. Three carbons—that of the Edison lamp, the new Cruto lamp, and of the lamp of Woodhouse and Rawson—have a radiation coefficient of 0·0000169 and 0·0000174; while 30 filaments give for the radiation constant values between 0·0000127 and 0·0000132. The three carbons first named are black; the others show grey surfaces. The mean value of C for these two different varieties of filament stand in the relation of 100 to 75·5. This is almost exactly the same relation which Leslie, at the beginning of this century, found for lampblack and graphite—viz., 100 to 75. It may, therefore, be asserted that incandescent lamp filaments with grey surfaces should be classified as graphite carbons.

A knowledge of the constant, C, makes it possible to determine the temperature of the filament for every condition of incandescence when we know the size of its radiating surface. It is interesting to know what the temperature of the filament is when the incandescent lamp is in operation at normal brightness. The result is a surprising one—viz., that the normal temperature of all sorts of lamps is very nearly the same, and is included in an interval between T = 1,565deg. and T = 1,580deg. of the absolute scale. In the case of some lamps of very great brilliancy—that is to say, of lamps with thick filaments, which can be brought to higher temperatures without

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serious damage, and which can consequently be operated at higher economy—we find the normal temperature to be about 40deg. higher.

It is, further, of importance to know between what temperatures the filament changes when the candle-power of the lamp is varied through considerable range—from two candles to 30 candles for a 16-c.p. lamp, for example, or from 20 to 300 candles in the case of a 200-c.p. lamp. The result of measurements shows that the temperature variations which correspond to such changes in brightness amount to about 180deg. In practice, accordingly, glow-lamp illumination covers a range extending from 1,400deg. to 1,600deg. for small lamps, and 1,450deg. to 1,650deg. for large lamps. If we confine ourselves in the study of incandescent lamps to this range of temperatures, we may write, in place of equation (5) the simple form—

$$\Delta S_{T, T_0} = C . F . T . e^{aT} = \frac{i \Delta P}{J} \quad . \quad . \quad (6)$$

since in these cases the quantity $T_0 . e^{aT}$ is very small as compared with the quantity $T . e^{aT}$. This is shown by the following small table:

T_0	$T_0 . e^{aT_0}$	T	$T . e^{aT}$
273+50°	$1\,295 \times 10^3$	1,400°	576×10^3
+75°	1·554	1,450°	740
+100°	1·854	1,600°	1,554
+125°	2·203	1,650°	1,989

In this simpler form equation (6) indicates in what degree the current must increase in order to bring about a given rise of temperature in the filament. To make this matter clearer, I have drawn up the following table:

T	$T . e^{aT}$	T	$T . e^{aT}$	T	$T . e^{aT}$
1,400°	576×10^3	1,500°	948×10^3	1,600°	$1{,}554 \times 10^3$
1,410	606	1,510	996	1,610	1,634
1,420	637	1,520	1,047	1,620	1,717
1,430	670	1,530	1,100	1,630	1,803
1,440	704	1,540	1,156	1,640	1,894
1,450	740	1,550	1,214	1,650	1,989
4,460	777	1,560	1,276	1,700	2,541
1,470	816	1,570	1,340	1,800	4,136
1,480	858	1,580	1,408	1,900	6,712
1,490	902	1,590	1,479	2,000	10,860

From these data, and from the expression

$$\frac{d(T . e^{aT})}{dT} \cdot \frac{1}{T . e^{aT}} = \frac{1}{T} \, t a,$$

it may be seen that for the entire range of temperature from 1,400deg. to 1,600deg. the following simple law holds true—viz., that every increase in the energy of the current amounting to ½ per cent. raises the stationary temperature of the incandescent lamp 1deg.

To show in greater detail the changes which the filament suffers by change of current and potential difference, and the changes which the resistance of the filament and the amount of light emitted suffer through change of temperature, I introduce the four following tables, which may also serve to indicate the manner in which the investigation of 33 types of incandescent lamps was carried out. In the eight vertical columns of the tables are given respectively 10 values: the strength of the current, i; the difference of potential, ΔP; the resistance, W; the energy, E; the candle-power, H; the quantity, $\frac{H}{E_3}$; the efficiency, $E_1 = \frac{E}{H}$; and the absolute temperature, T. As unit of brightness, the British standard candle has been selected, and H denotes the mean horizontal intensity. Of the lamps to which these four tables refer, two had black carbons and two grey carbons. The quantity R in each table refers to the radiation factor for brightness—the factor, namely, by which the mean horizontal candle-power is to be multiplied in order to get the mean spherical candle-power. These quantities were determined by measuring the lamp in 132 positions, as evenly distributed through space as possible.

WOODHOUSE AND RAWSON'S LAMP.

("60 V., 30 C.P.")

F=0·889 square centimetre. R=0·780. C=0·0000169.

i	ΔP	W	E	H	$q=\frac{H}{E_3}$	$E_1=\frac{E}{H}$	T
0·8768A	41·41V	47·23Ω	36·31W	1·82NK	$38·1 \times 10^{-6}$	19·95 W	1,400°
0 9855	45·18	45·85	44·52	3·60	40·8	12·37	1,441
1 0967	49·01	44·69	53·74	6·55	42·2	8·20	1,479
1·2108	52·79	43·60	63·90	11·07	42·4	5·77	1,514
1·3264	56·72	42·76	75·23	17·85	41·9	4·21	1,548
1·3853	58·60	42·30	81·18	22·38	41·8	3·63	1,561
1·4460	60·59	41·90	87·61	27·61	41·1	3·17	1,578
1·5058	62·48	41·49	94·08	34·13	40·9	2·76	1,592
1·5675	64·46	41·12	101·05	41·16	39·9	2·55	1,606
1·6290	66·32	40·71	108·63	48 35	38·4	2·23	1,620

SUNBEAM LAMP.

("80 V., 5 A., 200 C.P.")

F=5·04 square centimetres. R=0·711. C=0·0000131.

i	ΔP	W	E	H	$q=\frac{H}{E_3}$	$E_1=\frac{E}{H}$	T
4·064A	53·90 V	13·26 Ω	219·0 W	22·72 NK	$2·16 \times 10^{-6}$	9·64 W	1,463°
4·218	55·74	13·21	235·1	28·47	2·19	8·26	1,478
4·442	58·49	13·17	259·8	38·77	2·21	6·70	1,498
4·747	62·26	13·12	295·5	56·82	2·20	5·20	1,524
5·056	66·07	13·07	334·0	81·23	2·18	4·11	1,549
5·377	70·00	13·02	376·4	115·1	2·16	3·27	1,573
5·689	73·82	12·98	420·0	156·9	2·12	2·68	1,595
5·980	77·49	12·96	463·4	205·8	2·07	2·25	1,615
6·282	81·29	12 94	510·7	263·7	1·98	1·94	1,636
6·584	84·99	12·91	559·6	334·7	1·89	1·69	1,654

LAMP OF THE ALLGEMEINE ELEKTRICITATS-GESELLSCHAFT, BERLIN.

("100 V., 16 C.P.")

F=0·760 square centimetre. R=0·801. C=0·0000129.

i	ΔP	W	E	H	$q=\frac{H}{E_3}$	$E_1=\frac{E}{H}$	T
0·4212A	77·19V	183·3Ω	32·51W	2·99 CP	$87·2 \times 10^{-6}$	10·87 W	1,464°
0·4431	80·89	182·5	35·85	4·13	89·3	8·67	1,483
0·4668	84·80	181·7	39 58	5·60	90·3	7·07	1,503
0·4903	88·83	181·2	43·55	7·41	89·7	5·88	1,522
0·5136	92·87	180·8	47·70	9·71	89·5	4·91	1,541
0·5360	96·71	180·4	51·84	12·42	89·2	4·18	1,557
0·5588	100·60	180 0	56·21	15·76	88·7	3·57	1,574
0·5823	104·58	179·6	60·90	19·70	87·2	3·09	1,591
0·6057	108·60	179·3	65·78	24·25	85·2	2·71	1,607
0·6295	112·57	178·8	70·85	29·41	82·7	2·41	1,621

NEW CRUTO LAMP.

("100 V., 0·59 A., 16 C.P.")

F = 0·632 square centimetre. R = 0·734. C = 0·0000174.

i	ΔP	W	E	H	$q=\frac{H}{E_3}$	$E_1=\frac{E}{H}$	T
0·3948A	78·53V	198·9Ω	31 00 W	2·21 CP	$74·2 \times 10^{-6}$	14·03 W	1,434°
0·4233	83·40	196 9	35·30	3·32	75·9	10·63	1,460
0·4506	87·56	194 3	39·45	4·69	76·4	8·41	1 482
0·4924	93·79	190·5	46·18	7·58	77·0	6·08	1,514
0·5180	97·60	188·4	50·56	9·93	76·8	5·09	1,532
0·5444	101·12	185·7	55·05	12·75	76·4	4·32	1,550
0·5706	104·41	182 9	59·58	16·10	76·1	3 70	1,566
0·5990	108·27	180·4	64·85	20·67	75·8	3·14	1,582
0 6305	112·11	178·7	70·68	26·60	75·3	2·66	1,600
0·6579	115·99	176·3	76·32	33·06	74·2	2·31	1,618

PRACTICAL NOTES ON DYNAMO CALCULATION.* XIII.

BY ALFRED E. WIENER.

(Continued from page 310.)

28. *Dimensioning of Commutator—(a) Diameter and Length of Brush Surface.*—In low-potential machines with small number of divisions, the thickness of the substructure determines the diameter of the commutator; in high-potential machines, however, especially those of multipolar type, where the number of commutator segments is very

* From the *Electrical World* (New York).

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great, the width at top of the commutator bars, their number, and the thickness of the insulation between them fix the outside diameter.

The bars must be large enough in cross-section to carry the whole current generated in the armature without undue heating, and shall continue so after a reasonable amount of wear. They must be of sufficient length to allow a proper number of brushes to take off the current.

The same brush contact surface may be obtained by employing either a broad thin brush on a small-diameter commutator or a narrow thick one a large diameter, the number of bars being the same in both cases, their width, consequently, larger in the latter case. With larger diameter and greater consequent peripheral velocity there will be more wear of both brushes and segments, and greater consumption of energy due to the increased frictionof the brushes.

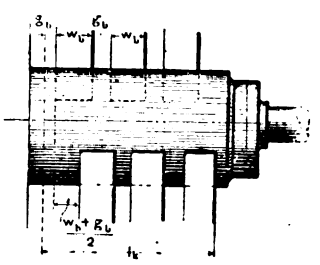

FIG. 39.

The segments are usually made of copper (cast, rolled, or forged), phosphor bronze, or gunmetal, sometimes brass, and even iron being used; the materials for the substructure are phosphor bronze, brass, or cast iron.

From all this it will be obvious that a general formula for the diameter of the commutator cannot be established, and that, on the contrary, this dimension has to be properly chosen in every case with reference to the armature diameter to the design of the commutator, to the materials employed, to the strength of the substructure, or the thickness of the bar respectively, and, finally, with reference to the wear of the segments.

The commutator diameter being decided upon, the size of the brushes can now be calculated, as shown in Section 29, and from this the length of the commutator can be found.

In order to prevent annular grooves being cut around the commutator, the brushes ought to be so adjusted that the gaps between those in one set do not come opposite the gaps in the other set. Denoting, Fig. 39, the width of each brush by w_b, their number per set by n_b, and the gap between them by g_b, we consequently obtain the total length of the commutator brush surface from:

$$l_k = (n_b + \tfrac{1}{2}) \times (w_b + g_b) \quad . \quad . \quad (71)$$

This length of brush surface should be available even after the commutator has been turned down to its final

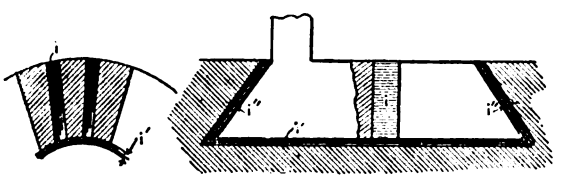

FIG. 40.

diameter. The original diameter must therefore have a somewhat larger contact length. An addition to l_k of from ¼in. to 1in., according to the depth of the bar, is thus necessitated.

(*b*) *Commutator Insulations.*—In a commutator the insulation has to form a part of the general structure, and has to take strain in common with other material used. From its natural cleavage and hardness, therefore, mica is particularly suitable for commutator insulations, and is, in fact, almost exclusively used for this purpose, only asbestos and vulcanised fibre being employed in rare cases.

The thickness of the commutator insulation ought to be proportional to the voltage of the machine, and, for the various positions with reference to the bars, see *i*, *i'*, *i''* (Fig. 40), should be selected within the following limits.

TABLE XXXIV.—Commutator Insulations for Various Voltages.

—	Up to 300 volts.	400 to 750 volts.	800 to 3,000 volts.
Side insulation (*i*) ...	·020″ to ·030″	·030″ to ·040″	·040″ to ·060″
Bottom insulation (*i'*)	3/64 ,, 1/32	1/32 ,, 1/16	1/32 ,, 1/16
End insulation (*i''*) ...	1/16 ,, 3/32	3/32 ,, 1/8	1/8 ,, 1/16

29. *Brushes and Current Leads*—(*a*) *Brushes.*—The best breadth of the brush contact surface, with reference to the prevention of excesssive sparking at the commutator, is that equal to the width of one commutator segment, Fig. 41. If, however, this would make the commutator too long, two bars may be covered by the brush, as in Fig. 42.

In the former case not more than one armature coil is short-circuited at any time, while in the latter case two coils, at times, are simultaneously short-circuited under each set of brushes.

The circumferential breadth of the brush contact may accordingly be expressed by

$$b_k = \frac{d_k \times \pi}{n} - i \quad . \quad . \quad . \quad . \quad (72)$$

or, respectively, by

$$b_k = 2\left(\frac{d_k \times \pi}{n} - i\right) \quad . \quad . \quad . \quad (73)$$

where:

b_k = circumferential breadth of brush contact, in inches;
d_k = diameter of commutator, in inches;
n = number of commutator divisions;
i = thickness of side insulation, in inches (see Table XXXIV.).

For copper brushes the result obtained by (73) should be the maximum breadth employed; for carbon brushes, however, where the coils are short-circuited through the comparatively high resistance of the carbon b_k may be chosen so as to cover three bars of the commutator.

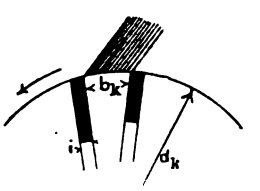

FIG. 41.

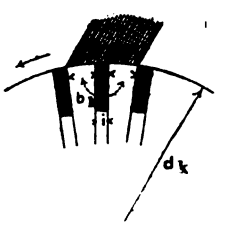

FIG. 42.

Having decided upon b_k by either one of the above formulæ (72) or (73) respectively, or having selected an intermediate value, the width of the contact area, and subsequently the width of the brushes, can be found for a given current output of the dynamo by providing contact area in proportion to the current intensity. In order to keep the brushes at a moderate temperature, and the "loss of commutation" within practical limits, the current density of the brush contact should not exceed 150 to 175 amperes per square inch in case of copper brushes (wire, plate, and gauze), and 30 to 35 amperes in case of carbon brushes.

The total axial width of the brush surface can consequently be expressed by

$$w_k = \frac{C}{150 \times b \times b_k} \quad . \quad . \quad . \quad . \quad (74)$$

for copper brushes, and

$$w_k = \frac{C}{30 \times b \times b_k} \quad . \quad . \quad . \quad . \quad (75)$$

for carbon brushes.

w_k = total axial width of brush contact surface, in inches;
C = total current output of dynamo, in amperes;
b = number of pairs of brush sets (usually either $b = 1$, or equal to the number of pairs of poles, $b = P$).

For the purpose of securing a good contact, each contact surface should be subdivided into a set of n_b individual brushes, of a width w_b each, not exceeding 1½in. to 2in. In small machines, where one such brush would suffice, it is good practice to employ two narrow brushes, even as low down as ⅜in. each, in order to facilitate their adjusting or exchanging while machine is running.

(b) Current Leads.—Care must also be exercised in the proportioning of those parts of a dynamo which serve to lead the current collected by the brushes to the external circuit. For if material is wasted in these, the cost of the machine is unnecessarily increased, and if, on the contrary, too little material is used, an appreciable drop in the voltage and undue heating will be the result.

In order to guard the design of such parts, among which may be classed brush-holders, cables, conductor rods, cable

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lugs, binding posts and switches, the following Table XXXV. has been prepared, which contains practical averages of the current densities to be employed for cross section and contact surface of the various materials used:

TABLE XXXV.—Average Current Densities for Cross-Section and Contact Surface of Various Materials.

—	Material.	Current density.	
		Square mils per ampere.	Amperes per square inch.
Cross-section.	Copper wire	500 to 800	1,200 to 2,000
	Copper rod	800 to 1,200	800 to 1,200
	Copper-wire cable..	600 to 1,000	1,000 to 1,600
	Copper casting.....	1,400 to 2,000	500 to 700
	Brass casting	2,500 to 3,300	300 to 400
Brush contact	Copper brush	5,700 to 6,700	150 to 175
	Carbon brush	28,500 to 33,500	30 to 35
Sliding contact	Copper – copper ...	10,000 to 15,000	67 to 100
	Brass < copper.. brass ..	20,000 to 25,000	40 to 50
Screwed contact	Copper – copper ...	5,000 to 8,000	120 to 200
	Brass < copper.. brass ...	10,000 to 15,000	67 to 100

(To be continued.)

A NEW SAFETY CONNECTOR.

The introduction of electrical heating and cooking apparatus and the rapidly extending use of the same has shown the necessity of improved arrangements for connecting and disconnecting the conducting wires from the utensils while in use. The kettles, saucepans, etc., require frequent cleansing, and the wires would be damaged if not detached.

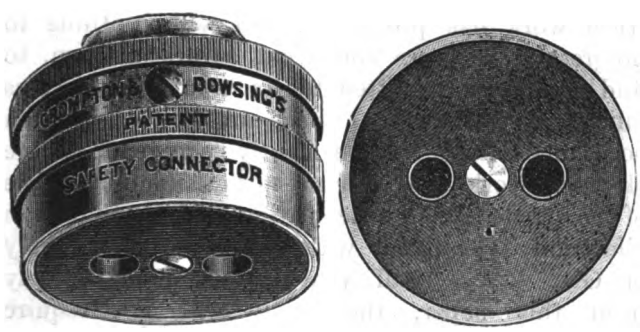

FIG. 1.

The ordinary system of using a plug attached to the wire and inserting it in a socket affixed to the apparatus is not by any means a perfect arrangement, and may prove absolutely dangerous. Protection to some extent may be afforded by a ring of metal or porcelain around the pins, acting as a shield, but, nevertheless, the fact

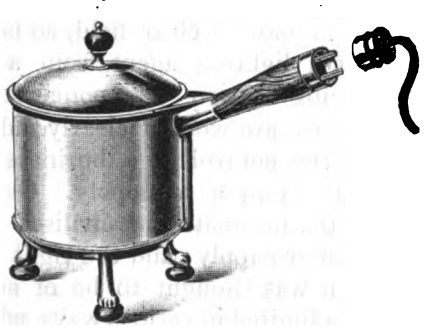

FIG. 2.

remains that there are "live" ends, and a fork or other piece of metal coming in contact with same would cause "fireworks," and possibly send the cook into hysterics. The most serious thing would be the banishing of the electrical cooking apparatus from the household on account of the imaginary danger to life. To prevent all possibility of accidental contact, Messrs. Crompton and Co., Limited, are introducing a patent safety connector in which there are no exposed contacts. The usual arrangements for the connection are entirely reversed, as the pins (or other plug forms of contact) are fixed on the utensil itself, and surrounded with a shield of metal to protect it from mechanical injury. The socket attached to the flexible wire is made with the contact tubes sunk well into the base, and connected up in the ordinary manner. In front of the socket, and covering the entrance to the tubes, is a fibre or porcelain disc, pierced with two holes for the admission of the pins, and free to move on a central screw. A spring fixed underneath tends to keep the disc in such a position that the ends of the tubes are always covered. When the pins are inserted in the holes of the disc, contact is not made until a quarter turn is given to the socket, when the pins are allowed to enter the tubes. The action is extremely simple, and is as natural as turning a key in a lock. Immediately the plug is pulled off, the shield springs round, covering the holes and automatically protecting them. The working parts of the safety connector are enclosed in a nickel-plated case, and two milled rings give plenty of grip power. Fig. 1 is a general view of the safety connector, and Fig. 2 shows the method of using. It will be noted that the connections are brought up to the handle. This prevents the contacts becoming wet and greasy when the utensils are in use, and there is less danger of damage in the cleaning.

The new safety connector can be applied to electric light standards, or, indeed, to any kind of portable fitting, and the necessity of keeping the wire attached is obviated. For floor sockets the safety connector is of considerable value, as the loose blocks or plugs necessitated by the ordinary system are dispensed with when the socket is not in use.

Messrs. Crompton and Co., Limited, are adapting the principle of the safety connector to high-tension switches, terminals, and connections, which will be automatically protected, thereby entirely preventing accidental contact, and consequent injury or loss of life.

HOWARD'S GRAPHIC WIRING TABLE.

We have received from Messrs. W. T. Glover and Co., 39, Victoria-street, Westminster, and Salford, Manchester, a graphic wiring table which has been drawn up by Mr. A. H. Howard, and which possesses some novel features. The dimensions of copper wires and cables are shown in both decimals of an inch and in metric measurements, and the equivalent sizes in solid and stranded wires, the fall of potential, the rise of temperature with given amounts of current, and other necessary information are given. The arrangement is clear and simple, and electric light engineers can at once see the best form of mains and conductors for employment on the work in hand, without resorting to laborious calculations. The various wires and cables are arranged above one another in vertical columns according to their area, ranging from ·001in. to 1 square inch. Thus, all equivalent areas are shown in the same horizontal lines, while diagonal lines give the fall of potential per 100 yards upon any sized conductor with any current from 1 to 1,000 amperes. A series of curves, printed in red, shows approximately the temperature of any conductor with any given current. These curves are based upon experiments in the Edison laboratory made for the purpose of ascertaining the rise in temperature of insulated wires enclosed in wooden casing.

A special feature of the table is the fact that the divisions are drawn at distances proportional to the logarithms of the areas, instead of being directly proportionate to the areas. The diagonal lines showing the fall of potential are thus made parallel instead of radial, with the result that all parts of the table are equally easy to decipher; and a much larger range of sizes is shown in the space than would otherwise be the case.

The resistances of the several conductors are given, in separate columns, at per 1,000 yards and per mile. The weight per mile is also shown.

Directions are given for using the table, which is drawn upon a fairly large scale, and is so arranged as to admit of additional lines being inserted to embody any data that may be useful in particular cases, such as the resistance, etc., of iron, platinum, or other metals which are used in electrical work.

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Vol. XIII. of new series of "The Electrical Engineer" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

AS OTHERS SEE US.

It is a great mistake to think criticism, even when it is seen to be biassed, is valueless. We have often noticed that the very best way to see into the faults of any special apparatus is to talk with a rival inventor of such apparatus. He is profuse in his explanations, showing every faulty point in everything that has preceded his design, ignoring every good point in what has gone before, but restricting his explanation of his own work to the praising of the manner in which he has avoided all these faults. Chats with two rival inventors give an almost infinite source of amusement if the listener can manage to remain in a perfectly negative condition of mind. Human nature is almost always too strong for inventors; they can seldom see any good outside their own doings. But then they are real men, they are so enamoured of their own work that they really believe in what they say. We cannot always say the same of the advocate, and thus it was with some interest that we read a paper by Mr. N. H. Humphreys in our contemporary the *Journal of Gas Lighting*. This paper has systematically belittled electric lighting. It is hardly ever, or never, fair in the selections of work it criticises, and it looks upon everything electrical with prejudice. Well, notwithstanding all its complaints, notwithstanding its prophecies, electrical work has progressed and will continue to progress. We were somewhat surprised, then, to find an article admitted to its columns of a less bilious character than usual—an article in which occasional efforts have evidently been made to see electrical work in a tolerant spirit. The full title of the article is "The Regulations for the Supply of Electricity Compared with those for the Supply of Gas." We shall venture to quote largely from this paper, though it will not require many words to show why its conclusions are erroneous. The author puts the position of gas as regards legislative enactment very clearly as follows:

"The various enactments by which the supply of gas to the public is controlled and regulated were drafted at a time when the suppliers of gas were supposed to have a clear field, so far as the distribution of a lighting agent from a manufacturing or producing station was concerned. The terms in which they are worded clearly indicate that they aimed at the control of a business that was to a very great extent a monopoly. Gas was regarded as one of the necessities of civilised life—something like the water supply; and the right to cut off or discontinue it was thought to be of such importance that it was limited in various ways, while at the same time penalties were introduced for deficiencies either in the quantity or the quality of the supply. The value of the monopoly represented by the right to supply gas was always heavily laboured by the representatives of the public, whenever additional or extended powers were sought. It is relied upon as a valuable weapon at all meetings of the 'gas consumers' indignation' kind, and it has also been brought out as one of the reasons why the gas supply should be in the hands of the local authorities."

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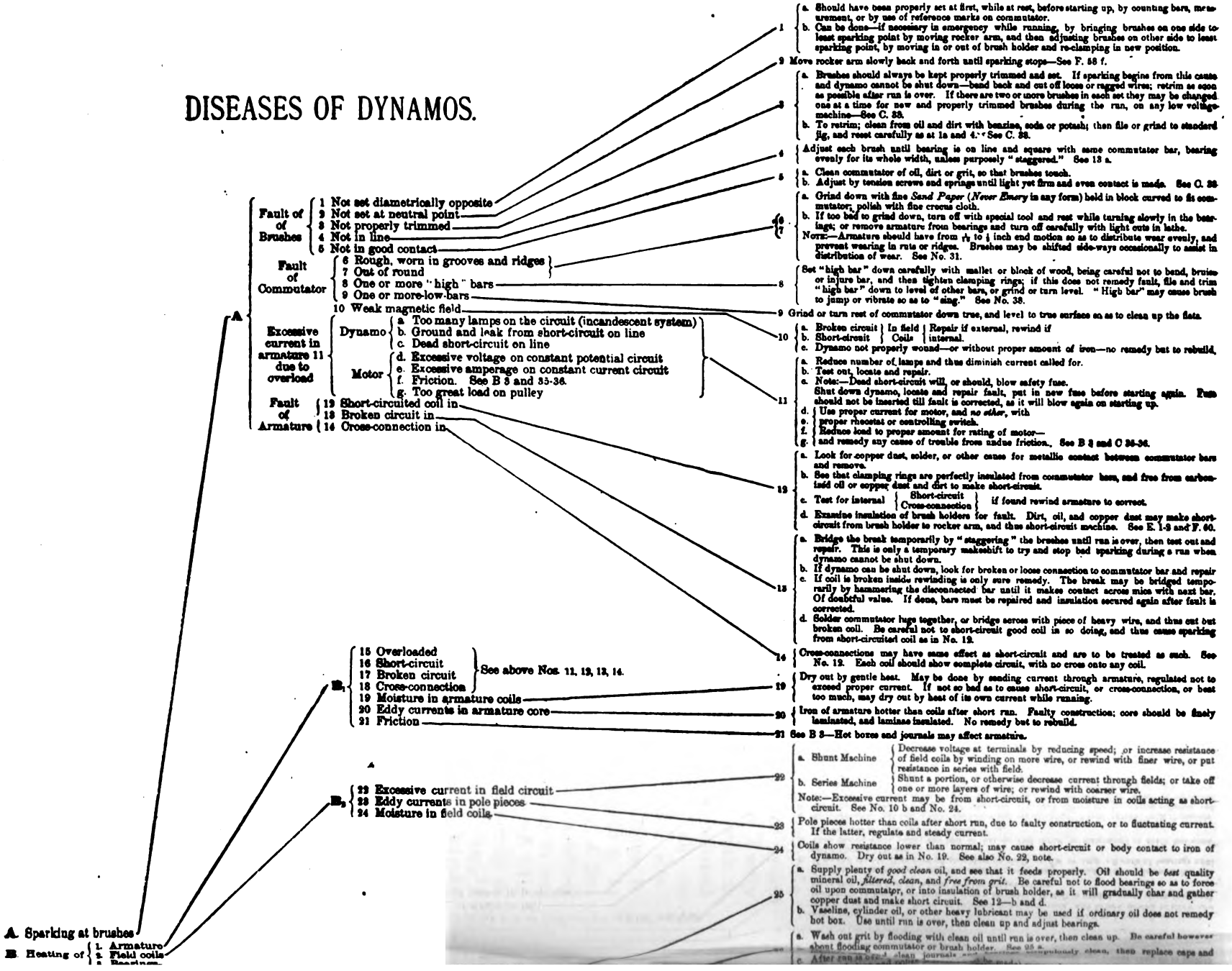
DISEASES OF DYNAMOS.


A. Sparking at brushes
B. Heating of 1. Armature 2. Field coils
Fault of Brushes
1 Not set diametrically opposite
2 Not set at neutral point
3 Not properly trimmed
4 Not in line
5 Not in good contact
Fault of Commutator
6 Rough, worn in grooves and ridges
7 Out of round
8 One or more "high" bars
9 One or more low bars
10 Weak magnetic field
Excessive current in armature due to overload 11
Dynamo
a Too many lamps on the circuit (incandescent system)
b. Ground and leak from short-circuit on line
c. Dead short-circuit on line
Motor
d. Excessive voltage on constant potential circuit
e. Excessive amperage on constant current circuit
f. Friction. See B 3 and 35-36.
g. Too great load on pulley
Fault of Armature
12 Short-circuited coil in
13 Broken circuit in
14 Cross-connection in
B1
15 Overloaded
16 Short-circuit
17 Broken circuit
18 Cross-connection
See above Nos. 11, 12, 13, 14.
19 Moisture in armature coils
20 Eddy currents in armature core
21 Friction
B2
22 Excessive current in field circuit
23 Eddy currents in pole pieces
24 Moisture in field coils
1 a. Should have been properly set at first, while at rest, before starting up, by counting bars, measurement, or by use of reference marks on commutator.
b. Can be done—if necessary in emergency while running, by bringing brushes on one side to least sparking point by moving rocker arm, and then adjusting brushes on other side to least sparking point, by moving in or out of brush holder and re-clamping in new position.
2 Move rocker arm slowly back and forth until sparking stops—See F. 58 f.
3 a. Brushes should always be kept properly trimmed and set. If sparking begins from this cause and dynamo cannot be shut down—bend back and cut off loose or ragged wires; retrim as soon as possible after run is over. If there are two or more brushes in each set they may be changed one at a time for new and properly trimmed brushes during the run, on any low voltage machine—See C. 33.
b. To retrim; clean from oil and dirt with benzine, soda or potash; then file or grind to standard jig, and reset carefully as at 1a and 4. See C. 33.
4 Adjust each brush until bearing is on line and square with same commutator bar, bearing evenly for its whole width, unless purposely "staggered." See 13 a.
5 a. Clean commutator of oil, dirt or grit, so that brushes touch.
b. Adjust by tension screws and springs until light yet firm and even contact is made. See C. 33
6 7 a. Grind down with fine Sand Paper (Never Emery in any form) held in block curved to fit commutator; polish with fine crocus cloth.
b. If too bad to grind down, turn off with special tool and rest while turning slowly in the bearings; or remove armature from bearings and turn off carefully with light cuts in lathe.
Note:—Armature should have from 1/8 to 1/4 inch end motion so as to distribute wear evenly, and prevent wearing in ruts or ridges. Brushes may be shifted side-ways occasionally to assist in distribution of wear. See No. 31.
8 Set "high bar" down carefully with mallet or block of wood, being careful not to bend, bruise or injure bar, and then tighten clamping rings; if this does not remedy fault, file and trim "high bar" down to level of other bars, or grind or turn level. "High bar" may cause brush to jump or vibrate so as to "sing." See No. 38.
9 Grind or turn rest of commutator down true, and level to true surface so as to clean up the flats.
10 a. Broken circuit / b. Short-circuit — In field: Repair if external, rewind if; Coils: internal.
c. Dynamo not properly wound—or without proper amount of iron—no remedy but to rebuild.
11 a. Reduce number of lamps and thus diminish current called for.
b. Test out, locate and repair.
c. Note:—Dead short-circuit will, or should, blow safety fuse. Shut down dynamo, locate and repair fault, put in new fuse before starting again. Fuse should not be inserted till fault is corrected, as it will blow again on starting up.
d. e. f. g. Use proper current for motor, and no other, with proper rheostat or controlling switch. Reduce load to proper amount for rating of motor— and remedy any cause of trouble from undue friction. See B 3 and C 35-36.
12 a. Look for copper dust, solder, or other cause for metallic contact between commutator bars and remove.
b. See that clamping rings are perfectly insulated from commutator bars, and free from carbonized oil or copper dust and dirt to make short-circuit.
c. Test for internal: Short-circuit / Cross-connection — if found rewind armature to correct.
d. Examine insulation of brush holders for fault. Dirt, oil, and copper dust may make short-circuit from brush holder to rocker arm, and thus short-circuit machine. See E. 1-3 and F. 60.
13 a. Bridge the break temporarily by "staggering" the brushes until run is over, then test out and repair. This is only a temporary makeshift to try and stop bad sparking during a run when dynamo cannot be shut down.
b. If dynamo can be shut down, look for broken or loose connection to commutator bar and repair
c. If coil is broken inside rewinding is only sure remedy. The break may be bridged temporarily by hammering the disconnected bar until it makes contact across mica with next bar. Of doubtful value. If done, bars must be repaired and insulation secured again after fault is corrected.
d. Solder commutator bars together, or bridge across with piece of heavy wire, and thus cut out broken coil. Be careful not to short-circuit good coil in so doing, and thus cause sparking from short-circuited coil as in No. 12.
14 Cross-connections may have same effect as short-circuit and are to be treated as such. See No. 12. Each coil should show complete circuit, with no cross onto any coil.
19 Dry out by gentle heat. May be done by sending current through armature, regulated not to exceed proper current. If not so bad as to cause short-circuit, or cross-connection, or heat too much, may dry out by heat of its own current while running.
20 Iron of armature hotter than coils after short run. Faulty construction; core should be finely laminated, and laminae insulated. No remedy but to rebuild.
21 See B 3—Hot boxes and journals may affect armature.
22 a. Shunt Machine: Decrease voltage at terminals by reducing speed; or increase resistance of field coils by winding on more wire, or rewind with finer wire, or put resistance in series with field.
b. Series Machine: Shunt a portion, or otherwise decrease current through fields; or take off one or more layers of wire; or rewind with coarser wire.
Note:—Excessive current may be from short-circuit, or from moisture in coils acting as short-circuit. See No. 10 b and No. 24.
23 Pole pieces hotter than coils after short run, due to faulty construction, or to fluctuating current. If the latter, regulate and steady current.
24 Coils show resistance lower than normal; may cause short-circuit or body contact to iron of dynamo. Dry out as in No. 19. See also No. 22, note.
25 a. Supply plenty of good clean oil, and see that it feeds properly. Oil should be best quality mineral oil, filtered, clean, and free from grit. Be careful not to flood bearings so as to force oil upon commutator, or into insulation of brush holder, as it will gradually char and gather copper dust and make short circuit. See 12—b and d.
b. Vaseline, cylinder oil, or other heavy lubricant may be used if ordinary oil does not remedy hot box. Use until run is over, then clean up and adjust bearings.
a. Wash out grit by flooding with clean oil until run is over, then clean up. Be careful however about flooding commutator or brush holder. See 25 a.
c. After can be sure journals are thoroughly clean, then replace caps and

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E Motor { 1. Stops / 2. Fails to start / 3. Runs backwards or against brushes }

F. Dynamo fails to generate

B1
28 Journals too tight in bearings
29 Bent or sprung shaft
30 Bearings out of line
31 End pressure of pulley hub, or shaft collars against bearings
32 Too great load or strain on belt
33 Armature out of centre in polar space

C.
34 Armature or pulley out of balance
35 Armature strikes or rubs against pole pieces
36 Collars or shoulders on shaft, hub, or web of pulley strike or rattle against bearing
37 Loose screws bolts or connections
38 Singing or hissing of brushes. See A 3a. 4 and 5
39 Flapping or pounding of belt joints or lacing
40 Slipping of belt from overload
41 Humming of armature lugs or teeth as they pass pole pieces

D1
42 Engine fails to regulate with varying load
43 Series Motor. Too much current for load and motor runs away.
44 Shunt Motor { a. Regulator not properly set / b. Current not correct / c. Motor not properly proportioned and therefore fails to regulate }

D2
45 Same as 42
46 Overloaded. See A 11
47 Short-circuit in armature. See No. 12
48 Striking or rubbing of armature. See No. 35
49 Friction. See B 3
50 Weak magnetic field. See No. 10

E1-3
51 Great overload. See 11 f and g
52 Very excessive friction. See B 3, 25 to 33
53 Circuit open { a. Safety fuse melted / b. Broken wire or connections / c. Brushes not in contact / d. Switch open / e. Current fails or is shut off from station }
54 Complete short-circuit of field
55 " " " " armature
56 " " " " switch

E4
57 Wrong connections within motor.

58 Reversed residual Magnetism { a. Reversed current through field coils / b Reversed connections / c. Earths magnetism / d. Proximity of another dynamo / f. Brushes not in right position. See No. 31-2-5 }
59 Too weak residual magnetism
60 Short-circuit in machine. See Nos. 12 and 54, 55, 56
61 Short-circuit in external circuit

F.
62 Field coils opposed to each other
63 Open circuit { a. Broken wire / b. Faulty connections / c. Brushes not in contact. See No. 5 / d. Safety fuse melted or broken. See No. 53 a. / e. Switch open. See 53 d. / f. External circuit open }
64 Too great load on dynamo
65 Too much resistance in field regulator

---

28 { Remove some of cap, put in packing to bring bearing and easy rotation by hand. / b. Turn down, smooth and repolish journal, or ream or scrape bearings to proper fit.

29 Bend or turn true by careful springing or turning in lathe. Probably new shaft will be needed.

30 { Loosen foot of bearings and shift until armature turns freely by hand with belt off, and is yet in centre of polar space. Ream out bolt and dowel pin holes, and fit new dowels to allow new position to be kept when bolts are drawn up tight. If shift is needed *up* or *down* then pack up or trim down foot of bearing to allow proper setting.

31 { a. See that foundation is level and that armature moves freely with end motion—See note No. 67. / b. If no end motion, then turn off shoulders on shaft, or file or trim off ends of bearings until end motion is obtained. / c. Then line up shaft, pulley and belt, so that no end thrust is maintained on shaft, but armature has free end play while in motion.

32 { a. Reduce load so that belt may be slackened and yet not slip. Avoid vertical belts if possible. / b. Use larger pulleys, wider and longer belts, run with slack side on top to increase adhesion and pull off belt, without excessive tightening, so as to drive full load. Belt should be tightened just enough to drive full load smoothly, without any vibration and flapping of belt. Vibration and flapping of belt will cause lamps to wink.

33 { a. Bearing may be worn out, letting armature move out of centre, and need replacing. See No. 36. / b. Centre armature in polar space and adjust bearings to new position. See No. 30. / c. File out polar space to give equal clearance all around. / d. Spring pole away from armature and secure in place. This will be a very difficult, if not impossible job, in large and rigid machines.

34 { Faulty construction. Armature and pulley should have been properly balanced when first made. May be helped somewhat by careful balancing on knife edges and adjusting.

35 { a. Bend or press down and secure any projecting wires, and secure strongly with proper tie bands of wire. / b. File out pole pieces where armature strikes. See Nos. 30-33 for possible remedies.

36 See Nos. 30-31 bearings may be worn out and *too loose*, and therefore rattle. New bearings needed.

37 { Tighten up all screws, bolts and connections to firm bearing, and *keep them so* by daily attention. The jar and tremor of running dynamo tends to work screwed connections loose when not held by check nuts.

38 { a. Apply a *little mineral* oil, or better yet vaseline, or hold piece of stearic acid (adamantine) candle to commutator and then wipe off. Just a *faint trace* of oil or grease should be all that is required. / b. Lengthen or shorten brushes in holder, until firm smooth and yet gentle pressure is maintained free from any hum or vibration. See Nos. 3, 6, 7, 8, 9 and 31.

39 Use endless belt. If laced belt must be used have *square* joints properly laced.

40 Tighten belt, or reduce load. See 32.

41 { a. Slope ends of pole pieces so that armature teeth do not pass edges all at once. / b. Decrease magnetism of field, or increase magnetic capacity of teeth.

42 { Adjust governor of engine to proper regulation if possible. If not, get a better engine. Engine should regulate closely, with proper steam supply, from "no load" to "full load."

43 { a. Series motor on constant current circuit { 1. Put in a shunt and regulate until proper current for load is obtained. / 2. Use proper regulator or governor to control magnetism of field for varying load. } / b. Series motor on constant potential circuit { a. Put in resistance and cut down current. / b. Use proper regulator on controlling switch. / c. Change to automatic speed regulating motor. }

44 { a. Adjust regulator to control speed. / b. Use current of proper voltage and no other, with proper rheostat. / c. Get a better motor—one that is properly built and designed for the work.

45 See 42

46 Overloaded. See A 11

47 { Open switch, hunt out trouble and remove. Keep switch open, and arm of rheostat to position "off" while locating and repairing fault; then close switch and shift arm gradually to position "on" to see if everything is correct. With series motor no great harm will result from motor stopping or failing to start; Shunt motor on C. P. circuit, armature may and probably will burn out, or fuse blow.

48 See No. 35

49 See B 3

50 See No. 10

51 See 11 f and g

52 See B 3, 25 to 33

53 { a. Open switch, hunt out and repair trouble then put in fuse. See note to 11 C. / b. Open switch, hunt for and repair trouble. See No. 13. / c. Open switch to repair fault. See No. 5. / d. Remedy obvious. Also see that switch is in proper order to make proper connection. / e. Open switch, return starting lever to position "off." Wait for current testing from time to time by closing switch and moving starting lever to close circuit.

54 { Test for, and repair if possible. Look to insulation of binding posts and brush holders. Poor insulation, or dirt, oil and copper dust make short-circuit. See No. 12.

55 See 54

56 See 54

57 { Connect up properly, referring to proper diagram. If proper diagram is not to be had try reversing the connection to brush holders. Other changes may be made until proper connections are found for rotation desired, then connect up permanently.

58a, 58d, 58c { Send current from another machine, or from battery, through field coils in proper direction to correct fault. Polarity to be tested by compass needle. If connections or windings are not known, try one way and test; if not correct, reverse connections try again and test.

58b { Connect up properly for rotation desired, referring to proper diagram of connections. See that connections for series coils (in Compound Dynamos) are properly made, as well as those for shunt coils. See 57

58f { Shift brushes until evidence of improvement is given. Position of brushes for best generating power should be clearly indicated and is generally at or near neutral points. See Nos. 1, 2 and 5.

59 See 58

60 See Nos. 12 and 54, 55, 56

61 { Lamp socket, or other part of line short-circuited or grounded may prevent building up of shunt or compound machines. Search out and remedy before closing switch. See also 54, 55, 56.

62 { Reverse connections of one of field coils and test; compass should show opposite polarity of pole pieces. If after such trial dynamo does not build up try 58 a.c.d. If current does not then come up in proper direction, cross field connections, or recharge in opposite direction. See 55.

63 { a. Search out and repair. See No. 13. / b. See No. 37. / c. See No. 5. / d. See No. 53 a. / e. See No. 53 d. / f. Test out and repair, *with dynamo switch open* until repairs are completed.

64 { Reduce load to pilot lamp alone (Shunt or Compound Incandescent Machine.) After dynamo comes up to full voltage, as shown by pilot lamp, or voltmeter, close the other circuit in succession and watch and regulate voltage. See 11 a and 65.

65 { Gradually turn regulating switch to cut out resistance and watch pilot lamp. When dynamo comes up regulate, &c.

Note:

Never use ice or water to cool off bearings, as it may get into armature and ruin it, unless it has been made water-proof as in some cases of street-car motors.

Never shut down because of hot box until remedies 32, 28, 26 and 25 have been tried and proved useless. If absolutely necessary to shut down, get belt off as soon as possible, do not allow shaft to "stick" in stopping, get boxes or bearings out and cool off naturally as soon as possible and not in water as this may ruin them, then scrape, fit, polish, clean shaft and test for free turning by hand before belting up and starting again.

Cleanliness about Dynamo or Motor is imperative; dirt, oil, copper dust may prove source of great annoyance or damage. Small tools, bolts or pieces of iron must be kept away from dynamo as they may be drawn into, or fall upon armature and ruin it.

A Good Rule. Never allow loose articles of any kind to be placed upon any portion of dynamo. Brass or copper oil cans are best to use as they are non-magnetizable.

All connections must be large clean and firm. Look over and tighten loose connections, screws or bolts daily.

Always keep copper brushes raised from commutator when dynamo is at rest. Poor cheap oil is poor economy; use none but the best of mineral oils. All new oil should always be filtered before using.

Oil from self-oiling bearing should be filtered before being used again.

Keep cotton waste off the commutator. Use canvas or cloth to wipe with.

A piece of pine makes a good burnisher to use on commutator to keep it clean and smooth.

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Mr. Humphreys cannot see that anything in the nature of a "necessity" ought never to be a monopoly, except that the monopoly be in the hands of the people themselves. Light is a necessity, and to tax the masses for the pecuniary benefit of the few, as has been done in the case of gas, is a monstrous mistake. Can Mr. Humphreys point to any other industrial manufacturing operation where there is free and open competition with capital so remunerative? We are not of those who would generally restrict the profits of the capitalist. We do take exception, however, in sweating the population for the benefit of the few when air, light, or water is in question. These necessities should be given to the people at the lowest possible cost, and that can only be done when the necessary arrangements are conducted properly by the people themselves. When it became certain that electricity must become a competitor with gas for lighting purposes, those interested in the general welfare of the country, though hardly pressed by the parties interested in the development of electrical work, refused to give monopolist facilities. They had been given to gas, and this was seen to be a mistake. So great was this feeling that in the earlier electrical enactments too little freedom was given, and there was a general outcry that development was cramped. We only agree partially with those who condemn this early legislative work. Mr. Humphreys deals lengthily with the question that a would-be customer can demand connection under certain circumstances both with gas and electric light mains, and that the terms which can be imposed upon small consumers are better for electricity than for gas. He also tells us that he has never heard that the gas managers impose even the terms allowed, while assuming that the electric light managers do so. Has he any proof of this? Here is what he says:

"If the matter was thoroughly enquired into, it would be found that the absence of anything in the way of a minimum charge for gas entails a considerable loss on the suppliers. The question has never been raised yet, because no urgent necessity has arisen for doing so; nor have I heard of a case where a guarantee of minimum consumption was demanded, except in connection with special circumstances, such as extending the service or main beyond the prescribed limit.

"The electricians have secured a very substantial protection against losses of this sort by the insertion in their provisional orders of a clause which runs something like this: 'They shall be entitled to charge at the following rates per quarter: for any amount up to twenty units, 13s. 4d.; and for each unit over twenty units, 8d.' The price named, of course, varies according to each case; but the principle is that a consumer must pay for twenty units each quarter, whether he uses it or not. Even during the summer quarter, not less than this amount must be paid for. Applying this rule to the case of gas, twenty units may be taken as representing two thousand cubic feet. Every gas company has five, ten, or even a larger percentage of customers on its books who do not pay for over one thousand cubic feet in the summer quarters at any rate. The right to charge a minimum of two thousand cubic feet per quarter, would mean an increase of income sufficient to warrant a reduction in price; and gas companies are placed at an unfair disadvantage, if such a privilege is allowed to their competitors but denied to themselves."

The right to charge and the charging are two different things. We have experience of this difference in another matter. Certain men paid about ten thousand pounds for certain water rights. When the money was gone beyond recall they found they had the rights still, but not the water. We do not question the right of electrical engineers to charge, but we question their actually doing so. Other points of Mr. Humphreys are made in the following paragraphs, only one or two, however, of which we shall notice:

"A point in connection with the charge for public lighting may next receive attention. The 1871 Act provides that the price of gas supplied to public lamps may be settled by agreement, or, in case of difference, by arbitration; regard being had to the circumstances of the case and the price charged to private consumers. So far, this is quite as much as could be expected; but in many private Acts it has been over-ridden by a condition, inserted under pressure at the demand of the local authority, to the effect that public lamps should be supplied at the lowest price charged to any consumer. Such a stipulation was brought forward and approved in the spirit already noticed—that of regulating a monopoly—and evidently with regard to the probability that the whole of the streets and public spaces would be lighted by gas, causing the aggregate consumption to be larger than that of any private customer. But it is a strong point with the electric lighting companies to secure, not the whole, but a selection, including the cream, of the public lighting, and the same authorities who forced the above obligation on gas companies are perfectly willing to favour electricity in this respect. If their endeavours are attended with success, the gas company lose all the high-power lamps, and a large proportion of the remainder; being left with a comparatively small and widely-distributed consumption in the by-lanes and outskirts. The loss of a privilege should, in common fairness, carry with it the removing of an obligation bearing upon that privilege; and the hardship involved in the obligation to supply the leavings of their competitors at the old rate, is too obvious to need further amplification.

"We have, however, not yet exhausted the advantages afforded to electricity as compared with gas. The gas companies' powers are usually supposed to cease at the meter, and the consumer can do as he pleases beyond it. If he chooses to vary the pressure in the mains in the vicinity, by suddenly and frequently altering the rate of his consumption, the company have no remedy. He may put one hundred lights on, or cut them off without notice; and I have heard it alleged by a solicitor that the gas company have no right to ask how many lights are in use. The same

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gentleman, by the way, has since proved perfectly willing to allow an electric lighting company the right to inspect the whole of his wires and lights as often as they choose. But Clause 21 of the 1871 Act seems to give power to enter the consumer's premises and inspect the fittings at all reasonable times. This clause may be useful in case of a disputed account, or where a meter has failed to register; but it is not often used, and many undertakings have preferred to drop it entirely for the sake of working peaceably with their customers. This power to inspect, whatever it may be worth, evidently has reference only to questions relating to the quantity of gas consumed, and the charge for the same. There is no right to raise a question as to the suitability or efficiency of any appliance in use.

"The following extracts from electric lighting provisional orders, however, point to a different footing: 'Provided also that if the owner or occupier . . . uses any form of lamp or burner, or uses the energy supplied to him . . . so as to unduly or improperly interfere with the efficient supply of energy to any other body or person, . . . the undertakers may discontinue to supply energy to such premises. The undertakers shall not be required to supply any premises unless they are reasonably satisfied that the electric fittings are in good order, and not calculated to affect injuriously the use of energy.' These clauses admit a large extent of control right up to the point of consumption. They are further of use in aiding the electric company to control the supply of fittings, which is a very important branch of the business, and in many cases furnishes (at present, at any rate) the chief part of the profits. Persons will naturally hesitate about placing an order for electric fittings with a local tradesman when there is a risk that the company may condemn the whole. The important feature, however, is that whereas gas companies are helpless in the matter of controlling wasteful or careless usage, the suppliers of electricity have very wisely secured considerable powers in this direction."

When legislation was considered for gas concerns, such things as gas-engines were unknown, and the fluctuations of neighbouring lights caused by their extensive use not therefore considered. But they came up, and these effects had to be considered. Electricians tried to provide against widespread complaints because of fluctuations in neighbouring lights through the action of one consumer. We could write a long article as to the remarks on inspection and control of fittings, but leave Mr. Humphreys's words without further comment than to say there is a difference between gas and electricity, and a difference between their fittings. The one set of fittings may be suitable within wide limits, the other not. We take it that this inspection and control is vastly in favour of the consumer, and we think all electrical engineers also take this view.

DISEASES OF DYNAMOS.

Lieutenant C. D. Parkhurst has contributed to the *Transactions* of the American Institute of Electrical Engineers a special supplement on the diseases of dynamos. We have reproduced this supplement as we think it ought to be carefully studied by every man who is engaged in central-station work, or, in fact, in any way engaged in the construction or use of dynamos. The amount of labour involved in the compilation of a sheet of this kind is immense, and Lieutenant Parkhurst is to be congratulated upon the exhaustive details he has given.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ELECTROMOTIVE FORCE.

SIR,—"Student" gives, on p. 304, a number of definitions of this term, which exhibit some difference as to its relation to the other term, "potential difference," which (like "voltage" and electric "pressure") is commonly regarded as a synonym. In the gradual differentiation of technical terms there is sure to be some little confusion, especially where no important distinction exists.

There is, however, a real distinction in this case, involving a relation of cause and effect. Had "Student" consulted my book, "Electricity, Its Theory, Sources, and Applications," he would have found, p. 106, a definition which embodies that distinction: "Electromotive force, shortly written E.M.F., and symbolised by E in formulæ, measures the generative power in terms of potential—that is, of the capacity to generate current, or to overcome resistance." This in relation to batteries. On p. 299 it is said more generally, "Electromotive force is the general name for whatever may be the agency which sets up electric current. Some writers object to the use of the term, which is, however, too useful to be set aside. E.M.F. corresponds to, and is always accompanied by, *potential* in static electricity; hence it is often called *electric pressure*."

This is the very distinction which is implied in your remarks (p. 307). The common sense of the terms shows that E.M.F. applies to the originating cause, the first effect of which, as of all forces, is to set up a pressure, or stress, which then results in the motion which is called current. In a secondary sense the pressure, or potential difference between any two points in a circuit, is also the acting E.M.F. between those points.

We may say that while the *pressure* is a manifestation of energy, and *potential* is an expression of it, E.M.F. is the energy itself. It is the potential energy charged upon a molecular chain of matter, and it is the energy that chain can deliver up as heat or work, under those conditions which constitute an electric circuit. This is put in the form of a law, p. 318 of my "Electricity," "*Wherever there is free energy present* (as heat in thermo-electricity), *or wherever there is potential energy, seeking to become free* (as when chemical affinities can come into play), *in presence of differential molecular structures or conditions, there energy takes the form of electric potential.* The quantity of energy associated with any molecular conditions, or acting in the molecular chain, measures the E.M.F. due to the particular conditions. The generation of E.M.F. in dynamo machines also depends upon the energy applied to moving the wires across a magnetic field, in which they are subjected to molecular stresses."

As to examiners, is not the suggestion on p. 307 somewhat over-cynical? No doubt they are subject to human weaknesses. I should probably regard with more favour a reply in electrolysis based upon molecular theories, in which I believe myself, than one dependent upon the atomic dissociation ideas, which I consider absurd; but still, as would most others, I should certainly consider whether the student had fairly mastered the ideas which it had been his misfortune to be taught.—Yours, etc.,

JOHN T. SPRAGUE.

TURNING DOWN ELECTRIC LIGHTS.

SIR,—I thank you for publishing my letter in your last issue, but not for your *résumé* of the *Birmingham Gazette* article, or for your article thereon. As, however, you have

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devoted your leader and two columns to "walking into" my patents, I also thank you in anticipation for permitting me to reply in half the space.

As the commercial value of the patents lies in the switch arrangements which switch from parallel to series, or from one series to another, I will deal with them.

Firstly, take the switch which switches from parallel to series. If there are two lights in a bedroom, railway carriage, or elsewhere, my switch, by a single movement of the switch handle lowers both lamps to such a low pitch that one can just see one's way about, and in doing so cuts off from four-fifths to five-sixths of the current, at the same time reducing the cost per hour to something between one-fifth and one-sixth of what it is when not lowered. Here may I point out where an error has crept into your leader—the wiring or existing switches are *not* necessarily altered. The usual double cord from which a 16-c.p. lamp is hung may be cut close to the lamp, and a pair of 8-c.p. lamps, with a switch attached to them, may then be placed in its stead, which switch will either raise, lower, or put the light out; but if it is always left full on, then the usual existing switches at the door act as usual. Permit me also to point out an error in your *résumé* of the *Gazette* article. The cluster of six does not switch from series to parallel. It works this way: when full on it runs in three lots of two series, but when I throw the switch handle over it runs in two lots of three series, and gives a pleasant subdued light suitable for entertaining-rooms, churches, etc. When full on it uses 3½ amperes, and when turned down it uses 1½ amperes, or considerably less than half: this is much pleasanter than turning out above half the lamps and having alternate glares and dark places and strong shadows. In no case do I turn out any of the lamps or bring others (usually out) into play, and in no case do I use a resistance, which is, after all, the same as if a man slowed his engine by putting on the break or having a blow-off cock on his cylinder.—Yours, etc.,

THOMAS BUDWORTH SHARP.

County-chambers, Birmingham, Sept. 18, 1894.

ADVERTISING BY ELECTRICITY.

SIR,—I was surprised to see in a paragraph of a contemporary of yours, commenting on the throwing of advertisements on Nelson's column, etc., in Trafalgar-square, the statement made that it is impossible to decipher any words.

From the notices which have recently appeared in the daily papers, it would seem that a great majority of the public not only see a light, to which they would scarcely object, but can read and recognise well-known advertisements. Being interested in the method of throwing signs to such a distance, through the courtesy of the Electrical Long-Distance Advertising Syndicate, I have attempted to photograph some of them, and I enclose a print of a negative taken a few months ago on an ordinary plate, about 9.40 p.m., giving 10 minutes' exposure with $f/_{16}$ stop, the distance of the screen (St. Martin's Church) from the lantern being 250 yards. Recently a similar apparatus was used at a large *fête* held in the grounds of Mr. Gladstone's residence at Hawarden, and a local photographer succeeded in taking several negatives showing various sentences, which in this case were thrown on the trees in the park.—Yours, etc.,

VERITAS.

CITY AND GUILDS OF LONDON INSTITUTE.

LECTURE III.—THE VOLTAGE REQUIRED TO PRODUCE ANY REQUIRED CURRENT IN A WIRE OF GIVEN RESISTANCE.

(Specially contributed.)

In our previous lectures we have seen:

1. That we must have a difference of electric pressure in order to obtain a current.

2. That the path or circuit of the current must be continuous all round, must return to itself—must, in fact, be closed.

3. That the current in the circuit depends not only on the pressure acting, but also upon the resistance offered by the circuit.

This *resistance*, *current*, and *pressure* are quantities that can be measured, but before carrying out such measurement we have to decide upon units of measurement, just as in measuring lengths we have the "yard" as the unit. This is merely an arbitrary length between two particular points. According to the Act of Parliament the Imperial yard is defined in this way: "That the straight line between the centres of the transverse lines in the two gold plugs in the bronze bar deposited in the office of the Exchequer shall be the genuine standard yard at 62deg. F." The yard may be called a practical unit. If every standard yard was lost, the work of reconstruction would be a little troublesome. In electrical work an effort has been made to obtain units that should not be of so arbitrary a character, and this has led to a double set of units. It is with only one of these sets of units that we need trouble ourselves at present—the practical units. Quite lately the Board of Trade has issued an order referring to these units—to be called standard units—of which I may read the following paragraphs:

"I. *Standard of Electrical Resistance.*—A standard of electrical resistance denominated one ohm being the resistance between the copper terminals of the instrument marked 'Board of Trade Ohm Standard Verified 1894' to the passage of an unvarying electrical current, when the coil of insulated wire forming part of the aforesaid instrument and connected to the aforesaid terminals is in all parts at a temperature of 15·4 C.

"II. *Standard of Electrical Current.*—A standard of electrical current denominated one ampere being the current which is passing in and through the coils of wire forming part of the instrument marked 'Board of Trade Ampere Standard Verified 1894,' when, on reversing the current in the fixed coils, the change in the forces acting upon the suspended coil in its sighted position is exactly balanced by the force exerted by gravity in Westminster upon the iridio-platinum weight marked A, and forming part of the said instrument.

"III. *Standard of Electrical Pressure.*—A standard of electrical pressure denominated one volt being one-hundredth part of the pressure which, when applied between the terminals forming part of the instrument marked 'Board of Trade Volt Standard Verified 1894,' causes that rotation of the suspended portion of the instrument which is exactly measured by the coincidence of the sighting wire with the image of the fiducial mark A before and after application of the pressure, and with that of the fiducial mark B during the application of the pressure, these images being produced by the suspended mirror and observed by means of the eyepiece.

"In the use of the above standards the limits of accuracy attainable are as follows:

"For the ohm, within one-hundredth part of 1 per cent.

"For the ampere, within one-tenth part of 1 per cent.

"For the volt, within one-tenth part of 1 per cent.

"The coils and instruments referred to in this schedule are deposited at the Board of Trade Standardising Laboratory, 8, Richmond-terrace, Whitehall, London."

The *ohm* is the name given to the unit resistance. This standard unit is the equivalent wire resistance to the resistance offered to an unvarying current by a column of mercury at the temperature of melting ice, 14·4521 grammes in mass of a constant cross-sectional area, and of a length of 106·3 centimetres.

The *ampere* is the name given to the unit current, and is that current which, when used to deposit silver from a solution of nitrate of silver under certain conditions, deposits it at the rate of 0·001118 of a gramme per second—that is, 4·0248 grammes per hour. It may be interesting to know a little more about the electrolytic action of the current. This table gives you some information.

One ampere deposits per hour	1·174	grammes	copper.	
,, ,, ,,	4·025	,,	silver.	
,, ,, ,,	2·441	,,	gold.	
,, ,, ,,	1·099	,,	nickel.	

or

1lb. copper is deposited per hour by	386·4	amperes.	
,, silver ,, ,,	162·7	,,	
,, gold ,, ,,	185·8	,,	
,, nickel ,, ,,	412·8	,,	

The *volt* is the name given to the unit pressure, or

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E.M.F., and is that pressure which if steadily applied to a conductor whose resistance is one ohm will produce a current of one ampere.

The materials which offer least resistance to the current are the metals, hence these are said to be good *conductors*. Certain materials—such as paraffin, glass, dry air, etc.—offer great resistance to the current, and are termed *insulators*. Mr. Cully gives the accompanying table of good and bad conductors:

Good conductors.	Semi-conductors.	Insulators.
Silver	Carbon	Wool.
Copper	Graphite	Silk.
Gold	Acids	Sealing-wax.
Aluminium	Saline solutions	Sulphur.
Zinc	Sea-water	Resin.
Platinum	Melting ice	Guttapercha.
Iron	Pure water	Indiarubber.
Tin	Stone	Shellac.
Lead	Dry ice	Paraffin.
German silver	Dry wood	Vulcanite.
Antimony	Porcelain	Glass.
Mercury	Dry paper	Dry air.

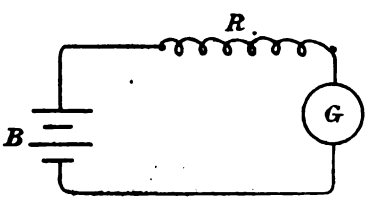

FIG. 1.

Generally, copper is employed for electric conductors. All these wires which I use to make the connections are of copper, though the wires of which these coils are made—which have been carefully made to have resistances of one or more ohms, or parts of an ohm—are some made of German silver and some of platinoid.

I want you now to pay a little closer attention to this circuit. You see it consists of the battery, B, some large connecting wires, a coil of wire which has a large resistance, indicated in the diagram by R, and a galvanometer. The *complete circuit* resistance then includes the resistance of the

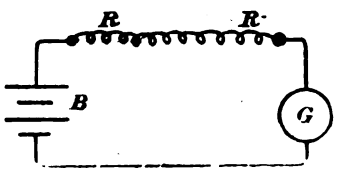

FIG. 2.

liquids and metals of the battery, the resistance of the various connecting wires, of the coil R, and of the galvanometer. The resistance of the battery is generally called the *internal* resistance of the circuit, that of the other parts the *external* resistance. You will see that it is very easy for me to vary the external resistance by putting different connecting wires or coils, while the internal resistance cannot be so varied at will. We shall learn more by-and-by about this internal resistance, and find that when the battery is working there is usually a variation in internal resistance. I am now using one that varies as little as any, and a galvanometer that by direct reading shows the current. The

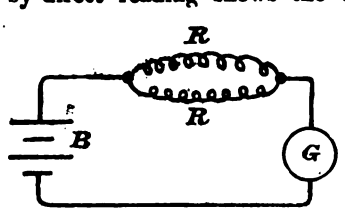

FIG. 3.

internal resistance we will symbolise by *r*, the external by R. The resistance of the coils I am using is very large compared with the other resistances of the circuit.

1. Join up the circuit, as shown in Fig. 1. We get a deflection on the galvanometer, which you see. Call that deflection C.

2. I now join a second coil to the first, as in Fig. 2, and when resistances are joined like this they are said to be in series. By this means I have increased the resistance, and see, at once the current falls to a point showing about half what it was before—that is, now $\frac{C}{2}$. It would be exactly half had the total resistance of the circuit been doubled.

3. Arrange the coils as in Fig. 3—in parallel. Now we see the current, C, is almost doubled.

In each of these experiments we may assume the pressure to have been constant.

We see, then, that lengthening the wire without altering its sectional area increases its resistance — that is, the resistance of conductors increases directly as their length; double the length, and you double the resistance. Our third experiment shows that when the length is unaltered—for the length of wire in each of the coils is the same—and the sectional area is increased, the resistance is decreased; for putting two wires side by side is the same as putting one wire of the original length and double the sectional area. Thus resistance depends upon material employed, upon length of material and sectional area of material.

Current, then, is inversely proportional to resistance; or

Current varies *inversely* as resistance,

which we may symbolise—

$$C \propto \frac{1}{R}.$$

I am now going to modify the three experiments just tried by using another battery to give double the pressure of the former one.

We see that all else, except battery, being as No. 1, we get twice the current we originally obtained.

In the second case we also get twice the original current, and also in the third case.

This shows us that current varies *directly* as pressure, or E M.F., which in symbols we write

$$C \propto E,$$

where E indicates pressure.

Combining the two sets of symbols, we may write

$$C \propto \frac{E}{R},$$

which reads thus:

Current varies *directly* as E.M.F., or pressure, and *inversely* as R (resistance).

In the early part of this century Prof. Ohm proved more than this with steady continuous currents—not only that

$$C \propto \frac{E}{R},$$

but that

$$C = \frac{E}{R};$$

or, expressed numerically in practical units,

$$\text{amperes} = \frac{\text{volts}}{\text{ohms}}.$$

And this connection between current, pressure, and resistance is known as *Ohm's law*.

Now, knowing any two of these quantities, the third can be found by simple arithmetical operations. But before troubling about the arithmetic I want you to look at the subject from any other point. Instead of saying a conductor has a small resistance, we may say it has great conductivity, or a conductor of great resistance has small conductivity. Hence conductivity and resistance are inverse properties. Because of this Mr. Sprague has suggested that we should look upon a conductor as having capacity, rather than as having resistance. Suppose, then, for a moment we consider this suggestion. We might take for a unit the wire that has capacity for one ampere under a pressure of one volt. This wire of unit capacity would have a certain length with a given sectional area. If two wires were used in parallel of this length and sectional area, the capacity would be doubled, and every conductor might thus be looked upon as composed of parallel wires of given capacity. Lengthening a wire would decrease its capacity, increasing its sectional area would increase its capacity. I have merely mentioned this that you may be prepared to find opinions varying as to the best way to treat the subject. At the present time most people are content to use the term "resistance" in the manner I have endeavoured to explain to you.

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CITY AND GUILDS EXAMINATION.

(Concluded from page 304.)

SECTION II.—DYNAMOS, MOTORS, ETC.

Answer questions Nos. 2 and 5 of the ordinary grade, and not more than four of the following:

27. A four-pole Gramme armature of a motor is required to give at 400 revolutions a minute a back electromotive force of 100 volts. Flux from each pole-face 3,000,000 magnetic lines. [Neglect resistance and armature reaction.] State the number of armature conductors required and the current through each if the total current is 200 amperes.

28. Illustrate, with sketches, the difference between a wave winding and a lap winding as applied to a four-pole continuous-current armature.

29. What is magnetic slip in a multiphase rotary-field motor? And what is approximately the relation between current, torque, and magnetic slip?

30. State the best relation between armature resistance and armature reaction for shunt motors to run at constant speed under variable load, current being supplied at constant voltage.

31. Give hand sketch illustrating construction of an alternator with fixed armature.

32. What is the usual value of the intensity of the magnetic field in the gap space of ordinary continuous-current dynamos? Also, what determines its variation from one edge to the other of the pole-face?

33. An alternate-current transformer has 200 turns in its secondary winding, the induced electromotive force in which is 102 volts, the frequency being 100 periods per second. Assume that B will not exceed 4,000 lines per square centimetre. What must be the sectional area of the core?

34. What are the essential differences of construction to be found between arc lamps for alternate currents and arc lamps for continuous currents, and what are the reasons for these differences?

35. You have two dynamos of same type and size. Describe the method of testing them for efficiency, in which only the waste power is supplied, and is supplied electrically.

36. What features in the design of a dynamo determine whether it will or will not run without sparking?

SECTION III.—LIGHTING AND POWER.

Answer questions Nos. 4 and 6 of the ordinary grade, and not more than four of the following:

37. Give a diagram showing connections of a switchboard for three alternators intended to work in parallel four feeders and one exciting dynamo.

38. Give sketches of, and briefly describe, any system of bare copper underground conductors.

39. Compare critically the merits, as far as the line is concerned, of the following systems of power transmission by alternating currents—viz.: (*a*) single phase; (*b*) two-phase with three wires; (*c*) two-phase with four wires; (*d*) three-phase.

40. Describe and sketch a lightning-guard for overhead power lines.

41. Explain the interaction of capacity and self-induction on alternating circuits and the troubles it may cause.

42. Compare critically, both as regards capital outlay and working expenses, the distribution within a radius of 1½ miles of continuous currents with that of alternating currents.

43. Explain the various ways in which the term "load-factor" is used.

44. A continuous-current motor is run on a series arc light circuit. Describe a means for keeping its speed constant under varying load.

45. Draw up, briefly, a schedule of rules and conditions to be fulfilled by consumer before you will connect his circuit to the public mains.

46. Illustrate Lord Kelvin's law of economic proportion in cost of lines by an example of continuous-current power transmission; taking the case of a line for delivering 100 h p. at a distance of four miles; maximum voltage, 3,000 volts.

47. Find the stress in a copper wire 160 mils in diameter, weighing 77lb. per 1,000ft., used for a 60-yard span with a sag of 1ft.

48. Sketch the connections of a synchroniser.

SOME NEW RECORDING INSTRUMENTS.

The scope for improvement in electrical recording appliances lies not so much apparently in altogether new methods or principles of action, as in the elaborating of details and constituent parts already well known. By taking any ordinary type of instrument, and paying careful attention to its improvement in every little detail, much better results may be obtained than have been hitherto accepted as sufficient.

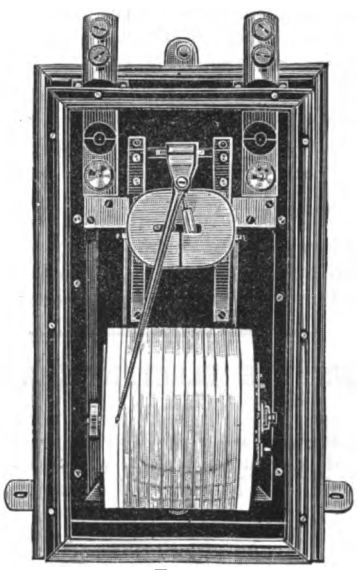

FIG. 1.

In the latest forms of recording voltmeters and ammeters brought out by Messrs. Nalder and Harrison this plan seems to have been largely followed, although at the same time some really novel features are also to be noticed in both these classes of instruments.

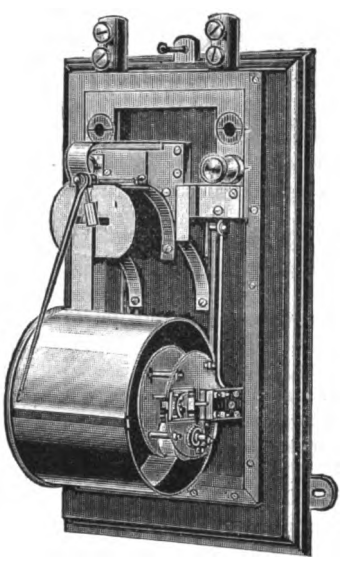

FIG. 2.

The voltmeters, which are intended to register on a circuit with more or less constant E.M.F., are made somewhat after the D'Arsonval type, the magnet being wound in such a manner that it will be saturated when the E.M.F. is about 30 per cent. lower than the voltage of the circuit on which it is intended to register. Thus the hysteresis error is negligible.

The ammeters, on the other hand, are made with a very small amount of iron, which is fixed in the most effective position; they are accordingly well suited for both alternating or direct current circuits. Throughout the whole device the effort has been, of course, to secure a maximum amount of force to move the registering or recording pen

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(of the usual ink-trough type) with a minimum consumption of electric energy: and these instruments require for their operation less than 10 watts.

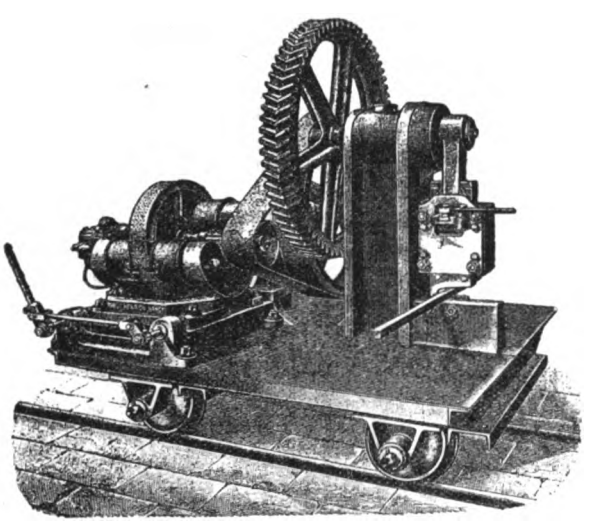
In the ammeters, as above mentioned, a special arrangement of the magnetic field is provided, so as to concentrate force on the movement actuating the recording pen; this is done by shaping the iron in a novel fashion, and by the moving iron on arms attached to the spindle which is on the outside of the coil, thus increasing the force transmitted to the recording pen and obtaining practically equal division on the scale.

With these instruments, the makers state that they have succeeded in reaching such a degree of sensitiveness as to record variations of less than ·3 per cent. In both classes of instrument the controlling force of the index and pen is that of gravity, due to a variable weight, and an additional means of careful adjustment between pen and recording surface is given by pivoting the drum on which the paper is placed with its clockwork motive power. A few turns of a screw with milled head will then give a movement to the drum surface outwards towards the pen, or inwards away from it, and a very delicate adjustment is thus obtained.

We illustrate in Figs. 1 and 2 views of an ammeter with glass front cover and of the same in perspective with cover removed. The voltmeters are somewhat similar, but we hope to give illustrations of these in some future issue, also further details of the results obtained with same.

PORTABLE ELECTRIC SHEARS.

We illustrate herewith a portable electric shears which is being used at the metallurgical works of the Petit-Fils de F. de Wendel, at Hayange, Lorraine. Large bars of



iron have to be cut there, and it is often inconvenient to take them to the shears, so the plan has been adopted to bring the shears to the iron instead. The shears are operated by a Henrion electromotor, which takes 75 amperes and 110 volts, and runs at 800 revolutions per minute. The tool is mounted on wheels, and the same motor can be connected so as to drive the apparatus to the part of the works where it may be required. Current is obtained by means of a trolley from the general installation in the works. The arrangement has resulted in great economies of time and money.

THE ELECTROLYTIC PRODUCTION OF CAUSTIC SODA AND CHLORINE.

On a recent occasion Mr. Christian Allhusen, one of the founders and directors of the great chemical works at Newcastle-on-Tyne, addressing the shareholders of his company, intimated to them that "civilised man requires chlorine, just as material man requires bread, and the fact that we can produce chlorine just as cheaply as any firm or company in the world is the sole excuse for the determined struggle we have carried on, and are now carrying on, for the continuance of our existence." In this sentence Mr. Allhusen referred to the competition which has for a considerable period been carried on in the country between the two great chemical processes of Le Blanc and Solvay. For a number of years past the latter process, which is based upon a well-known chemical reaction that permits of the production of soda by means of carbonic acid acting upon ammonia and brine, appears to have held the field in reference to the production of carbonate of soda, while the process represented by Mr. Allhusen has been first, or at any rate claims to be so, in reference to the economical production of chlorine. It now appears, however, says the *Times*, that both systems are in danger of being superseded by a new process, originated at the establishment of the Aluminium Company, of Oldbury, Birmingham, by Mr. H. Y. Castner, the managing director of the works there. This process differs radically from any of the numerous processes that have been attempted to be put in operation for the electrolytic production of soda. Its essential feature is the employment of a moving body of mercury, which completely separates the products of the electrolysis, and by its movement takes the place of a diaphragm, the amalgam formed by the electric action being decomposed electrically as rapidly as it is so formed. The use of mercury as a cathode is a very old idea, but one which has not hitherto met with any success, the great difficulty standing in the way being the enormous quantity of mercury required in carrying on such a process, and the great quantities to be handled in order to obtain relatively small quantities of caustic soda. Mr. Castner has effectually solved this difficulty at the Oldbury Works, the cells employed, each divided into three compartments, being capable of being continuously rocked or tilted, so as to give to the contained mercury a flowing motion from side to side. Two outside compartments contain the alkaline chloride solution and the carbon anodes, while the middle compartment contains an iron cathode and the caustic solution. The solution of salt or chloride is continuously circulating through the outside compartments, wherein it is being electrolysed, and then returns to saturators, where it is recharged with salt. The electric current, traversing the salt solution, liberates chlorine, and also forms sodium amalgam. The process is, of course, continuous, and it has demonstrated, among other results, that the electrical efficiency is as much as 88·90 per cent.; that no hypochlorites are produced, their production being a defect in other kindred processes; that the solution forming and carrying the electrolyte is in continuous use; that the E.M.F. required for each cell is low, due to the non-accumulation of sodium in the mercury, and particularly to the fact that the electrodes are brought almost into contact.

Anyone who is at all familiar with the phenomena of electrolysis will understand from this rather too technical description that results have been achieved of great importance. The process has now been in regular operation at Oldbury for over six weeks, and it has been found that each cell, which is 6ft. long, 3ft. wide, and 6in. deep, decomposes 56½lb. of salt daily, producing 38½lb. of caustic and 34½lb. of chlorine in 24 hours, for an expenditure of 3½ i.h.p. The caustic solutions produced contain 20 per cent. of caustic soda, and yield by direct evaporation a solid caustic of 99½ per cent. purity, while the chlorine gas is of 95 to 97 per cent. purity, the balance being hydrogen. The cells in which the process is carried on are practically automatic, and require little or no attention. A cell in full operation may be stopped, emptied, taken completely apart, put together again, and started in less than two hours by the labour of two men. The Aluminium Company have erected at Oldbury a plant of 30 cells, with a daily output of 1,200lb. of pure caustic soda and 1,000lb. of chlorine, with an expenditure of 110 i.h.p.

A number of chemical experts who have examined the process, including Sir Henry Roscoe, M.P., Mr. Ludwig Mond (of Brunner, Mond, and Co.), and the chief officials of the United Alkali Company, have expressed a favourable opinion of the process and its prospects.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Portsmouth.—Tenders for the second-hand plant offered for sale by the Corporation have to be in by to-morrow.

Hoylake.—The Hoylake and West Kirby Local Board are prepared to receive proposals for lighting the street lamps of their district by electricity. For particulars apply to the surveyor, Local Board Offices, Hoylake, Cheshire.

London.—Among tenders invited by the Great Western Railway Company, Paddington Station, by the 8th prox. are the following: telegraph instruments, telegraph apparatus, copper wire, G.P. wire, telegraph ironwork and tools, telegraph drysalteries, and carbons for electric light.

St. Pancras.—The Vestry are prepared to receive tenders for the following works in connection with their new central station at King's-road, Camden Town, and several sub-stations: main switchboard, electrical instruments, etc., motor transformers and accessories, wiring and lighting certain buildings. The drawings can be inspected, and specifications, schedules of quantities, and general conditions can be obtained at the offices of Prof. Henry Robinson, 13, Victoria-street, Westminster, on payment of 5s. Tenders are to be sent in by Thursday, October 11.

South Shields.—The following tenders are invited for the supply and erection of the following plant, for the Corporation: Section A—boiler-house plant, including boilers (marine type), fittings, pipes, chimneys, etc. Section B—pump-house plant, including double-acting, slow-speed, circulating and feed pumps, cast-iron tank, pipes, and fittings in connection therewith. Section C—engine-house and sub-station plant, including 100 and 25 kilowatt steam alternators, with double or triple compound engines, steam exciter, circulating pipes, switchboard and instruments, sub-stations, and transformers. Section D—underground work, including rubber-covered cables, cast-iron pipes, boxes, switches, and trenching. Section E—arc lamps, lamp-posts, switches, and transformers. Section F—meters. Firms tendering are at liberty to tender for any section or sections, or for the whole of the sections, but not for part of a section. Copies of specification, including plans, conditions of tender, and contract, can be obtained at the Borough Electrical Engineer's Office, South Shields, on and after 17th inst., on payment of £3. 3s., which sum will be returned on receipt of a *bonâ fide* tender. Tenders, sealed and marked "Tender for Electric Lighting," to be delivered to Mr. J. Moore Hayton, town clerk, Court Buildings, South Shields, by October 31.

RESULTS OF TENDERS.

Dundee.—A tender by Messrs. Siemens Bros., for the supply of a Willans engine and Siemens dynamo, has been accepted by the Electricity Supply Works at £1,466.

Liverpool.—The tender of Messrs. Crompton and Co., Limited, has been accepted for the electric lighting of the coaling jetty, East Float, Birkenhead, belonging to the Mersey Docks and Harbour Board.

BUSINESS NOTES.

Hull.—Waltham-street Chapel has been lighted electrically.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,721.

Folkestone.—The Town Council have deferred the consideration of Councillor Baker's electric light scheme.

Blockley.—A public meeting is to be held to consider the question of the future lighting of the streets.

Knightsbridge, W.—Messrs. Roger Dawson, Limited, are putting in about 3,000 lights in Wellington Court, Knightsbridge.

Globe Telegraph and Trust.—The directors announce the payment, on the 18th prox., of an interim dividend of 1s. 3d. per share.

London, E.C.—The Wool Exchange is having an electric light installation, which is being carried out by Messrs Roger Dawson, Limited.

Appointment.—As will be seen from our advertisement columns, the Bradford Corporation want a man to erect Crompton-Howell accumulators.

Nottingham.—St. Paul's Church has been restored and decorated. The electric light installation has been carried out by Mr. Joseph Blackburn.

Eastern Extension Telegraph Company.—The Board has declared an interim dividend of 2s. 6d. per share for the quarter ended June 30 last.

Halifax.—Up to the present time about 100 persons have signified their intention of becoming customers of the Corporation for the electric light.

Eton.—The Local Board have received a letter from the Board of Trade announcing the revocation of the Windsor Electric Light Supply Order of 1890.

Swansea.—The Electric Light Committee of the Swansea County Council are taking preliminary steps towards getting the town lighted by electricity.

Broughty Ferry.—The Northern Electric Supply Company, of Aberdeen, have given notice that they attend to apply for a provisional order for the burgh.

Coventry.—The City Council have affixed their seal to mortgages on rates—£2,000 for electric lighting and £100 to repay existing loan of that amount.

London, W.—Thomas's Hotel, Berkeley-square, is being lighted electrically, the work being carried out by Messrs. Roger Dawson, Limited, of Berners-street, W.

Clark's Engineering and Machine Tool Company, Limited.—This Company has been registered, with a capital of £5,000, to carry on business as ironfounders, mechanical engineers, etc.

Woolwich.—The Woolwich Electric Lighting Company have given notice to the Local Board that they are going to extend their mains from High-street to light the parish church.

Dewsbury.—There have been 60 applications for the post of electrical engineer to the Corporation, and Mr. J. B. Mitchell, of Bradford, has been appointed at a salary of £180 a year.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending 16th inst. amounted to £1,084, as compared with £708 in the corresponding week of last year.

Penzance.—Mr. W. T. L. Perry has had installed the electric light at his premises in Parade-street, the motive power being supplied by an engine used in his fish-curing business. The installation was carried out by Mr. V. Corin.

Blackburn.—The art gallery has been lighted electrically, under the supervision of Mr. Walter Leake. A 40-h.p. "National" gas-engine has been installed in the basement, driving a Yorkshire dynamo of an output of 120 amperes and 110 volts.

Hove.—The work in connection with the installation of the electric light in the Town Hall is now nearly completed. The whole building has been wired, and the light is ready for use everywhere except in the large room, the Board-room, and the committee-room.

Friesland Manufacturing Company, Limited.—This Company has been registered, with a capital of £18,000 in £1 shares, to enter into an agreement with W. M. Callender, and to carry on business as manufacturers of and dealers in plastic material, and as engineers and electricians.

City and South London Railway.—The receipts of the Company for the week ended September 16 were £826, against £758 for the corresponding week of 1893, or an increase of £68. The total receipts for the current period of the present half-year amount to £9,402, as against £8,906 in the corresponding period of 1893.

Liquor Register Syndicate, Limited.—This Company has been registered, with a capital of £18,000 in £1 shares, to acquire and develop certain patents, and to carry on the business of electricians, mechanical engineers, suppliers of electricity, and manufacturers of appliances for registering receipts of money and sales of goods.

Electric Plant for a Colliery.—A new colliery is being opened out on the Park Hall estate, near Eckington, by Mr. Job. It is intended to work the mine entirely by electric power, and to have it lighted both on the surface and underground electrically. The electrical work will be carried out by Messrs. John Davis and Son, of Derby.

Coventry Electrical Engineering Company, Limited.—This Company has been registered, with a capital of £5,000 in £1 shares, to acquire and carry on the business of electrical engineers and machinists now carried on by the Coventry Electrical Engineering Company at Ryley-street, Coventry, and to enter into an agreement for that purpose.

Bromsgrove.—The Town Local Board have been considering the question of electric lighting. Mr. Hall, pursuant to notice, moved that the Board consent to the application of Messrs. Hemming and Co. to lay down apparatus for electrical lighting in the district, all legal rights of the Board being reserved. This was seconded by Mr. Leadbetter, and after some discussion was passed.

Aberdeen.—At a joint meeting of the Watching and Lighting and Gas and Electric Committees of the Town Council, it was reported that the cost of the electric lighting of Union-street, at 7d. per unit, was £262 2s. 10d. per annum. It was decided that the gas department should supply the current for street-lighting at 2½d. per lamp per hour, the Lighting Committee to bear the cost of the carbon and maintenance.

Brush Company.—The directors of the Brush Electrical Engineering Company, Limited, recommend a dividend at the rate of 6 per cent. per annum on the preference shares, and at the rate of 5 per cent. per annum on the ordinary shares of the Company for the half-year ended June 30, 1894, carrying forward a sum of about £3,700 to next account. The transfer books will be closed from September 25 to October 8, both inclusive.

Chester.—Councillor T. Browne, at a meeting of the Town Council, asked when the Council were to be informed upon the actions of the Electric Lighting Committee. Councillor Deeley said he was of opinion that they could start an installation of the electric light in Chester with at least 5,000 incandescent lights, apart from the street-lighting. A meeting of the committee was to be held shortly, and the subject further considered.

Huddersfield.—The Electric Lighting Committee of the Town Council have recommended that discounts of 2½ per cent. be allowed to consumers of over 1,000 units up to 10 per cent. on a consumption of over 4,000 units in the half-year; that the supply of electrical energy for motive and domestic purposes other than lighting be charged at the rate of 4d. per unit; and a revised scale of meter rents adopted. These recommendations have been approved.

Liverpool.—The Works Committee of the Mersey Docks and Harbour Board have recommended the Board to provide electric

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lighting installations at (1) the new coaling jetty, Duke-street Bridge, East Float, Birkenhead, and (2) at the Albert Dock warehouses. Mr. Glynn said he was sure the Board would be glad to hear that the old Albert Dock was going to be revived and the electric light placed there. The recommendation was approved.

Warminster.—The committee of the Local Board appointed to consider the desirability of extending the electric light through the town have recommended that the light should be carried to the Obelisk, by the erection of six additional arc lamps, at a cost of £184. 10s., and £50 for a dynamo. Mr. Smith proposed the adoption of the committee's report, and that the committee be empowered to carry out the work, and this was eventually agreed to.

Halifax and Bermudas Cable.—The directors, in their report for the year ended June 30, state that the result of the working is a profit of £328, as compared with £1,717 for 1892-93. The cable receipts in the past year were £3,462, as compared with £4,856 in the preceding year. This decrease is due to the partial failure of the crops of the island, the absence of distressed shipping, and a decline in visitors' messages incidental to the prevailing business depression.

Dover.—In reference to the notice of intention to lay electric light mains in Wood-street, which was not included in the original scheme, the surveyor recommended that permission should be granted. The surveyor presented the account of the work of opening out the pavements for laying the mains for August, which amounted to £186. 6s. 1d. The total cost has been £681. 13s. 10d., of which about £280 has been paid. The account was ordered to be forwarded to the company.

Altrincham.—The clerk to the Local Board has received a letter from the Board of Trade in reference to the application of the Electric Lighting Act to the district by the Altrincham Electric Supply Company, enquiring as to the measures taken for securing the safety of the public and a sufficient supply of the electric light, together with a description of the system by which the energy was to be supplied, and asking for the observations of the Board on the matter. This was referred to the Fire and Lighting Committee.

Wigan.—At a meeting of the Gas Committee held on Monday, when there were present Mr. Holmes (chairman), the Mayor, Messrs. Benson, Ashton, Richards, Hilton, John Johnson, Millington, Phillips, Rigby, and Fyans, the report of the Electrical Lighting Sub-Committee was received. The committee expressed their pleasure on receiving the report, and resolved that the sub-committee be requested to invite five or six manufacturers of electrical plant to submit schemes and tenders as suggested in the report of the sub committee, and that copies of the report be circulated to the members of the Council.

Llandudno.—Consequent upon the receipt by the Improvement Commissioners of a notice from the Llandudno Electric Supply Company of their intention to apply to the Board of Trade for a provisional order to supply the town with electricity, the Water and Gas Committee recommended the Commissioners to apply themselves for a provisional order authorising them to supply electricity for public and private purposes. As an amendment to this, Mr. Jones moved that prior to the application being made a public meeting be held in order that the question might be fully ventilated. Upon being put to the meeting the amendment was lost.

Bootle.—Councillor I. A. Mack has moved at a meeting of the Town Council "that application be made to the Board of Trade for a provisional order, to be confirmed in the next ensuing session of Parliament, authorising the Council to supply electricity for public and private purposes within the borough, and that the Parliamentary and By-Laws Committee be instructed to take the necessary steps for this purpose." He explained that it was only a provisional application which would confer on them the right of lighting the borough with electricity. If they did not secure this power a private company might step in, and they would then be in the same position as they were now with the gas company. The recommendation was carried.

New Swindon.—Mr. Hinton, at a meeting of the Local Board, mentioned that Mr. E. C. Skurray, of the firm of Messrs. Skurray and Son, of the Town Flour Mills, has offered to light a lamp on the Whale Bridge, in Princes-street, if the Board would bear the expenses of laying the wires, etc., from the mill. Mr. Skurray had told him that since the works at the mill had started the electric light had proved most successful and inexpensive. He (Mr. Hinton) thought the Board would do well to accept Mr. Skurray's offer, and try the experiment. With that object in view, he proposed that the ward committees of that district be asked to consider the matter. Mr. Batt: Could we not light Princes-street? Mr. Thomas: I should like to see it carried into the main street. After some further remarks, Mr. Hinton's proposition was agreed to.

Bath.—A meeting of the City of Bath Electric Lighting and Engineering Company, Limited, has been held, the chairman, Mr. T. O. Callender, presiding, to authorise an application for a provisional order. The company at present holds a seven years' license only, and its operations are confined to a certain area of the city. It is proposed by means of a provisional order to extend the right of supply to the whole of the city, and also extend the time limit of the authority. The consent of the local authority has not yet been formally applied for, but on receipt of the statutory notice of the intention of the company to seek for the powers, it has decided to withhold its assent. The Chairman, who moved the formal resolution authorising the application, said that when the intentions of the company were clearly laid out before the authority he did not think they could persist in objecting. The resolution was carried.

Yarmouth.—The report of the Electric Lighting Committee of the Town Council contained a statement by the borough surveyor that the cost of lighting the 24 lamps on the Marine-parade and Regent-road had been for the month of August £9. 16s. for labour, £9. 14s. for gas, and £3. 10s. for waste oil and sundries—making a total cost of £24. The committee recommended discontinuance of running the temporary installation after September 30 until such time as the permanent plant should be ready. Messrs. Laurence, Scott, and Co., of Norwich, have taken new premises at 28, Regent-street, Yarmouth. The shop taken by this well-known firm for business purposes has been fitted up with a dynamo of their own make (I.X.L.), and a gas-engine supplies the motive power. Various forms of electroliers are shown, beside all the necessary fittings for private houses and business firms.

Felixstowe.—Resolutions have been proposed at a meeting of the Felixstowe Local Board, the first offering the principle that the water and gas should be brought into the hands of the Local Authority, and the second referring to the whole Board in committee to interview the directors of the companies concerned with a view to purchase. These resolutions were carried unanimously, the only alteration in the wording of the resolutions as submitted being the addition of the words "if reasonably practicable," on the suggestion of Mr. Downing, who also explained that in framing the resolution as to the Authority having control of the lighting, the words "gas, electricity, or other light" were embodied, because if the negotiations with the gas company did not prove satisfactory, the surplus power of the two engines to be used in the sewage works could be utilised in the lighting of the town with electricity.

Eveley. — Messrs. Drake and Gorham are putting up an installation for Mr. J. T. Smithies, of Eveley, Hampshire, where the power will be supplied by a turbine, the number of lights being about 100. The D.P. accumulators will be capable of supplying 91 16-c.p. 60-watt lamps for four hours, or 58 for nine hours. The dynamo will be a five-unit machine of the Electric Construction Company's make. The mains between engine-room and house will consist of hard-drawn copper wire fitted on porcelain insulators, and the installation will contain a patent Nevile accumulator switch to prevent the dynamo from discharging itself through the battery should the power fail from any cause. A telephone line will be fixed between the engine-room and house to avoid the necessity of a messenger being sent with instructions to the attendant. The firm have also just completed an installation at Mr. Heath Harrison's house, Lecourt, in the same county.

Direct Spanish Telegraph Company.—The report for the half-year ended June 30 states that the accounts for the half-year show, after providing for debenture interest, a balance to the credit of profit and loss of £4,075. The traffic receipts show a decrease of £868 as compared with the corresponding period of 1893, this decrease being due to the continued stagnation of business in England, Spain, and France. The working expenses are £43 less than those for the corresponding period of last year. After adding the usual sum of £2,500 to the reserve fund, the balance of profit and loss amounts to £1,575. To this the directors propose to add £951 from interest and profit on investments, and recommend the payment of the dividend at the rate of 10 per cent. per annum on the preference shares, and a dividend, free of income tax, of 1s. 8d. per share, being at the rate of 4 per cent. per annum on the capital paid up from the due date of payment on the ordinary shares of £5 each. The reserve fund will then amount to £21,270.

Edinburgh. — The sub-committee of the Edinburgh Town Council on electric lighting recommended to the Lord Provost's Committee that a deputation of three members should go to London to select a lamp for public lighting in Edinburgh, several specimens having been fitted up at Westminster by the Corporation's consulting engineer. On Tuesday, at a meeting of the Town Council, the Lord Provost, in connection with the recommendation to appoint a deputation to inspect the specimens of electric lamps for public lighting which the Corporation's consulting engineer had fitted at Westminster, explained that Prof. Kennedy wished to throw the responsibility of the selection on the Corporation. Some demur was made to another deputation, and Mr. Waterston proposed that only one member of Council should go. Finally it was agreed that Bailie Dunlop and Councillor Mackenzie should form the deputation. The Electric Committee earlier in the day accepted an estimate for 175 lamp-posts for electric arc lamps to light the streets sanctioned. The contractors for the posts are Messrs. Mackenzie Bros., iron-founders, Edinburgh.

Ravensthorpe.—The installation of the electric light by the Ravensthorpe Self-Help Co-operative Society has been celebrated by a festival which was promoted in connection with the local society's women's guild. The plant has been put in by Messrs. Ullathorne and Hartley, electrical engineers, of Bradford and Halifax, the fittings and appliances being of the latest and most approved style. There are 11 arc lamps of 2,000 c.p. each, and eight of half that illuminating capacity. In addition to these, 102 incandescent lights are placed about the interior of the premises, their power varying from 8 to 16 candles. The preliminary cost, including new engine-house, engine, and dynamo, has been £747, but it is computed that the saving in depreciation of stock alone will go a long way towards contributing to this outlay. The hall was brilliantly lighted on Saturday by four of the large lamps, and the effect was very pretty. Mr. Eli G. Rothwell, president of the society, occupied the chair at the evening meeting. Mr. Ullathorne, in the course of a few remarks, spoke of the superiority of electricity over gas for illuminating purposes, and claimed that in actual cost—apart from its advantages in the shape of saving in depreciation of stock and property, as well as the physical

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comforts derived from its being a non-heat-producing light—it was incomparably cheaper than gas.

Wakefield.—The City Council have held a meeting at which it was stated that the town clerk had reported to the committee that the Corporation's electric lighting order had been confirmed by Parliament; and he was instructed to arrange for a further meeting of the committee, and the attendance of Mr. Hammond, as soon as the site for the proposed new sewage works had been finally decided upon. As he was about to put these minutes to the meeting the Mayor remarked: I should like to see the light, gentlemen. Councillor Reynolds rose to ask what was being done in the matter of electric lighting. Councillor Nicholson (chairman of the committee) was understood to say, in reply, that his committee were waiting for the Sewage Committee to know whether they could have a certain site for their electric works. Councillor Reynolds wanted to know if it were an understood thing that the electric lighting was going to be a part of or connected in any way with the sewage department. If so, it seemed a very comical mixture. Councillor Nicholson rejoined that the committee were simply waiting for the land required. The minutes were then confirmed.

Fermoy.—On Friday evening an intimation was sent to the Fermoy Town Commissioners that Mr. C. J. Furlong would meet them at the Court House *re* the project of introducing the electric light as an illuminant into Fermoy. At the meeting Mr. Wm. Eager, C.T.C., presided. Mr. Furlong, in the course of his remarks, expressed the hope that the Commissioners would be successful in their project. As to the use of his mill wheel as motive power, the only difficulty to contend with would be that at times the river would be in flood, when the back water would prevent the wheel from working. At all other times the wheel would be sufficient to generate any amount of electricity required. As to cost he had not gone fully into that, but he thought that a charge of £2 per year per horse-power would be reasonable and equitable. For the public lighting of the streets he considered 32 h.p. would be sufficient, which would be equivalent to an annual rental for the wheel and water supply of £64. If a private supply were needed for houses and shops, he thought that 80 h.p. would be the maximum required, that was in the event of the supply being taken in generally by private consumers. If the project were successful, he would be the first to take a private supply. After some further discussion, the town clerk (Mr. P. J. Lane) was directed to make enquiries as to the cost, working, etc., in towns such as Carlow, Killarney, Kingstown, etc., where the electric light has been adopted.

Winchester.—A few weeks ago the Corporation, by a majority of two, decided to apply to the Board of Trade for a provisional order to enable them to borrow a large sum to light the city with electricity, and thus secure themselves against the possibility of a private company getting an order. There has since been held a special Council meeting to confirm the resolution to apply for the order and empower the town clerk to spend £250 in obtaining it. There had already been spent in preliminaries the sum of £100. A memorial from over 600 ratepayers, protesting against the scheme and the obtainment of the order, was presented and read. Mr. Shenton moved, and Mr. Gibb seconded, that the resolution should be confirmed, and they repeated the arguments used a few weeks ago. A discussion followed that lasted nearly two hours. In the course of it the local gas company was stigmatised as a monopoly, and the recent reduction of its prices was asserted to be due to fear of the electric lighting scheme. Several speakers said that they only supported the proposal to obtain the provisional order as a protection for the ratepayers and to secure to them any profit there might be in electric lighting. Others contended that if any expense would fall on the rates they would not go beyond the provisional order. There was a large muster of ratepayers in the Council-chamber, who applauded the opposition once or twice; and the Mayor (Alderman Stopher) threatened to have them turned out. On a division being taken, 11 voted for the confirmation of the provisional order and 10 against. It is understood that every step in the scheme will be opposed, and that the elections in November are likely to be largely influenced by the question.

Middlesbrough.—A committee of the Middlesbrough Town Council, consisting of Alderman J. A. Jones, chairman, the Mayor (Councillor Baker), Alderman A. Hinton, together with Mr. D. Terrace, gas manager, and Mr. Alf. Sockett, deputy town clerk, having visited the electric lighting works at Newcastle, Leeds, Bradford, Halifax, Huddersfield, and Blackpool, have furnished the following report to the Corporation: "(1) That the electric light is a paying business, and a profit is to be made by its adoption. (2) That the consumers in all places testified to the fact of its being superior to gas, and would on no account return to the latter. (3) That its sanitary effects are in the right direction and admitted by all consumers. (4) That the consumers' goods are not injured as in the use of gas. (5) That the several systems acted well, though the committee were exceptionally pleased with the installations at Blackpool, Huddersfield, and Leeds; and (6) that having regard to the fact that a large sum of money will be immediately spent in the extension of our gas plant, and, in the event of the electric light not being adopted, that an additional sum will ere long be required for the purchase of further premises in Durham, East, and Bath streets, and probably elsewhere, and having further regard to the fact that the electric light is rapidly extending over the land, and that our neighbours are moving forward on these lines, and that it is not desirable that a private company should obtain powers for Middlesbrough to be approached hereafter for purchase (as in the case of Newcastle), the sub-committee are of opinion that it would be in the true interests of the borough to proceed forthwith with the laying down of an electric installation at a cost not exceeding £25,000."

Ayr.—A minute of the Lighting Committee of the Town Council bore that the clerk read the following letter received from Mr. Hammond: "Great Trinity-lane, E.C., London, August 31, 1894. The time has arrived when the Board of Trade should be asked to approve the system that has been fixed upon at Ayr, and I shall be happy to take up the matter with the Department immediately. In order to enable me to do this, will you kindly write a letter to the assistant secretary, Board of Trade, advising them that I hold the position of consulting engineer to the Corporation, and have received your instructions to apply for approval of system." The meeting instructed the clerk to write to the Board of Trade in the terms suggested. The clerk also read the following letter from the Under Secretary for Scotland—namely: "Whitehall, September 1, 1894. Electric Lighting. Sir,—With reference to previous correspondence I am now directed by Sir George Trevelyan to intimate to you that he approves, in accordance with the Electric Lighting Acts, of the raising of a loan of £15,000 by the Provost, Magistrates, and Council of the burgh of Ayr, as Police Commissioners of the burgh, for the execution of works under the Ayr Burgh Electric Lighting Order, 1890. I am to add that provision for the liquidation of the loan within a period not exceeding 30 years will require to be made in accordance with Section 86 of the Public Health (Scotland) Act, 1867, which regulates the repayment in the present case, and for the information of the burgh authorities, in the event of the method of repayment by means of a sinking fund being adopted, I am to enclose a copy of sinking fund regulations framed by the Secretary for Scotland under Section 67 (3) of the Local Government (Scotland) Act for the guidance of the county councils constituted by that Act.—I am, etc., WM. C. DUNBAR."

Mansion-Lighting.—The installation of the electric light at Clewer Park, the residence of Sir Henry D. Gooch, has just been completed, and adds another to the list of electric-lit residences within the neighbourhood of Windsor. A direct vertical steam-driven dynamo is used, capable of developing 65 volts and 60 amperes. In the house next to the boiler and pumping room are the cells, 27 in number, which, when fully charged, will supply a 100 8-c.p. lights for 10 hours. The mains for conveying the current are carried underground by pipes from the battery-room to the house to a distributing board in the main corridor, the distribution being divided into 12 circuits, and from which all the rooms are lit. The outdoor offices, stables, coach-houses, and yard are all fitted with electric lamps. The dining-room is lit with a centre lamp, with rich crimson shade, which is fitted with a double switch for lowering or raising the light at pleasure, while on the side-table are two movable lamps which were formerly used as oil lamps, and have now been converted to their new use, the lamp screws having been utilised as switches. The conservatory adjoining the dining-room is lit by three lights. The drawing-room is artistically fitted up with electroliers, which are fitted with 24 electric candle lamps of Venetian glass, and movable lamps are on the tables, from which the wires can be detached by removing the plug, and removed to any part of the room. On the ground floor, the servants' rooms, including the butler's pantry, dining-room, etc., and a photographic dark room, are all fitted with electric light. On the upper floors, all the bedrooms have been fitted up on the latest approved methods. The billiard-room has five electric lamps, and also six lights over the table. The electric wires are carried underneath the floors and concealed in the walls, and everything has been carried out on a most complete scale. There is also telephonic communication between the house and the stables. The whole of the work has been carried out by Messrs. Roger Dawson and Co., of Windsor and London.

Radcliffe.—The Local Board have held a meeting at which it was reported that at a meeting of the Electric Lighting Committee, held on September 5, it was resolved that Mr. Bennett's offer to prepare plans and do everything requisite for obtaining the provisional order be accepted; that, if it be decided to proceed with the electric lighting of the district after the provisional order has been obtained, this Board do recommend that Mr. Bennett be appointed to carry out the works at the terms stated by him in his letter of July 13 1894; and that Mr. Bennett do prepare the plans for an installation in the first instance of not more than 6,000 8-c.p. lamps, and that the works be laid out in such a manner as to enable this Board to make future extensions therein. The Chairman said that the committee had no extravagant notion of going on too large a scale, and, as the Board would see, they had limited the maximum number of lights to 6,000 8 c.p. lamps. They estimated, so far as their information went, that an expenditure of something like £10,000 would put them down a plant, station, and all that was necessary for 5,000 or 6,000 8-c.p. lamps to distribute over, at all events, the most populous part of the district, so that the committee were desirous of keeping this matter within reasonable limits; and so far as he could form an opinion—and he thought the committee could form an opinion from the particulars supplied to them—the expenditure of that £10,000, when it took place, would not only not prove an addition to the rates, but would be a something which would to some extent, especially if it were appreciated by the public of Radcliffe as it was in other districts, do something in relief of the rates of the district. In reply to Mr. Lowe, the Chairman said that an 8-c.p. lamp would give considerably more light than their ordinary street lamps. Mr. Thornley asked whether in expending the £10,000 there would be provision made for extension. The Chairman replied in the affirmative, and said that in their scheme they had given particular instructions that everything should be so arranged that they could

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double the number of lights at much less cost. The minutes were approved.

Cardiff.—A meeting of the Cardiff Lighting Committee was held on Tuesday morning, under the presidency of Councillor Vaughan. It was reported to the committee that a large number of lamps were purposely broken. During the last two months 150 were broken by stone throwing alone. Alderman Carey stated that at the last meeting of the Watch Committee the members congratulated themselves upon the small number of breakages reported by the police. The borough engineer, Mr. Harpur, stated that the police reports on this matter were valueless. Not 5 per cent. of the broken lamps were reported. The committee considered a draft report which had been prepared for allowing the National Telephone Company to place their wires underground. As it was thought that eventually the tramways would be worked by electricity, the committee refused to recommend the adoption of the agreement which had been forwarded to them for their consideration by the Public Works Committee. The question of renting motors was introduced by Alderman P. W. Carey, who said there were many tradesmen, such as hairdressers, sausage-makers, people with lifts, and so on, who would use electricity, when the town's project was ready, if they could rent motors from the Corporation. A 3-h.p. motor would cost over £20, which was a large sum to disburse for some tradespeople. It was to the interest of the Corporation to have as much electricity used during the day as possible, and they could afford to be more generous to day consumers than to night consumers. The Borough Engineer thought the suggestion was practicable, but the subject was deferred for further consideration. The Borough Engineer reported that the Great Western Railway Company had refused to put in a siding at the electric works. Mr. Massey said he thought the site was selected because of its proximity to the railway. The Borough Engineer said that was so, but the company refused to make a siding because they said they would not be able to work their traffic if they did so. There was a siding 200 yards nearer the town, and the coal would have to be carted from there. It was decided to appoint a deputation to wait on the general manager of the company when some of the members next go to London.

Mr. Arthur Shippey.—A receiving order having been made on the 2nd ult. against Arthur Shippey, described as an electrical engineer, of 18, King-street, Cheapside, E.C., accounts have been furnished disclosing liabilities £4,101, of which £1,170 are unsecured, with an estimated surplus in assets of £4,797. From the observations of the official receiver (Mr. A. H. Wildy) and the statements of the debtor, it appears that he was adjudged bankrupt on July 29 1892. He then filed a statement of affairs showing liabilities £1.852, and an estimated surplus in assets of £5.916. No dividend has yet been paid, and the debtor has not yet obtained his discharge under those proceedings. After this adjudication he commenced to carry on business as an electrical engineer with a capital of £50 advanced to him by a relative. In 1886 another firm of electrical engineers commenced an action against him for infringement of patent rights, and he consented to an injunction being granted against him on certain terms In December of the following year he sold his business to a limited company entitled Shippey Bros., Limited, for £8,000, of which £3,000 was to be paid to him in cash by half-yearly instalments of £500, and the balance in shares. He asserts that he received no cash, but accepted further shares in lieu thereof; that £1 500 in cash or shares may be still due to him, and that he now holds no shares whatever, having transferred them all to various creditors as security for their claims. He adds that he expects that Shippey Bros., Limited, will shortly be bought out by a new company, and he anticipates the shares will then be of some value; further, that the company is under agreement to pay him a salary of £120 a year, but that owing to the injunction granted against his patents, business had not recommenced, and the salary has not been paid. The debtor attributes his present position to the injunction referred to, and to a loss upon a contract in 1887 for lighting Herne Bay with electric light, which was stopped by the injunction. The official receiver remarks that nearly the whole of the debtor's liabilities appear to have been contracted over three years ago. The valuation of the securities held by the creditors fully and partly secured (£8,099) is that of the debtor, who admits that their realisation is subject to contingencies, and to the obtaining of a market for them. The official receiver states that the debtor has been required to file a statement of his reasons for anticipating a surplus on realisation of his assets.

Barnet.—Mr. Robert Smith, of Barnet, writes to a local paper as follows: "A proposal to undertake the electric lighting of Barnet is now before the Barnet Local Board. An offer is made by Crompton and Co., Limited, in the following terms: (*a*) that the company puts down plant for the supply of public and private lighting for £10 000, this sum to be found by the Board; (*b*) that the Board pays the company £500 a year for the public lighting; (*c*) that the company uses the plant for the supply of private lighting on paying the Board £350 a year for five years, and £500 for two years; (*d*) that the agreement be for seven years, renewable on arbitration terms. I beg to submit the following reasons against this proposal being accepted by the Board: (1) That £10,000 is far too large a sum for Barnet to provide for a speculation, seeing that the whole ratable value of Barnet is only about £20,000; (2) that the electric lighting of the streets would be on a seven years' contract, and would cost about £50 yearly more than the present gas lighting, which is on a yearly contract; (3) the interest and sinking fund on the sum of £10,000 would be about £500 a year, which, with £500 for street-lighting, would involve an annual charge for the scheme of £1,000. *Per contra* the Board would receive £350, rising to £500 per annum, for the private lighting. On balance, the expenditure of the Board would be increased by £200 per annum, which would have to be met by an increase of 2d. in the Local Board rate. I gather from the proceedings of the Board, reported in the *Barnet Press*, August 25, that Mr. Morse, the chairman of the Electric Lighting Committee of the Board, would be in favour of the agreement if its terms were improved and its duration extended to 21 years. This suggests the question what would happen if Crompton and Co., Limited, were unable, through trade depression or financial crisis, to carry out its part of the contract. It is possible that the Board might have to work the concern at great loss. Crompton and Co., Limited, was formed in 1888 to take over an existing business. For the first four years the dividend on the ordinary capital ranged from 5 to 8 per cent. per annum, and then fell to 2½, and for the year ending March 31 last no dividend was paid on the ordinary capital, and the preference dividend was only half paid. In the report the directors propose to write off £20,000, a sum nearly equal to half the ordinary capital of the company. The £5 preference shares are quoted about £2 in the London Stock Exchange official list. In the balance-sheet attached to the report, among the assets appears the item 'Goodwill, £30,000.' The electric lighting of Barnet should be left over for the new Council which will shortly replace the present Board. It is certain that the Local Government Board will approve of no scheme without reference to that Council."

Kingston.—Councillor Collings moved, and Councillor Walker seconded, at a meeting of the Town Council, the confirmation of the Lighting and Market Committee's minutes. Councillor Baker moved, as an amendment, that the paragraph, "That all disused gas lamps be removed, and that the town clerk communicate with the gasworks manager on the subject, and request that the columns be placed in the Corporation yard at Ham-road," be expunged. He said it was unwise at the present moment to take away the gas lamps, because the previous night all the electric arc lamps in the town went out. The town was in darkness. The lamps had not been satisfactory since they were erected, and it would be as well to allow the gas standards to remain where they were until the light was perfect. They would not get damaged in the present position, but if they were taken down to Ham-road they probably would. He also remarked that he thought the arc lamps went out on the Sunday evening. Alderman J. Marsh asked if the chairman could give any reason for the removal of the gas columns. Councillor Moatt supported the action of the committee. Councillor Davison pointed out that they were about to lay down paving in London-street, which would necessitate the extension of the kerb into the roadway, and it was desirable that the paving should not be disturbed after it was laid down. Councillor Nuthall asked if it was true the lights went out on Monday night? He was in town, and he did not notice it. Councillor Carn stated that the approach to the bridge was as dark as pitch Councillor Collings, replying upon the discussion, said the fact was that the lights were put out purposely. The committee knew, and perhaps some members of the Council were aware, that at the present moment the works were not complete. They had never had them completed as yet, and they were still in the hands of the contractors. On Saturday some portion of the piping that connected the condensing apparatus with the well was sent back to Birmingham, and the result was that the condensing apparatus had not worked, and does not work. Consequently more work was thrown on the boilers. The boilers themselves had been a source of trouble to them, and they had been obliged to turn from one boiler to another in order to keep the light going. On Monday No. 2 boiler developed signs of weakness, and they considered it necessary to maintain the efficiency—and they must admit it had been efficient from the start—of the house and shop lighting and discontinue for a short time the lighting of the streets. It was better to do that than to impair the house and shop lighting, which had been perfect from the commencement. Councillor Baker: That being so, I will withdraw my amendment. The Council consented, and the motion was then carried.

Worcester.—At a meeting of the Watch Committee a letter was read from Mr. C. W. Dyson Perrins, asking the committee whether they could entertain the idea of supplying his house at the top of Malvern Link with electric light. Mr. Perrins explained that he should want sufficient current for from 200 to 300 lamps, as well as for one or two motors. He added his belief that the Malvern Local Board had allowed the provisional order which they obtained some years back to lapse, so that he presumed there would be no difficulty on that score. The matter was referred to the sub-committee. A letter was read from the sheriff—who had anticipated inability to attend the meeting—stating that, as requested by the Mayor, he had had an interview with the gas company with reference to the difficulty that the electric lamp-posts were erected exactly on a line with the gas-main in High street Mr. Millington reported that he had arranged the following terms: (1) that the gas company should at once proceed to alter the mains so as to allow of the erection of the standards; (2) that the Corporation should pay all expenses connected therewith, and that the Corporation should also pay reasonable charges by Messrs. Stallard and Son in connection with the matter. The Sheriff explained that unless they had arranged matters, a delay of six weeks would have been caused. Alderman Caldicott: I don't see why there should be any legal expenses for stopping a hole up and laying a pipe. The action of the Sheriff was confirmed. A letter was read from Alderman Ernest Day, apologising for absence, and calling attention to the "enormous obstruction"

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of electric light standards being fixed in the city. He suggested that the Watch Sub-Committee should go carefully through the plan, and where necessary arrange for hanging lamps or lights from brackets He was satisfied that the former in the main streets and narrow thoroughfares would be infinitely superior to the obstructive posts. The posts ordered could no doubt be utilised in other positions. Unless the matter was seen to, he was satisfied that serious complaints would be made against the Corporation, and might in a way cause a prejudice against electric light. He added that the positions for transformers appeared to be fixed in the pavement in the most objectionable places, and unless very great care was exercised in protecting openings, when the covers were off accidents would occur. The matter was referred to the sub-committee. Mr. G. E. Abell, assistant general manager of Lloyd's Bank, wrote stating the lamp being erected in front of the bank door could not fail to be a great nuisance to people driving up to the bank, and as it was a semi-public institution, he thought its convenience should be specially studied in a matter of kind. He therefore asked the committee to call the attention of the Streets Committee to the subject, with the view to the lamp being placed a few yards distant, and at a more convenient spot. Alderman Holland urged that the committee should have had a plan before them in order to decide where the standards should be placed. The Mayor, however, pointed out that they were not experts in the matter. The reference of the letter to the sub-committee ended the meeting.

Hertford.—In our last week's issue we referred to the public meeting which was held at Hertford on the subject of the electric lighting scheme. The resolution then passed has been considered by a special meeting of the Town Council. Considerable interest was taken in the meeting, a good number of ratepayers being present. The Mayor read some correspondence he had had with the Board of Trade with reference to the provisional order, the effect of which was that he had that morning received a letter from the Board of Trade stating that they would refrain from revoking the order on receiving an assurance from the Corporation that they intended to exercise their powers within a reasonable time. But if the Corporation refused to give effect to the order, and an application was received from a company, it would be for the Board of Trade to consider whether they should not revoke the existing order. Alderman Shelley proposed that the electric lighting scheme proposed by the engineer—extended so as to supply the Hertford General Infirmary—be carried out as speedily as possible. He strongly urged the Council to adopt the motion, and said that additional applications for the light had been received since the last Council meeting, bringing up the total applications to 1,400 lights. Councillor Ginn seconded the motion, and hoped the Corporation would give a substantial vote in its favour, as he firmly believed the light would be a success. Councillor Garratt moved an amendment, "That the report of the Lighting Committee as presented to the Town Council be referred back for further consideration, as it is considered that the details as to the profit and loss are incomplete in several important items." The Mayor: I am sorry to do it, but we have had an amendment before in almost the same words, and I rule it out of order. Councillor Garratt warmly protested against the ruling, and remarked that the Mayor was always trying to stop him. The Mayor said Mr. Garratt was at liberty to move that the report be referred back to committee, but he would not allow an amendment to be put in exactly the same terms as before. Councillor Garratt: I can move it again. Councillor Willshaw asked under what standing order the Mayor based his ruling; and this not being given, Mr. Wilshaw remarked: Then we had better throw it up. Councillor Garratt: I move the amendment. The Mayor: You can move an amendment that it be referred back to the committee. Councillor Robinson said he could not conceive any reason why the amendment should not be moved and the reasons given for it. He considered the Mayor was entirely out of order in his ruling. Councillor Garratt: I move the amendment. The Mayor: You can move that it be referred back to committee, and state your reasons for it, but I rule that you cannot move it on grounds that have been moved before. Councillor Garratt then stated his reasons for moving the amendment, pointing out several instances where, in his opinion, the estimates were inadequate. He believed it would result in a positive loss, and until it could be shown that the light could be produced without loss he should oppose it. No doubt the time would come when the light could be produced at a profit, but that time had not yet arrived. Councillor Robinson seconded the motion, contending that the estimates were very inadequate, both in regard to the capital required and the annual cost. The details were also imperfect, and until they could look forward to a scheme that would not burden the town he should oppose it. Alderman Dr. Shelley: As the amendment has been ruled out of order in this form, it is open to any other member to move as an amendment that the matter be referred back to the committee. The Mayor: Oh, yes. Addressing Councillor Garratt, he said: It is purely a matter of principle. Councillor Garratt: So it is with me After a pause, Councillor Garratt, again rising, said: If you intend to persist in this course, it is my intention to withdraw. Soon afterwards, Councillor Garratt got up and left the room, followed by Councillors Robinson, Brickwell, Pollard, and Wilshaw, the spectators applauding as they left the room. The Mayor: Does any other gentleman wish to speak on the proposition or move an amendment? Councillor J. R. Cocks said since the last meeting of the Council he had gone carefully into the estimates, and he could not agree with them, because he considered they were too rosy. The Mayor said he intended to have made a few remarks, but as there were no arguments to reply to he should not say anything. Alderman Dr. Shelley, after regretting that the gentlemen who had retired had not consented to alter the amendment in deference to the ruling of the Mayor, proposed that the Council adjourn for 10 minutes This was seconded by Alderman McMullen, and carried. All the members then left the court, and after an absence of nearly half an hour the whole of them (including Councillor Garratt and the others) returned. The Mayor then said that in consideration of the importance of the subject to the town, he would waive his objection, and allow Councillor Garratt to move his amendment in any form he liked. Councillor Garratt adhered to the form of his amendment as already given, and Alderman Dr. Shelley replied. The amendment was then put and lost by eleven votes against seven. The original resolution was then put, and the numbers were equal—viz., nine each The Mayor: The numbers being equal, I unhesitatingly give my casting vote in favour of the resolution. The resolution for adopting the electric light was accordingly carried, as were also subsequent resolutions giving effect to it.

Taunton—The Electric Light Committee have reported to the Town Council that they considered the subject of the extensions to the electric lighting, as approved by Dr. Fleming, and they recommended that the following be carried out:

No. 2 sub-station at St. James's-street—			
Cables	£827	14	9
Cost of laying cables and making connections	123	7	5
Two 30-kilowatt transformers and switches	261	16	0
Altering building for transformers	58	10	0
Instruments and fittings	68	1	0
Incidentals	90	10	6
	£1,450	0	0
No. 3 sub-station, similar to No. 1, cellar to be constructed under the road at East-gate	1,500	0	0
Coal-shed, weighing machinery, and other works at generating station	300	0	0
New boiler, large engine, dynamo, and other works	1,750	0	0
	£5,000	0	0

The committee recommended that application be made to the Local Government Board for their sanction to the borrowing of £5,000 for the foregoing works, to be repaid within a period of 35 years. Councillor Potter, who moved the adoption of the committee's recommendations, said he wished for many reasons that that task had not devolved upon him, as the Council were very reluctant in sanctioning the application of any committee for additional loans. It was no new experience in electric light undertakings, however, to require additional capital. Bristol, for instance in 1893 secured the loan of £66,000 for the purpose of electric lighting, and within 12 months afterwards they had to apply for another £24,000, which they duly received. At Taunton, however, they did not ask for such a large amount as that; they only asked for the modest sum of £5,000, and the whole of that they did not ask for at the present time. All they wanted was to raise £2,000 as speedily as possible, and with that they proposed to form a second sub-station, besides erecting a coal-shed and providing for other works at the central depôt, the whole of which amounted to £1,750. The balance between that sum and the £2,000 they would put to the £900 they had in hand and devote that money to laying the cables underground in compliance with the regulations of the Board of Trade. The present system of sub-stations had given entire satisfaction so far to the customers, and it had economical advantages which could not be over-estimated. It was very satisfactory to know that the extension of their business necessitated a calling up of more capital to work it. When they took over the light there were 1,000 lamps in use, and now there were 1,800, and he would be very much surprised if that number did not increase in a short time by 200 or 300. At present there was a large number of people asking for the light and waiting for it, and they had not a single transformer in stock for the purpose. When the first sub-station was formed it put 17 transformers out of use, all of which had since been taken up. It was proposed that the second sub-station should be formed in a cottage at the end of St James's-street. They could rent the cottage for 21 years at £10 per annum, and sublet it to one of their employés at £7 a year, and in it they could place two large transformers, which Messrs. Newton were to supply, and from it certain underground mains would be laid. They would clear away the overhead wires from the station, along Station-road, Bridge-street, North-street, around the Parade, and part of Cheapside, and replace them with the underground cables. No. 3 sub-station would be deferred until a time when the increased custom would testify the expenditure. In conclusion, Councillor Potter hoped the Council would do nothing to retard the progress of the work. Councillor Perkins failed to understand why the committee asked for £5,000 if, as Mr. Potter said, they only wanted £2,000 at once, but on being told it was to obviate the necessity of a second application and also that the money would only be raised as occasion required, he accepted the explanation. Alderman Standfast opposed the motion, and asserted that the Council were being misled. He said that if the whole of the extra 300 lights were really taken it would not justify them in spending another £5,000. The deficit on the working of the light was a large sum up to the present. They had already taken £660 out of the rates for that purpose, and they were asking for another £440, whilst not a penny was put down for depreciation, which would be about a thousand pounds a year. He

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sincerely hoped that the Local Government Board would not sanction the loan. The Mayor pointed out that Mr. Norris, the borough accountant, had estimated the loss on the electric light for the first year at £300, the rest being caused by paying off capital and interest. Alderman Chapman said the loss was certainly not so great as some seemed to think, especially as they had another quarter's income due to them. Councillor Lock said it was no new experience on the part of the Council to find they had to pay pretty dearly for their experiments, and he predicted that this £5,000 would not be the last loan that would be asked for. However, the money had to be obtained somehow, and he would accordingly vote for the motion. The ratepayers had not pluck enough to put forward anyone to oppose the purchase of the works at the last election, and therefore they should be prepared to pay the expense. Councillor Steevens expressed his belief that ere long the electric light business would more than pay its way. Alderman Standfast: Not in your time. Councillor Potter said few sane people supposed that the undertaking would pay the first year. There was only one way to make it pay in subsequent years, and that was by having adequate machinery and by an increase of trade. The more current they produced the cheaper they could produce it, as the cost of management, etc., would remain the same. The motion proposed by Mr. Potter was then put, and carried by 17 to 1.

PROVISIONAL PATENTS, 1894.

SEPTEMBER 10.

17180. **Improvements in electric arc lamps.** Rudolf Hermann Jahr, 47, Lincoln's-inn-fields, London.

SEPTEMBER 11.

17235. **Improvements in electrical incandescent lamps.** Gerard Leonard Frederik Philips, Eindhoven, Holland.

17281. **An improved transmitter or transformer for electric currents.** William Joseph Still, 4, South-street, Finsbury, London. (Complete specification.)

17284. **Improvements relating to the transformation and distribution of electric currents.** James Finney McElroy, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

17296. **Improvements in armatures for dynamo-electric machines.** William Robert Lake, 45, Southampton-buildings, Chancery-lane, London. (Rudolf Eickemeyer, United States.) (Complete specification.)

17297. **Improvements in armatures for dynamo-electric machines.** William Robert Lake, 45, Southampton-buildings, Chancery-lane, London. (Rudolf Eickemeyer, United States.) (Complete specification.)

17313. **Improvements in and relating to electric motors.** John Samuel Losch, John Huy Phillips, Joseph Winfield Moyer, and John Harrison Williams, 77, Chancery-lane, London. (Complete specification.)

SEPTEMBER 12.

17335. **Improvements in the methods of electrically governing the voltage of dynamos and speed of engines.** Jesse Graham and Harry Chapman, Sunbridge-chambers, Bradford.

17353. **Improvements in charging primary batteries.** Samue Miller and Charles James Grist, 20, Gracechurch-street, London.

17357. **Improvements in arc electric lamps.** Samuel Sealy Allin and William Henry Wood, 25, Garlick-hill, London.

17365. **Improvements in clamps for raising and lowering electric or oil floor standards, also applicable for table lamps, music stands, and the like.** Robert Walter Braham, 60, Red Lion-street, Clerkenwell, London. (Complete specification.)

17369. **An improvement in secondary voltaic batteries.** Ludwig Epstein, 28, Southampton-buildings, Chancery-lane, London.

17378. **Improvements in direct-current transformers.** Alexander Bewicke Blackburn and Thomas Large Boyden, 47, Lincoln's-inn-fields, London.

17379. **A safety device for electrical elevators or cranes.** Benjamin Willcox, 47, Lincoln's-inn-fields, London. (The Eisenwerk vormals Nagel and Kaemp Actien Gesellschaft, Germany.)

SEPTEMBER 13.

17445. **An improved electromagnetic friction clutch.** Walter Charles Bersey, 53, Chancery-lane, London.

17447. **Improvements in electrically-propelled vehicles.** Walter Charles Bersey, 53, Chancery-lane, London.

SEPTEMBER 14.

17498. **Improvements in or relating to electric alarm clocks.** Ernest Benest, 19, Southampton-buildings, Chancery-lane, London.

17502. **An improved electric time-signalling system and apparatus.** Percy Richard Julius Willis, 55, Chancery-lane, London. (Walter Aloysius Purcell, United States.)

17510. **Improvements in or relating to electro-depositing apparatus.** Henry Le Roy Bridgman, 323, High Holborn, London.

17525. **Improvement in laying electric conductors and in forming branch connections therefrom.** Joseph Alexander Jeckell, 46, Lincoln's-inn-fields, London.

17529. **Improvements in telephone receivers, transmitters, and silent closets.** Frederick Herbert William Higgins, 24, Southampton-buildings, Chancery-lane, London.

17542. **Improvements in the construction of the lead lining or casing of cells or boxes of electric storage batteries.** John Evelyn Liardet, 9, Warwick-court, Gray's-inn, London.

SEPTEMBER 15.

17566. **Improvements in electrodes chiefly designed for use in electric accumulators and other electric apparatus.** Wilhelm Schäfer and Arthur Heinemann, 11, Southampton-buildings, Chancery-lane, London.

17572. **Improvements in electrical switches.** Herbert George Keeble, 10, Coleman-street, London.

17588. **Improvements in cables or conductors for electrolytic and other purposes.** John Leith, 6, Lord-street, Liverpool.

SPECIFICATIONS PUBLISHED.

1893.

17189. **Electric switches.** Munro and McFarlane.

19688. **Electrical decomposing apparatus.** Richardson.

19765. **Electric switches.** Durward.

19791. **Electrolytic cells.** Hurter and others.

19934. **Electricity meter.** Abel. (Compagnie Anonyme Continentale pour la Fabrication des Compteurs à gaz et autres Appareils)

1894.

1164. **Armatures of dynamos and electric motors.** Pean and Lowndes.

12345. **Electrical transformers.** Wright.

13405. **Induction coils.** Cheetham and Brown.

13995. **Electric railways.** Thompson. (McLaughlin.)

14240. **Electrical call apparatus.** Wilke.

14290. **Electrical lampholders, etc.** Binswanger.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	5	5½-5¾
Bournemouth Electric Company	—	—
Brighton and Hove Company Original	100	210-215
—— "A" Ordinary	—	162-166
Brush Company, Ordinary	3	2⅝-2⅞
—— Nom. Cum., 6 per cent. Pref.	2	2⅝-2⅞
—— 4½ Debenture Stock	100	109-112
Charing Cross and Strand	5	4½-5½
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	12½-13½
—— 6 per cent. Cumulative Pref.	10	14½-14¾
—— 5 per cent. Debenture Stock	115	130-132
City and South London Railway, Consolidated Ordinary	100	36-38
—— Debenture Stock	100	121-123
—— 5 per cent. Pref. Shares	10	12½-13½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¾-2¼
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	95-100
Electric Construction, Limited	2	½-¾
—— 6 per cent. Debentures	—	87-92
—— 7 per cent. Cumulative Pref.	2	2-2½
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1⅜-1½
Elmore's French Company	2	⅞-1
Elmore's Wire Company	2	1⅜-1⅝
Fowler-Waring Cables	5	½-1½
W. T. Henley's Telegraph Works, Ordinary	10	7½-8¼
House-to-House Company, Ordinary	5	1-1½
—— 7 per cent. Preference	5	5½-5¾
India Rubber and Gutta Percha Works	10	23½-24½
—— 4½ per cent. Debentures	100	104-106
International Okonite, Ordinary	—	—
Kensington and Knightsbridge	5	4½-5½
—— 6 per cent. Pref.	—	6½-6¾
Liverpool Electric Supply, Ordinary	5	6¾-7
—— Pref.	—	—
Liverpool Overhead Railway	10	7⅞-8
—— Pref.	10	12¾-13
—— 4 per cent. Mortgage Debentures of £100	100	111-113
London Electric	5	—
Metropolitan Electric Supply	10	9½-10
—— 5 per cent. Reg. Debentures, 1-10,000 in Bonds of £10, £20, and £40	—	—
National Telephone, Ordinary	5	4⅞ 5⅛
—— 6 per cent. Cum. First Pref.	10	14½-15½
—— 6 per cent. Cum. Second Pref.	10	14-15
—— 5 per cent. Nom. Cum. Third Pref.	5	5½ 5⅝
—— 4½ per cent. Deb. Stock	—	109-112
Notting Hill Company	10	4½-5½
Oriental and Electric Company, £1 shares	1	1-1½
—— £5 Shares	—	7-7½
—— £4½ shares	—	5¾-6½
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	6¾-7½
—— 7 per cent. Pref.	5	8½-9
Swan United	—	—
Telegraph Construction and Maintenance	12	41-43
—— 5 per cent. Bonds	100	102-105
Westminster Electric Supply, Ordinary	5	6¼-6¾
Yorkshire House-to-House	4½	4¼-4¾

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NOTES.

Telephony in Russia.—A long-distance telephone has been established between Odessa and Nicholajew.

Madras.—The Madras Government has sanctioned a revised estimate for lighting the Arkonam Station by electricity.

Telephony in Austria.—A telephone line has been established between Brünn, the capital of Moravia, and the fortified town Olmütz.

Exhibition Lighting.—The exhibition of colonial products and manufactures now being held in Manchester is lighted by electricity.

Telephony in Hungary.—The Arad-Csanáder Railway Company have established telephonic communication between all their stations.

Electric Lighting in Holland.—The new station at Flushing adjoining the landing-stage has now been opened. It is lighted throughout by electricity.

Electric Light in Downing-street.—During the recess the electric light is being introduced into the Government offices in Downing-street.

Electric Traction in France.—Mr. E. Faye, who is connected with the Dijon tramways, has obtained a concession for electric tramways at Besançon.

The Berlin Exhibition of 1896.—The electric lighting of the Treptow Park will be carried out by the Elektricitäts-Gesellschaft Nieder-Schönweid.

Electric Lighting in Spain.—Schemes are being projected for the electric lighting of Orense, Allariz, Ginzo de Limia, Villafranca del Vierzo, Puenteáreas, and Lago.

Electro-Chemistry in Germany.—Among the applications of electricity to chemistry in Germany is, says the *Chemiker Zeitung*, that of the concentration of sulphuric acid.

Exhibition at Graz.—Under the auspices of the Austrian Minister of Commerce, an exhibition has been opened at Graz to show the advantages of electric motors in small industries.

Electric Traction in Spain.—A concession has been granted to Messrs. José Carbonnel and Busca for a narrow-gauge electric tramway connecting Barcelona with Sarria, Gracia, San Gervasio, San Martino, and San Andrès.

The Pacific Cable.—Mr. Hepworth Mercer, of the Colonial Office, and Mr. Sandford Fleming engineer of the Canadian Pacific Railway, have left London together on business connected with the projected Canadian-Australian submarine cable.

Electro-Harmonic Society.—It may be as well to remind our readers that the first smoking concert of the season will take place this (Friday) evening at St. James's Hall Restaurant, Regent-street, W. The concert commences at 8 p.m.

The Hampstead Central Station.—This central electric light station, belonging to the Hampstead Vestry, and situated in Lithos-road, Finchley-road, is to be opened on Monday evening next. Mr. R. Hackworth will switch on the light at 8. p.m.

Electric Lighthouse.—It is announced that the Yeu Lighthouse, Vendée, is to be lighted electrically. The South Wales engineers have been visiting Cornwall, and among the places inspected was the electric generating station for the light at the Lizard lighthouse.

New Dynamo Brushes.—The firm of Messrs. Schniewindt, of Neuenrade, Westphalia, have brought out a new system of wire dynamo brush, in which the finest wire that can be manufactured is used. There are said to be 13,000 wires to the square centimetre.

Telephony in Italy.—The Ministry have approved of the establishment of telephonic communication between Rome, Genoa, and Turin, Turin and Milan, Milan and Venice, and Rome, Florence, and Venice. Negotiations are also in progress for connection with Switzerland, Germany, and Austria.

Glasgow Technical College.—The Glasgow and West of Scotland Technical College Electrical Engineering Laboratory has just received an addition to its testing apparatus in the shape of a Siemens low-resistance bridge, which is capable of indicating resistances to the one-millionth of an ohm.

Rather Late.—The *Daily Chronicle* on Friday last discovered that Paris and Madrid were to be connected telephonically, and that on the Spanish side the wires have already reached Saragossa, and the line from Paris has gone as far south as Tarbes. We gave all this information in a note as far back as the 7th inst.

French Jocosity.—The following is a sample of French humour:—A gentleman enters a telegraph office: "I beg pardon, but as I was coming along this afternoon I saw myriads of flies settled on your wire. Can you suggest any explanation?" "About what time was it, sir?" "About four o'clock." "Ah, that accounts for it; that is the time I send quotations for sugar and honey."

Electric Lighting in Italy.—The new International Lyric Theatre in Milan is lighted by means of 2,400 incandescent lamps. Engineer De Benedetti, of Milan, has sent in to the syndic of Naples a request for a concession to establish a supply of the electric light, offering a reduction on the charges fixed by the existing gas and electric lighting companies. The subject has been referred to a committee for consideration.

The Antwerp Exhibition.—Correspondents are enquiring about the aerial castle at the Antwerp Exhibition. It is there, but one has to find it; and when discovered, its position is about 3ft. from the ground. The French are rather nasty about it. Some refer to it as *le ballon déchirable* instead of the *ballon dirigeable*. This is almost as bad as calling the proposed Atlantic-Mediterranean canal the *canal des deux mères*.

"Medical Battery" Company.—The Creditors' Committee of the "Medical Battery" Company, Limited, have issued a circular stating that as a difficulty has arisen in carrying out the reconstruction scheme, they are desirous of laying the matter before the creditors. A meeting for this purpose was convened for yesterday. As we stated some time ago, we hope the scheme will fall through if it is intended to conduct the business in the future as in the past.

Gas-Engines for Electric Lighting.—Mr. J. H. Killey, of Hamilton, Ontario, suggests in the *Canadian Engineer* that as in the United States a gas company are using a 300-h.p. gas-engine to run a dynamo, thereby enabling them to supply the electric light (in addition to gas-light) at a net cost far below that of the most economical steam-engines and boilers, it might prove advantageous to employ gas-engines up to 2,000 h.p. or 3,000 h.p., using Dowson gas in connection therewith.

American Institute of Electrical Engineers.—The last number of the *Transactions* of this institute to hand contains a paper on "Alternating Currents and Fuses" by Profs. D. C. Jackson and R. J. Ochsner, read in May last; a paper by Dr. F. Bedell and Mr. Carl Kinsley, entitled "A Study of the Residual Charges of

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Condensers and their Dependence upon Temperature," read on the 19th inst.; and "The Electric Brake in Practice," by Mr. E. A. Sperry, read on the same date.

Telephony in Luxemburg.—In comparison with its population, the Grand Duchy of Luxemburg is very prominent in the utilisation of the telephone. According to the last official report there are 1,313 telephones in the Duchy, of which 680 are in the town of Luxemburg. All the towns, and even villages, are connected with each other telephonically. In the chief town the service is continuous both day and night. The annual subscription is £3. 2s., which entitles the subscribers to connection with any part of the Duchy.

Electric Transmission in Germany.—The Elektricitäts-Gesellschaft of Frankfort-on-the-Maine have acquired a large site near Plettenburg in order to erect a central station for the electric transmission of power to Lüdenscheid, Plettenburg, Werdohl, and Herscheid. It is also intended to light the streets by electricity, and to supply current to an electric tramway. At Metzingen a project has been brought forward for electric transmission of power in connection with the existing central electric lighting station.

Telegraphy to the Cape.—The *Times* of yesterday states that the Government of Cape Colony are moving for cheaper inland telegrams, and negotiating for cheaper cables, and that there was reason to hope that Sir John Pender would meet them in the matter. Mr. French, the Postmaster-General, is coming to England to negotiate with the cable company and her Majesty's Government on these matters, as well as with regard to the entrance of the colony into the postal union, which, he hoped, would be accomplished on January 1.

English Telephone Lines.—A trunk telephone line in connection with the London and South of England Exchange has been opened between Exeter and Exmouth. It is working most successfully, and will be of great convenience to traders. There is now communication between Plymouth, Paignton, Torquay, Dawlish, Exeter, and Exmouth, and other intermediate towns. Telephonic communication has been established between Southwold and Dunwich by means of a coast line erected along the beach between the two places. The line crosses the river at Walberswick Ferry by means of a submarine cable.

Lighting in the Metropolis.—The *Daily News* has just discovered that almost all the London districts have now made or are making arrangements for electric lighting, and that most of them have decided to institute a municipal supply. Battersea is the last parish to consider the question. It has consulted electrical engineers, and received reports from them. It has also received notice from three electric lighting companies of their intention to apply for provisional orders to light Battersea. The Vestry is not prepared to undertake the work itself just yet, but it means to apply for a provisional order to keep companies out.

Overhead Railway for Berlin.—The following lucid paragraph is culled from a daily paper: "A project for a 'hanging' electric railway has been laid before the city authorities in Berlin. The railway consists of a light iron network, with iron rails supported by columns at equal distances. At the top, on the rails, within the network, run small wagons each with two axles. To each couple of these wagons hangs a passenger carriage. The line is to run from the Berlin Zoological Gardens to the Potsdam Platz. The carriages are all of one class, and a train is composed of only three carriages, each holding 40 persons.

Electric Lighting in Austria.—The Josefsstadt Theatre, which was the only one in Vienna lighted by gas, has with the opening of the present theatrical season received an electric light installation. Both auditorium and stage are lighted electrically, and there are about 600 incandescent lamps and a number of arc lamps, the latter being mainly used for stage purposes. The work has been carried out by the Internationale Elektricitäts-Gesellschaft. The Viennese Municipality have decided to extend the electric light installation in the Rathhaus. At Budapest the local authorities will light electrically the Redoubten Halls, a pleasure resort, at a cost of about £4,000.

Canadian Electrical Regulations.—The Canadian Parliament has just passed an Act providing for the inspection of electricity meters. This Act allows consumers, whenever they are dissatisfied with the action or tests of the electric light contractors, to have their wires and fittings tested by an electric light inspector upon application to the Inland Revenue Department, which has charge of the inspection under the Act. The Act also settles a question upon which there was formerly no written law in providing that any person discovered maliciously or fraudulently abstracting, or causing to be wasted or diverted, any electricity, shall be dealt with as guilty of theft, and punished accordingly.

Finsbury Technical College.—The autumn courses of lectures and laboratory work at this technical college begin next week. On Mondays, Prof. Silvanus Thompson will deal with alternate currents through the month of October, and in November will give four lectures specially upon modern alternate-current motors. The Wednesday evening lectures (elementary course), after the introductory discourse on October 3 by Prof. Thompson, will be taken by Mr. Eustace Thomas until November, when Prof. Thompson will take up measuring instruments. The laboratory course remains, as heretofore, under the charge of Mr. E. A. O'Keefe. The electroplating laboratory class under Mr. Rosseau will meet later in the session. Prof. Thompson's special course of lectures on "Central Stations for Electric Lighting" are to be given on Thursdays at 7.30 p.m., commencing October 4. Particulars of all these courses are to be obtained from the college registrar.

Telegraphic Delays.—At a meeting of the council of the Liverpool Chamber of Commerce on Wednesday, Mr. Hemelryk called attention to the delays in telegrams between Liverpool and the Continent, and to the stereotyped explanation of the Post Office that these were due to the "wires working badly." He believed that the postal authorities, in fact, did not take the trouble to enquire into the matter, inasmuch as some years ago, in the late Postmaster-General's time, complaints had been made and the matter had been remedied. Now, however, the delays had recommenced. He therefore moved that a deputation should be appointed to wait on the Postmaster-General. He believed the chief blame to rest on the shoulders of the foreign telegraph offices; at any rate, it was absurd that from a thousand miles away they could get a reply in half an hour, whilst from only a few hundred miles a reply came in five or six hours. A deputation was appointed as proposed.

Electrical Conductivity of Salts.—Mr. B. Völlmer, in *Ann. Physikal. Chem.*, gives the following: The conductivities of the acetates and iodides of sodium and potassium, and of lithium chloride, dissolved in ethylic and methylic alcohols were measured, as also those of the chlorides of sodium and calcium and the nitrates of silver and calcium, dissolved in ethylic alcohol. The molecular conductivities increase with increasing dilution, and approach a limiting value for infinite dilution, except in

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the case of calcium chloride and of calcium nitrate. The limiting values for the molecular conductivities in methylic and ethylic alcohol solution may be obtained from those in aqueous solution by multiplication with a factor, in the first case about 0·73, and in the second about 0·34. It appears, therefore, that the conductivity decreases with the rising molecular weight of the solvent. The temperature coefficients increase with rising dilution, and for very dilute solutions the conductivity coefficients are practically the same as those for the viscosity of methylic and ethylic alcohols. Ostwald's dilution law is not applicable to the solutions examined, and from the conductivities it is not possible to calculate the rise in the boiling point of ethylic alcohol in its solutions, as it is with water.

Electric Traction in Germany.—Official tests have been satisfactorily carried out on the Heckinhauser electric tramway, Barmen, and the line has been opened to the public. The electric cars which are being built for the Grosse Berlin Horse Tramway Company are to be started running by the middle of next month on the line between Leipziger Platz and Moabit. For years a railway on the Wartburg has been spoken of, and now the project has come up again. No decision has been come to as to the method of traction, but electricity will probably be adopted. The agreement with Messrs. Siemens and Halske for an elevated electric railway in Berlin will shortly be concluded. Steps are also being taken in connection with the electric tramway which the same firm propose to construct in Berlin between Gesundbrunnen and Pankow. The Grosse Berliner Horse Tramway Company are experimenting on their lines with accumulator cars. The accumulators have been supplied by the Hagen accumulator works, and their weight per car is 66cwt. In connection with the proposal to construct an electric tramway between Barmen and Schwelm, the principle of the scheme has been approved by the local authorities of the latter place. It is proposed to connect the line with the Heckinghauser tramway.

Electric Lighting in Bombay.—In accordance with a recent resolution of the Bombay Municipal Corporation, the Crawford markets have been fitted throughout with an electric light installation by Messrs. John Fleming and Co. The system, which has been fitted up under the supervision of Mr. Hoar, one of the firm's representatives, consists of some 20 large Brockie-Pell arc lights and about 60 incandescent lights. The former are distributed throughout the markets and the grounds and front of the building, while the smaller lamps are used as a means of illuminating the tower staircase, the superintendent's quarters, and the clock faces. Both circuits are fed by dynamos placed in the municipal workshops at Paltan-road, the current being conveyed to the lamps by means of armoured underground cables. The dynamos, which are of the Silvertown pattern, are capable of being driven respectively at 850 and 1,000 revolutions per minute, each dynamo being controlled by an elaborate switchboard, by which the power passing over the lines can be measured and adjusted. Alongside these instruments is placed another machine used for the lighting of the Municipal Offices, which can be started or stopped by a friction clutch. The motive power for the several dynamos is supplied by a large engine and boiler belonging to the Municipality.

Electric Lighting in Germany.—The Elektricitäts-Gesellschaft vorm. O. L. Kummer and Co., are largely extending their works in Dresden. The Houseowners Association of Wilhelmshaven have been discussing the question of the introduction of the electric light into the town. Messrs. Siemens and Halske have made a proposal, and circulars have been issued to ascertain the probable demand. The Municipality of Haynau have decided not to carry out the extension of the gasworks, estimated at £3,500, but simply to do repairs at a cost of £75. On the other hand, the Municipality is being asked to introduce the electric light, and an offer has been received from the Helios Company. A central electric light station has been built at Rottweil by Messrs. Feil, of Stuttgart. The water power of the Neckar is utilised, and the three-wire system is employed. It has been decided to light electrically the Neuestrasse, Brunswick. The arc lamps are to be suspended from chains fixed across the street. Current will be obtained from the electric station of Messrs. Meves and Co. The Municipality of Wilster have contracted with Messrs. Lahmeyer and Co., of Frankfort, to erect a central station for light and power purposes. The Municipality of Landstuhl have given permission, on the recommendation of Mr. O. von Miller, to Messrs. Bumb and Herrle and the Helios Electricity Company to establish a central station in the town. The proprietor of the Mostrich factory at Leinefeld is going to adopt the electric light, and will also supply some of the hotels with current.

Electrical Method Determining Transition Points.—Mr. E. Cohen, in the *Zeit. Physikal. Chem.*, says that if a voltaic element be formed by the immersion of similar electrodes in saturated solutions of the two forms of a substance capable of undergoing a transition change, then at temperatures above or below that of the transition the current will flow in opposite directions, becoming nil at the transition temperature itself. This forms the basis of the method; such an element being placed in a thermostat, and the current measured at various temperatures, the null point being carefully determined. Details of the method and of the mode of preparing the element and the electrodes are given in the paper. The method is applicable to transition changes due to loss of water of crystallisation, formation of double salts, double decomposition, and polymorphism. The following changes are examined and the temperature determined:

(1) $Na_2SO_4,10H_2O \rightleftarrows Na_2SO_4 + 10H_2O$. t = 32·8deg.
(2) $CdCl_2,2H_2O \rightleftarrows CdCl_2,H_2O + H_2O$. t = 34·1deg.
(3) $ZnSO_4,7H_2O \rightleftarrows ZnSO_4,6H_2O + H_2O$. t = about 42deg.
(4) $Na_2SO_4,10H_2O + MgSO_4,7H_2O \rightleftarrows Na_2MgSO_4,4H_2O + 13H_2O$. t = 20·8deg.
(5) $2MgSO_4,7H_2O + 2NaCl \rightleftarrows MgNa_2(SO_4)_2,4H_2O + MgCl_2,6H_2O + 4H_2O$ (good results were not obtainable).

The author points out that the method has the advantages of accuracy and speed, but is only applicable to conductors, whilst for some of these the preparation of the electrodes is a matter of very great difficulty. The paper concludes with a consideration of the method from the thermodynamical standpoint, the fundamental equation

$$E = W + T\frac{dE}{dt},$$

being applied for this purpose.

Austrian Electrical Trades.—A few weeks ago we referred to the reports issued by a Berlin commercial society regarding the condition of the electrical industry in Germany. Since then a similar report has been prepared by the Vienna Chamber of Commerce, and has been presented to the Ministry of Commerce. This report, which is for the year 1893, states that the central station of the Internationale Elektricitäts-Gesellschaft was favourably developed during that year, that the station was enlarged, and that its capacity had been increased to 4,000 h.p. The number of incandescent lamps connected to the mains had advanced to 70,000 and of arc lamps to 800, whilst a supply of current was furnished for the operation of 31 electric

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motors of powers ranging from 1 h.p. to 10 h.p. These motors are utilised not only for trade purposes, but also specially for the working of lifts. The company had assisted in the formation of a Hungarian electrical company. Extensions were also made by the Allgemeine Oesterreichische Elektricitäts-Gesellschaft, which supply current on a five-wire direct-current system. The total output of the company's station was distributed among 32,718 incandescent lamps, 1,778 arc lamps, and 57 electric motors. The second undertaking in Vienna where the direct-current system is employed is that of the Wiener Elektricitäts Gesellschaft, which at the end of 1893 supplied 21,678 incandescent lamps of 16 c.p., as compared with 13,972 at the close of the previous year. The report points out that the question of utilising electric power on the Vienna tramways had not passed out of the preliminary stage in 1893, and that the only success of the efforts put forth in this direction had been to cause the authorities to take an interest in the subject. Electrical installations had been carried out in other towns, partly by Vienna firms and partly by foreign companies, notably that at Baden, where current is supplied not only for lighting, but also for the operation of the Baden-Vöslau electric tramway.

Instructive.—At the Mansion House on Friday last, Charles S. Huelser, trading as Huelser and Co., Temple-chambers, was summoned before the Lord Mayor, at the instance of the Incorporated Law Society, for unlawfully pretending to be a solicitor. Mr. Humphreys, solicitor, who appeared for the prosecution on behalf of the Incorporated Law Society, said that the summons was taken out under the Solicitors Act, 1874. The matter complained of was a circular issued by the defendant in the form of a pamphlet, in which he described himself as "Huelser and Co., Temple-chambers, London, international patent solicitors and commission merchants." The words complained of were "international patent solicitors," and Mr. Humphreys submitted that no person could so describe himself unless he had a certificate to practise as a solicitor. In reply to the Lord Mayor, the defendant said he never intended to call himself a solicitor. The Lord Mayor asked him whether in the future he was willing to undertake to discontinue the use of the words "patent solicitors." The defendant replied that he should do it again, as he was fully entitled to do so. The Lord Mayor: In my opinion your using the words "patent solicitors" leads anyone to imagine that you were practising as a solicitor. The defendant: "Patent solicitors" is a compound word. I never attempted to practise as a solicitor. The Lord Mayor asked whether it would not be better to adjourn the case for the defendant to take the advice of friends. After some further conversation, in the course of which he repeated that he never called himself a solicitor, the defendant undertook for the future not to have the words "patent solicitors" printed on any circulars or note-paper. The Lord Mayor expressed an opinion that the covers of the circulars and the note-paper bearing the words "patent solicitors" should be destroyed. He adjourned the case. And yet there are patent agents who coolly describe their office as being "The Patent Office" without any action being taken by the government.

Telephones to Lightships.—The Rev. T. Hancocks, of Ramsgate, writes to a daily paper as follows: "My attention has been called to a statement in which Mr. Julius M. Price declares that electrical communication with lightships is a failure. Kindly insert this correction, as one fact is worth many theories. The Goodwin lightship, situated at the north end of the Goodwin Sands, is connected with the shore by telephone. No part of the planet is more perilous than this spot, and the vessel is fully exposed to what sailors call 'a breeze.' Yet for seven months the telephone has worked admirably, as my experience tends to prove. One of her crew, a member of my church, had a son critically ill ashore while his father was doing his two months on board. To relieve his anxiety I obtained permission at the coastguard station to speak the lightship. I told him the home news, had with him a general chat, and bade him good-night. I easily recognised his voice, quite as well as I ever heard one through a land telephone, and the Goodwin is over six miles from shore; also the officials assure me that the telephone is a complete success. There are only two drawbacks: (1) the chafe of cable near the ship necessitates frequent repairs—experience will soon suggest some safeguard; (2) the ship does not ride rough seas so lightly as before owing to her being anchored by four heavy chain cables instead of one. This, while no danger, is less comfortable for the crew, as she ships more seas aboard. It has been suggested that each cable should be supported by a buoy, which would probably remove this defect. But already this telephone has proved its immense value in saving precious life and valuable property. At a wreck, as at a fire, the first five minutes are worth the next five hours, and since the cable news of a ship on the Goodwins has reached land, the lifeboat has been despatched and all hands saved with a speed incredible to former times. The cable is no failure, but a thorough success."

Competition in Atlantic Telegraphy.—The following apparently inspired quotation from the *Railway News* explains itself: "Increasing attention is now directed to the probability of additional competition in Atlantic telegraphy, and, judging from the correspondence to hand, the shareholders are not quite reassured by the statement of the chairman, that the projected German line will be in 'friendly' hands. If, however, the new cable is to be laid by an independent company, the consequence must necessarily be a more or less serious diversion of business from the existing lines. It is reported that the German Government is prepared, or will at least be asked, to guarantee interest on the required capital, though it is difficult to see how German interests could be better served than by existing arrangements. The Anglo-American Company agree to hold a cable for the exclusive use of German business in connection with the Channel service, which thus has four ocean lines available as insurance against the mishaps to which cables are liable. The projected new line, which, it is said, will be laid *vid* the Azores, would not cost much less than a million sterling, and the expected return, say, of 5 per cent., on this capital would mean the abstraction of between £120,000 and £130,000 gross receipts from the existing pooled lines, involving a serious reduction of the present diminished dividends. It should surely be within the power of the supposed 'friends' of the Anglo-American Company to stop such a waste of capital and revenue. The money would doubtless be raised in this country, and the only object to be served, so far as English capital is concerned, would apparently be to develop business over the cable already laid to the Azores at the instance of the Portuguese Government. The present contract with the German Government expires in the year 1900, but it is understood that overtures will be made to terminate the arrangement at an earlier date so as to permit of the launching of the new project. The various companies said to be promoting the scheme being represented by practically identical board of directors, there should be little difficulty in preventing such clashing of interests as would be caused by the construction of the new line.'

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THE ELECTRICITY WORKS AT EALING.

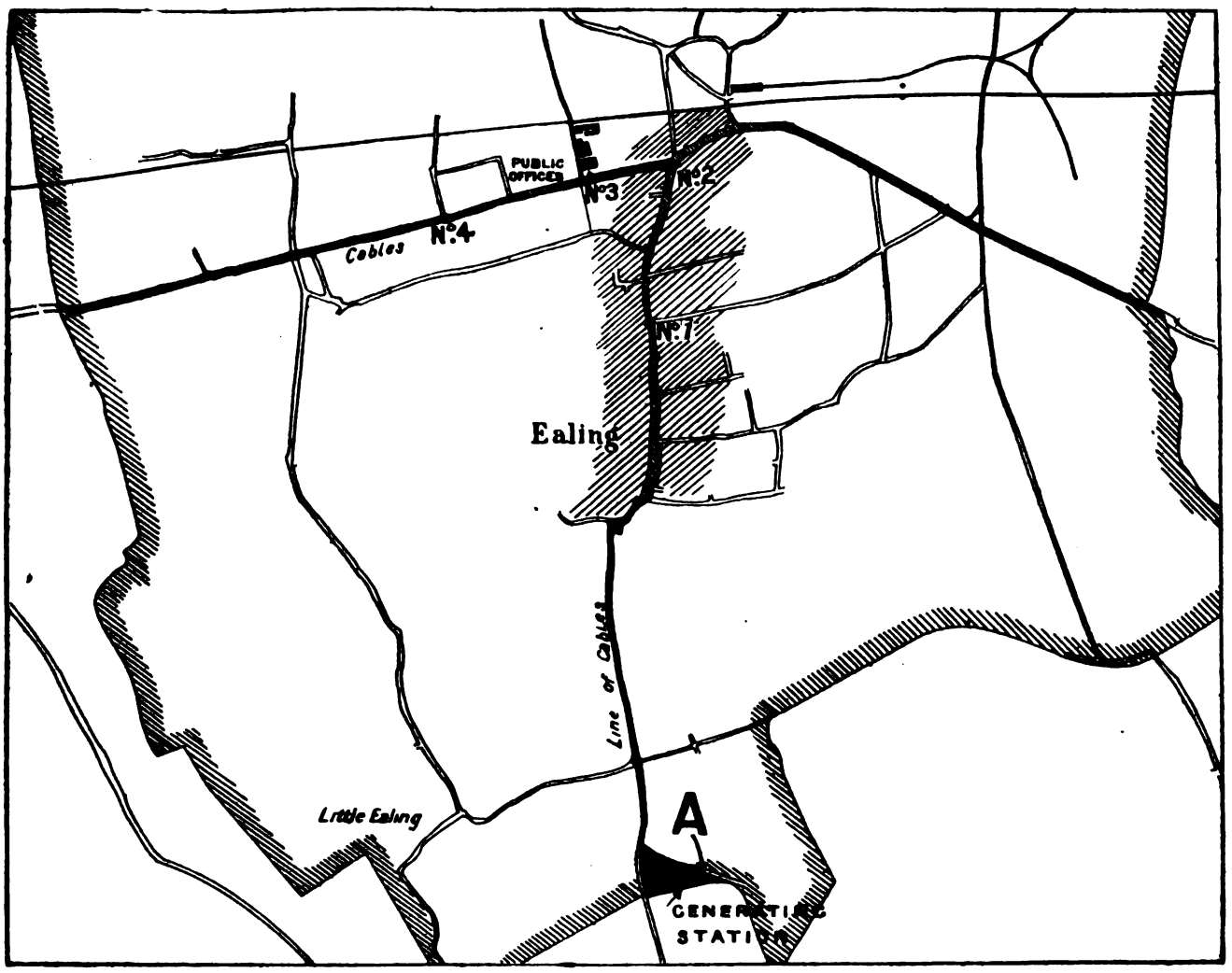
NOVEL DEPARTURE IN CENTRAL ELECTRIC LIGHT STATION PRACTICE.

General Remarks.

It is doubtful whether a more progressive and enterprising local authority could be found than that at Ealing. The Ealing Local Board was originally constituted in 1863, when the population comprised some 5,000 persons. The Ealing of that period and the Ealing of the present are entirely different. At the former date it was purely a village; there were no public gas lamps, no sewers worthy of the name, and with the exception of the main road there were no properly-formed roads in the district. At present, thanks to the successful policy of the Local Board, which on its for mation supplanted the old highway board in the above mentioned year, a complete transformation has taken place. The district is now provided with well-kept roads, with a complete drainage and sewerage system, and with gas and electric lighting, whilst the population has increased to some 27,000 souls. To Mr. Chas. Jones, M.I.C.E., engineer and surveyor to the Local Board, is due a large amount of credit for bringing the district to its present satisfactory position. The healthiness of the neighbourhood may be gathered from the fact that the death-rate is 11·3 per 1,000, this being lower than several of the best known health resorts in the country.

Ealing, together with Acton and Chiswick, constitutes the Ealing Division for parliamentary purposes. The public buildings, which are situated in the Uxbridge-road, form an imposing structure, erected from the designs of Mr. C. Jones. They include a Free Library, Science and Art School, and the Victoria Jubilee Hall, where an electrical exhibition will be opened on Wednesday next, and will be continued for 10 days. A convenient theatre is provided by the Lyric Hall in the Broadway.

The suburb of Ealing lies on the northern and southern sides of Uxbridge-road, and is about six miles distant westerly from the Marble Arch, or from the spot where criminals once met their doom at Tyburn turnpike. It is within the hundred of Ossulstone and the county of Middlesex, and in the diocese of London. Ealing is bounded on the east by Chiswick, Acton, and Twyford; on the west by Hanwell and Hayes; on the north by the River Brent, Harrow, Perivale, and Greenford; and on the south by Brentford. The district is a large one; the parish reaches two miles from north to south, and slightly over two miles from east to west, the acreage being about 3,225 acres.



Plan showing Site of Generating Station and Compulsory Area of Supply.

Historical.

A few remarks concerning the history of the district should be of interest. The horrors of war were little known in the neighbourhood of Ealing from the time of Canute down to that of the Civil War. Then an engagement took place on November 12, 1642, at Brentford, between the forces of the Royalists and of Parliament. Although this battle was not of any great extent, it resulted in much recrimination between the king and the disaffected subjects. A more terrible visitation than war occurred in 1665 and 1666, when the ravages of the plague carried off over 250 victims in 12 months.

Among the imposing buildings dedicated to divine service in the district may be mentioned St. Mary's, the parish church, which is a brick edifice built on the site of a former structure, originally erected in 1729. In addition to this there are eight other churches, besides a number of chapels belonging to various denominations. Of stately mansions there is a number in Ealing and its vicinity, these being erected in rich and spacious grounds and surrounded by

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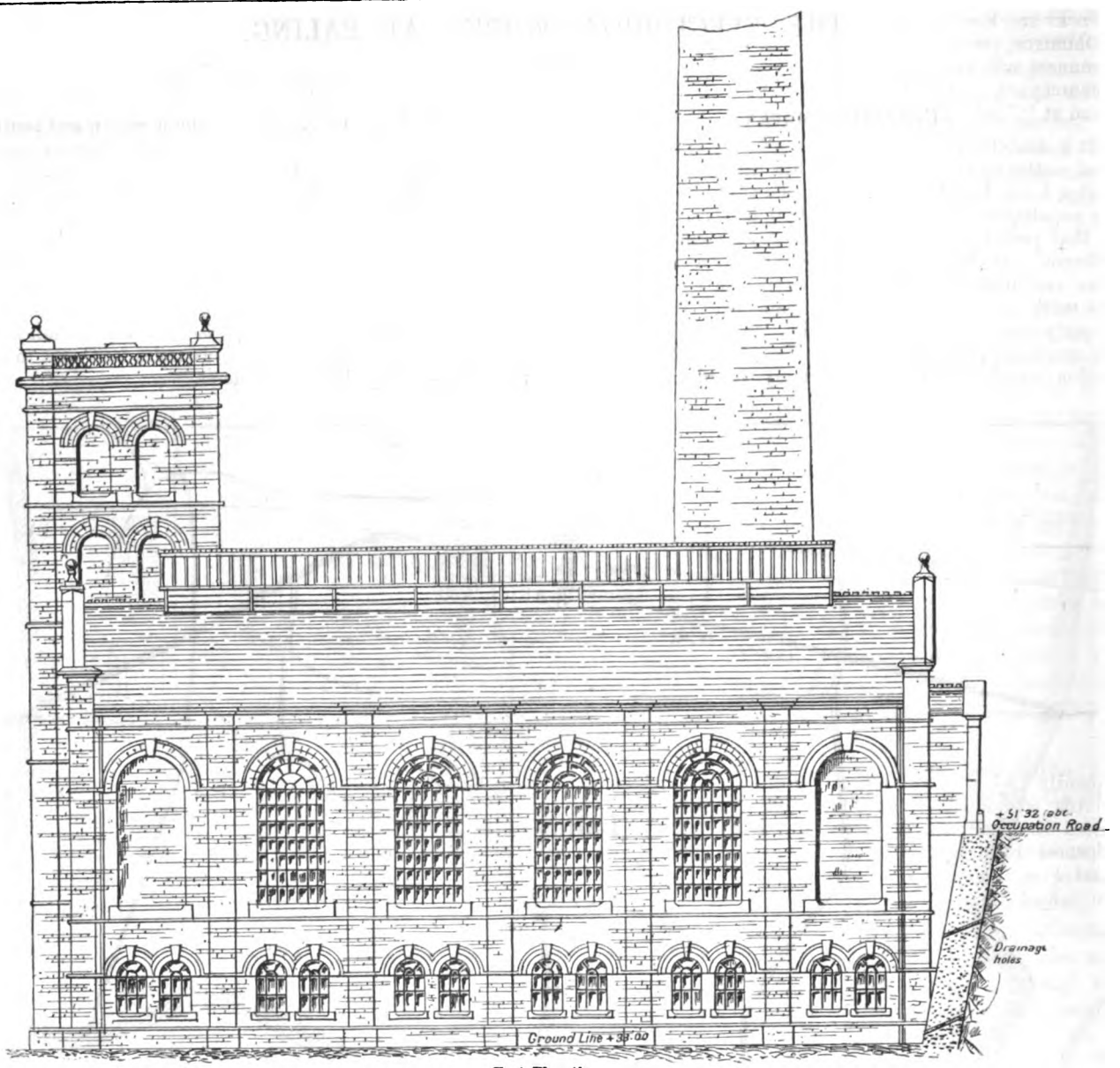
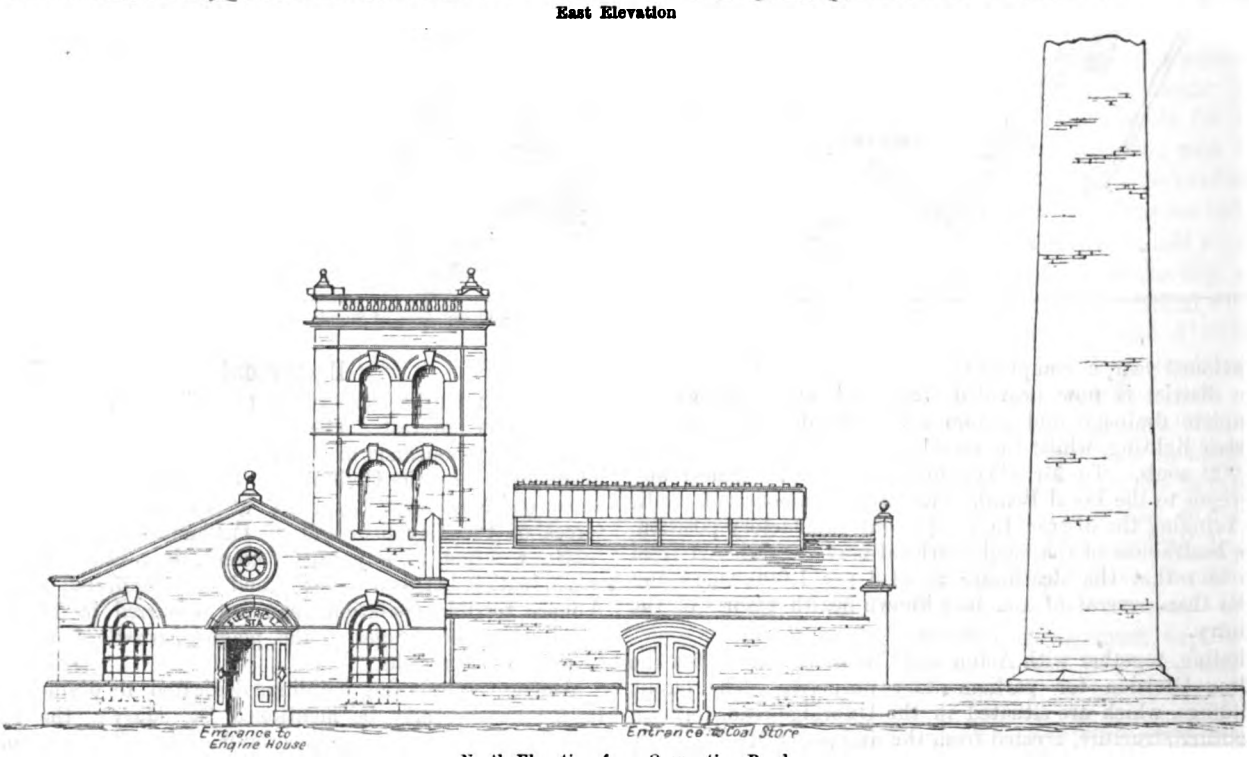


East Elevation



North Elevation from Occupation Road.

walks and noble trees. Castle Hill Lodge, which down to 1812 was one of the seats of the Duke of Kent, formerly stood on Castlebar-hill. This noble duke, who was the father of her Majesty the Queen, married in 1818 a princess of the house of Coburg. Amongst other notables we may mention the Earl of Rochford, the Dukes of Marlborough, Suffolk, and Argyll, Sir Francis Dashwood, the Percevals, Lord Brooke, and Lord Manners. John Horne

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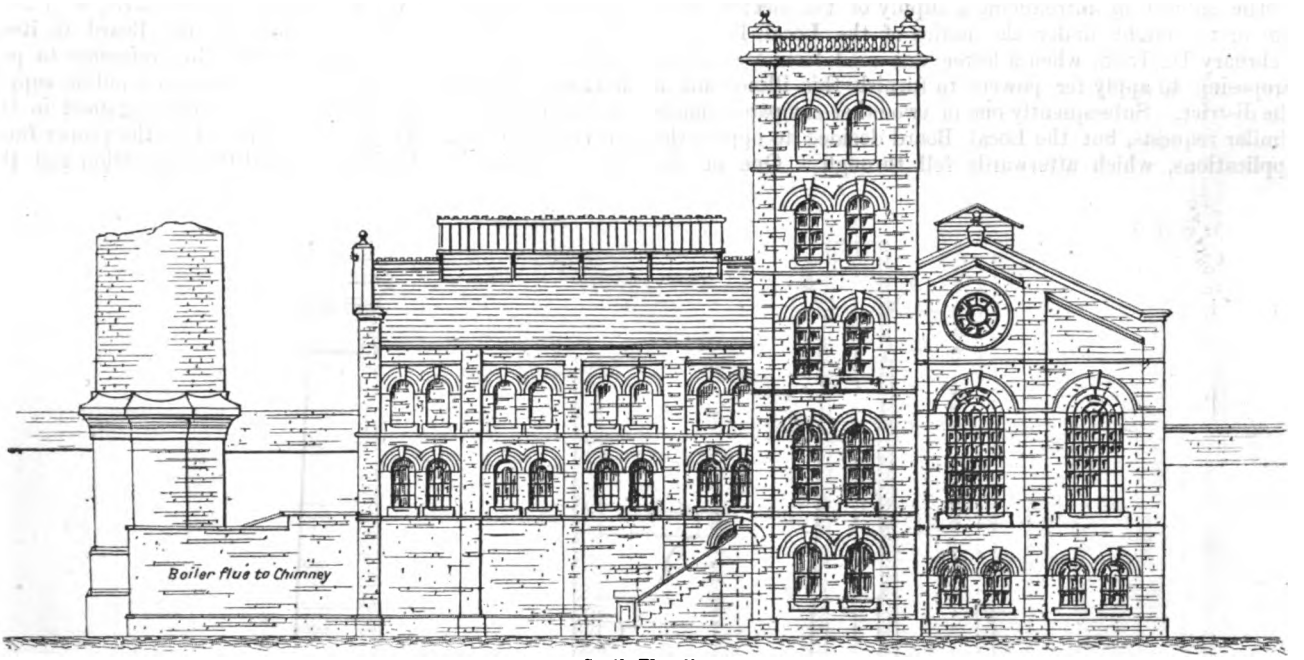
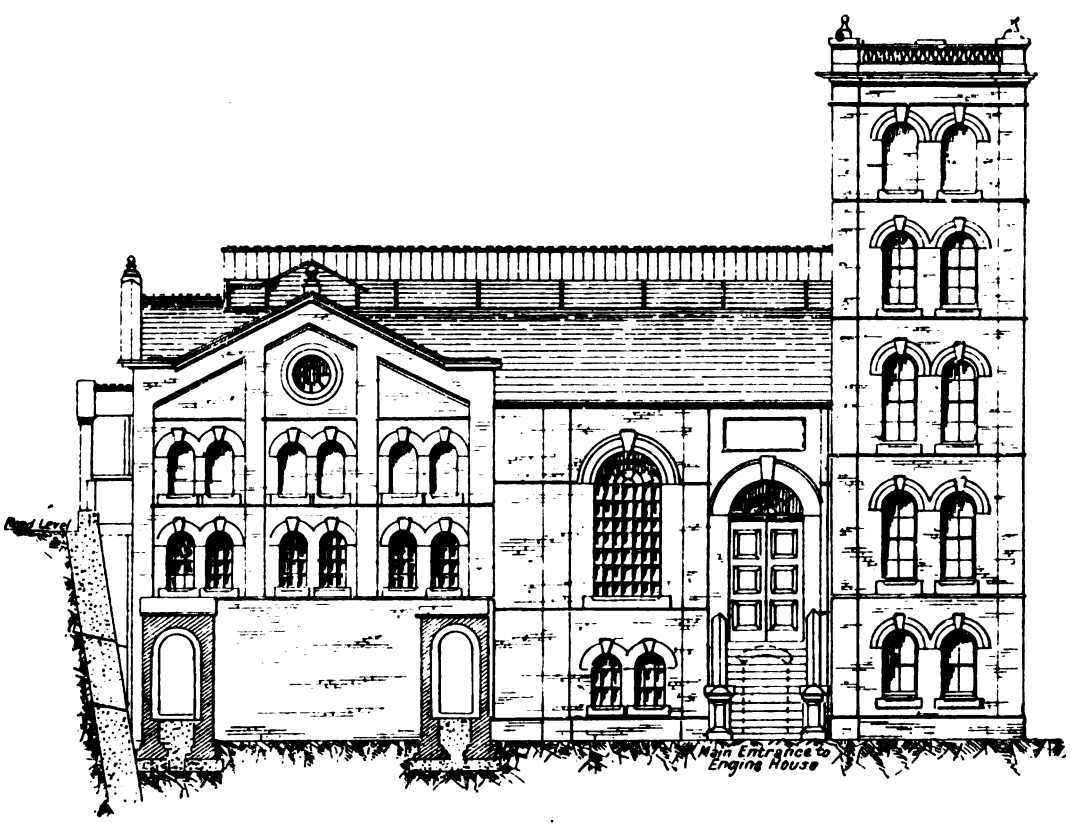
Tooke and the great political writer of the last century, John Oldmixon, were buried there. Sir William Lawrence, the eminent surgeon, died there, and was buried in the old parish churchyard. The great Lord Heathfield dwelt in the village and at "Fordhook," Henry Fielding, the novelist, and subsequently Lady Byron. In the drawing-room of "Fordhook," "Ada, sole daughter of my home and heart," was married to Lord King, afterwards Earl of Lovelace. The Right Hon. Spencer Horatio Walpole was for many years a resident, and Prof. Huxley was born in Ealing. Thackeray went to school there; Dickens often visited his sister, Mrs. Hogarth, at Ealing Dean; some of the best songs by Dibdin were written at his residence in Hanger-lane; and Edward Bulwer Lytton went to school in what was formerly known as Love-lane.

Among other notable buildings in the district may be mentioned Gunnersbury House. This historic mansion, now owned by Baron Rothschild, stands on rising ground on the outskirts of Ealing, where it borders on Turnham Green. The Grove, which towards the end of the seventeenth century was occupied by Sir William Trumbull, the friend of Pope, stands on the edge of Ealing Common. One speciality is the large private scholastic establishments; the largest private school in England—Great Ealing School—was kept for many years by the Drs. Nicholas. Probably not many private tutors could show a longer list of scholars who became men of note than could the Nicholas family, amongst others: Sir Henry Lawrence, Bishop Selwyn, Charles Knight, Sir Henry Rawlinson, Cardinal Newman, Captain Marryatt, William Makepeace Thackeray, Lord Truro, and many others. It would probably be difficult to find for the same size any district which possesses so many colleges, academies, and day schools as are to be found at Ealing, a fact which, considering the healthy condition of the locality, its proximity to the lovely haunts



South Elevation.



West Elevation.

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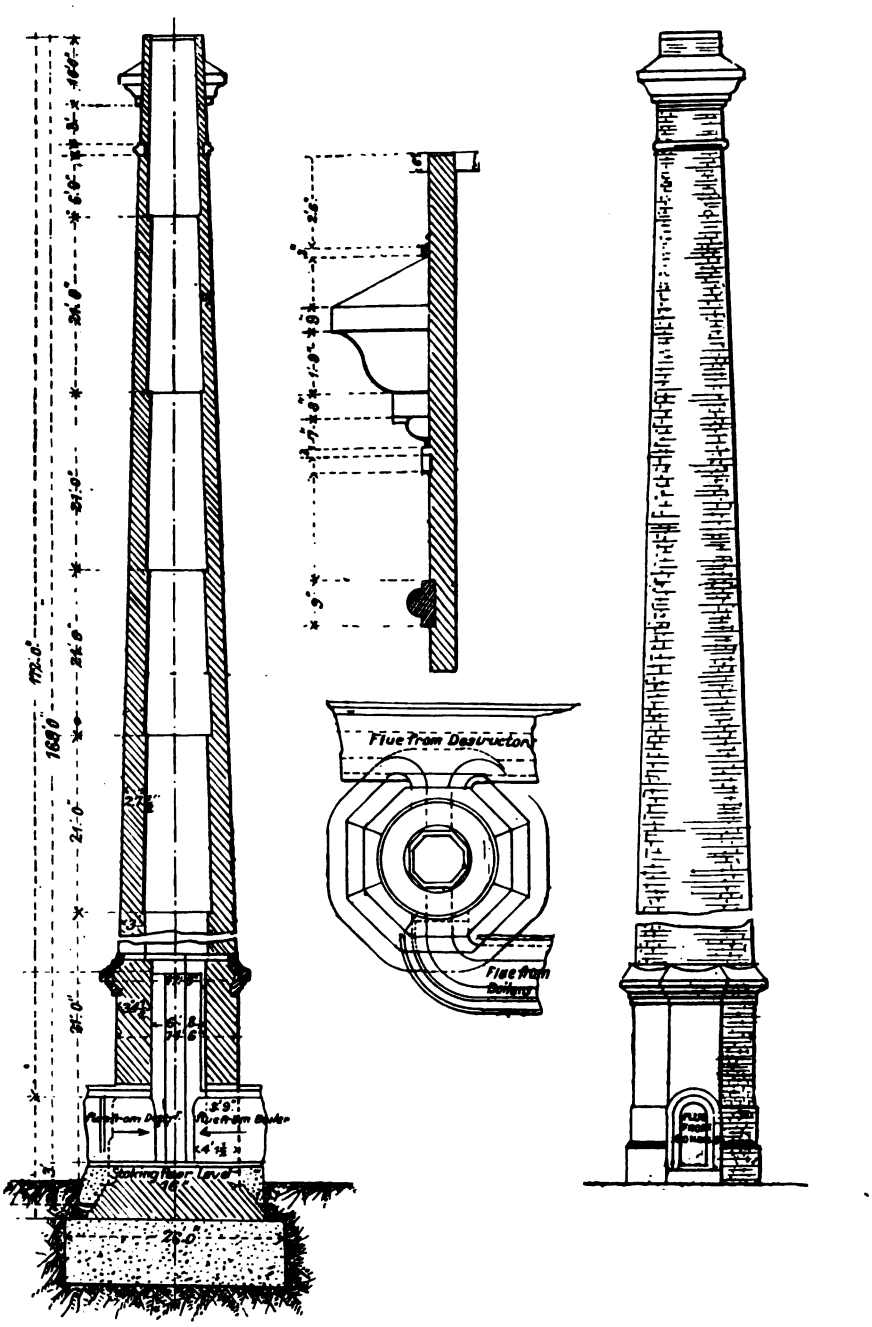
on the Thames, its many open spaces, etc., is not surprising. It is even said that there is no place in Ealing that can reasonably be called a slum. In this it differs greatly from its neighbour, Brentford.

Preliminary Steps in Electric Lighting.

The subject of introducing a supply of the electric light was first brought under the notice of the Local Board on February 16, 1888, when a letter was read from a company proposing to apply for powers to furnish this illuminant in the district. Subsequently one or two other companies made similar requests, but the Local Board decided to oppose the applications, which afterwards fell through. One of the members of the Local Board, Mr. Kasner, was the first to suggest that the Board should itself put down plant and provide a supply of electricity. On February 20, 1890, on the motion of the chairman (Mr. E. M. Nelson, J.P.), the Board unanimously decided to apply for a provisional order authorising the establishment and working of electricity works. As a result of this, a provisional order was granted to the Board in 1891.

Time passed away, and in December, 1892, the Local Board instructed their engineer, Mr. Jones, to communicate with Messrs. Bramwell and Harris, asking them to prepare a report as to the advisability of introducing a supply of electricity, and as to the most suitable scheme for lighting the district in this manner. The compulsory area of supply set forth in the order may be said to have practically determined the system which it was desirable should be adopted. This will be understood when it is mentioned that this area extends the whole length of the district from east to west, a stretch of some two miles, and from north to south to the extent of 1½ miles. Messrs. Bramwell and Harris, with their characteristic enterprise, recommended the Board to itself undertake the lighting of the district in preference to permitting a company to step in and establish a public supply of electricity by the transfer of the powers contained in the provisional order. The Board, as indeed is the proper function of all local authorities, adopted this suggestion and the scheme prepared by the consulting engineers, and the result is shown by the well-equipped electricity works now being set in operation.



Section, Plan, and Elevation of Chimney Shaft.

When the question of the site for the electricity works was discussed, it was found that there were available two places owned by the Board which were suitable for the purpose. One was the Drayton Green siding, a piece of land nearly at the extreme west of the district, and the other was a plot of vacant space at the sewage disposal and destructor station, off South Ealing-road, at the extreme south of the district; both sites were inspected by the consulting engineers, who recommended that the works should be built on the latter.

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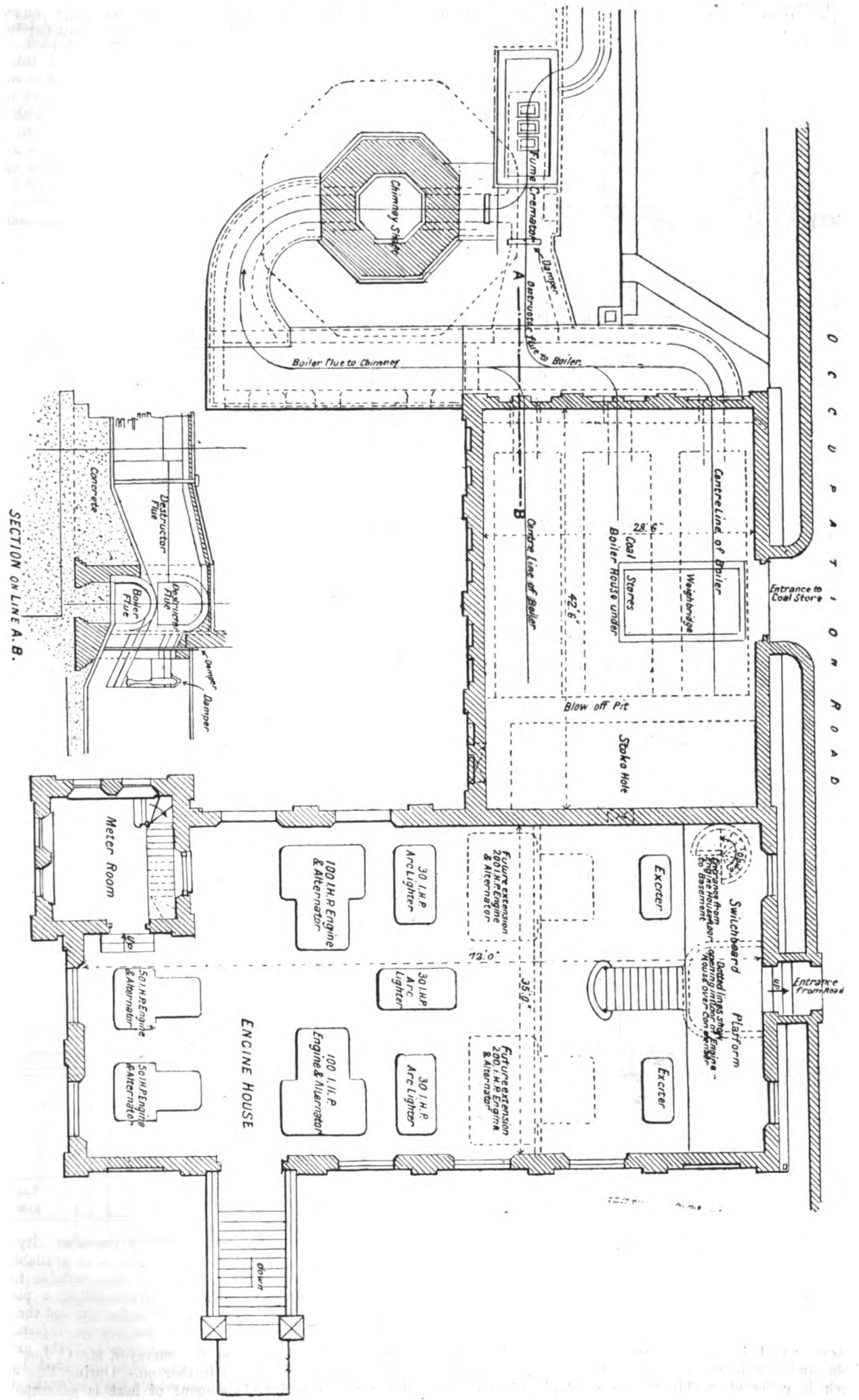

General Plan of Ealing Electricity Works.

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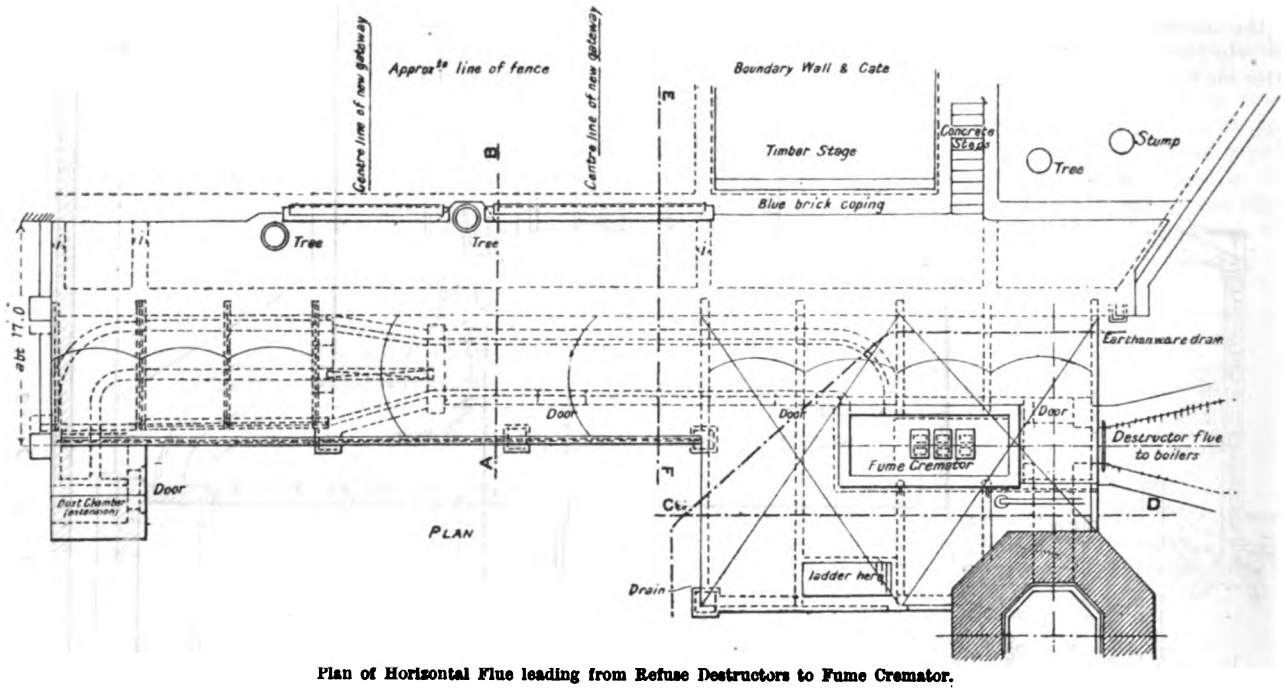
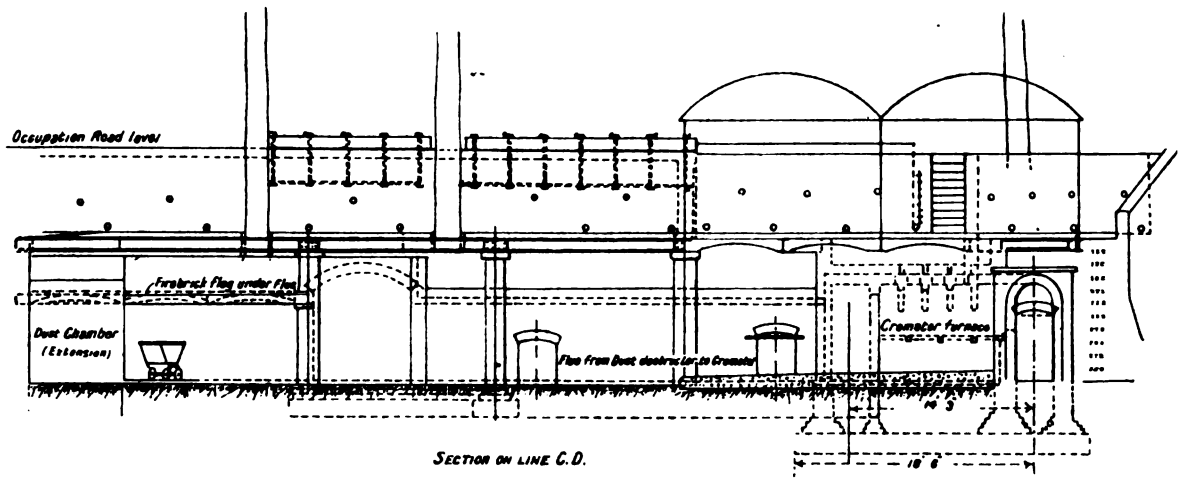
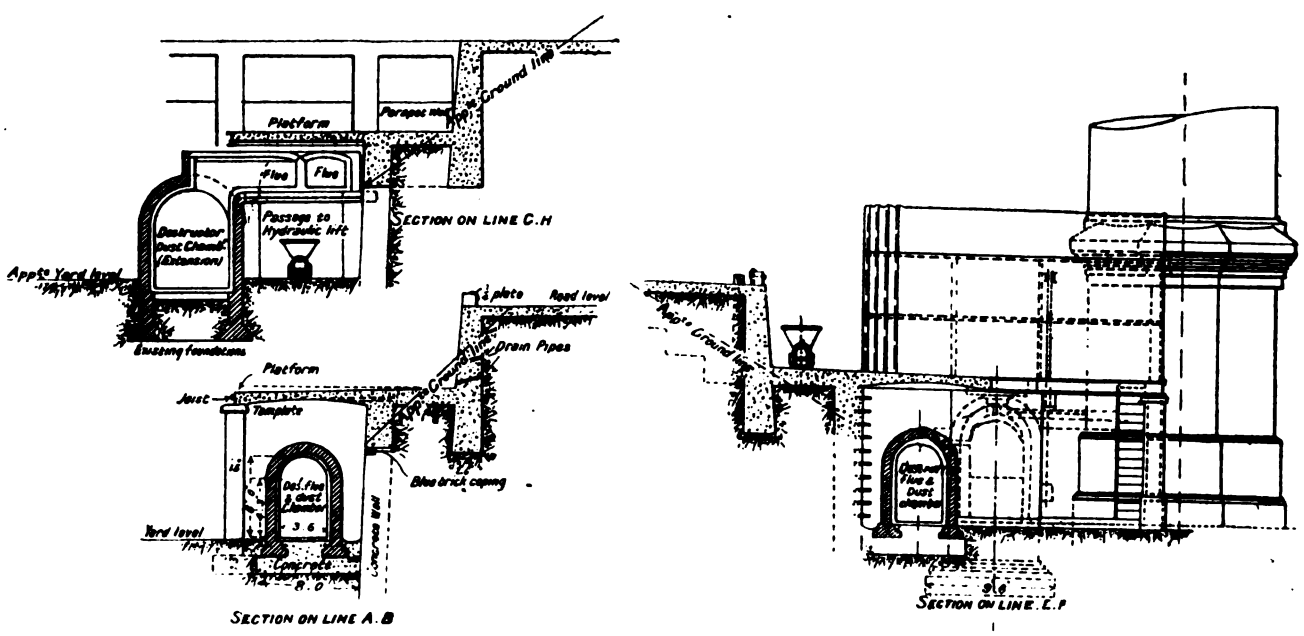
One of the reasons that led to the adoption of this suggestion was the fact that on the spot was ready at hand a lot of waste heat resulting from the incineration in a refuse Board, is conveyed to the destructor station, mixed with the sewage sludge, tipped into the destructors, and consumed. The process of destruction is practically completed by the



Plan of Horizontal Flue leading from Refuse Destructors to Fume Cremator.



Section (on line C D) of Horizontal Flue from Destructors to Cremator.



Section (on lines G H, A B, and E F) of Horizontal Flue from Destructors to Cremator.

destructor and in the "fume cremator" of the sewage sludge and dustbin refuse of the district. The latter refuse, which is collected weekly by the employés of the Local fume cremator devised by the surveyor, Mr. C. Jones, and to which reference is made further on. During this operation a very considerable amount of heat is generated. A

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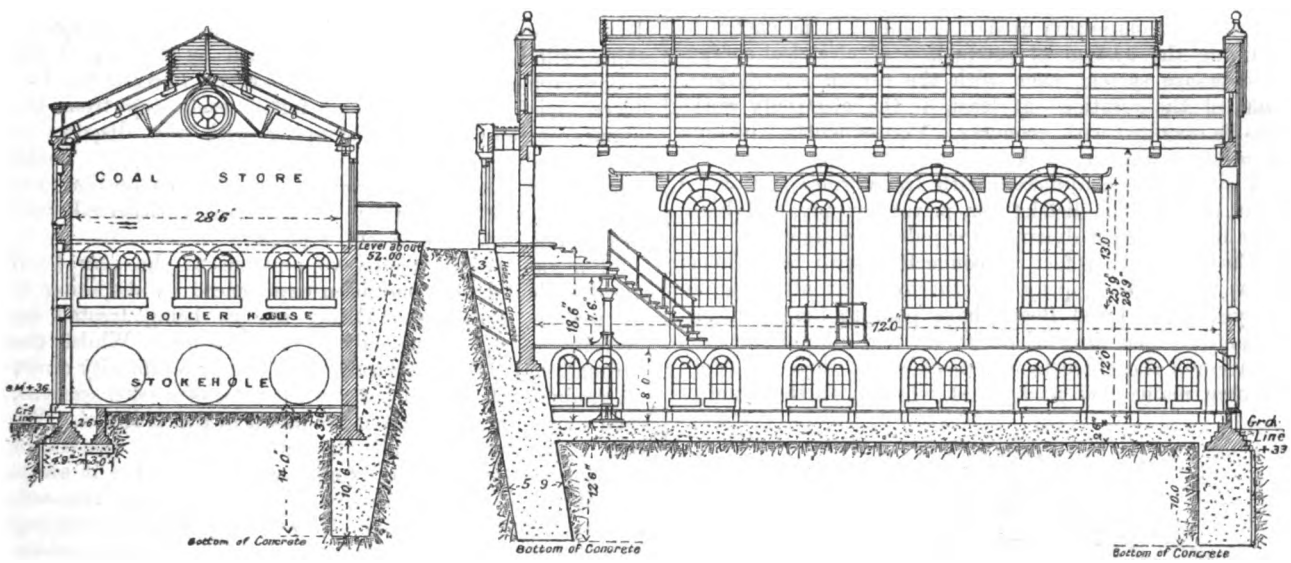
portion of it was already used to raise steam for the operation of the engines in the sewerage works, but a considerable quantity has hitherto passed up the chimney. It was this waste heat that the consulting engineers advised the Board to profitably utilise to assist in generating steam for the engines driving the dynamos. Another reason for the selection of this site was the question of a supply of water for the purpose of steam condensation, a matter which



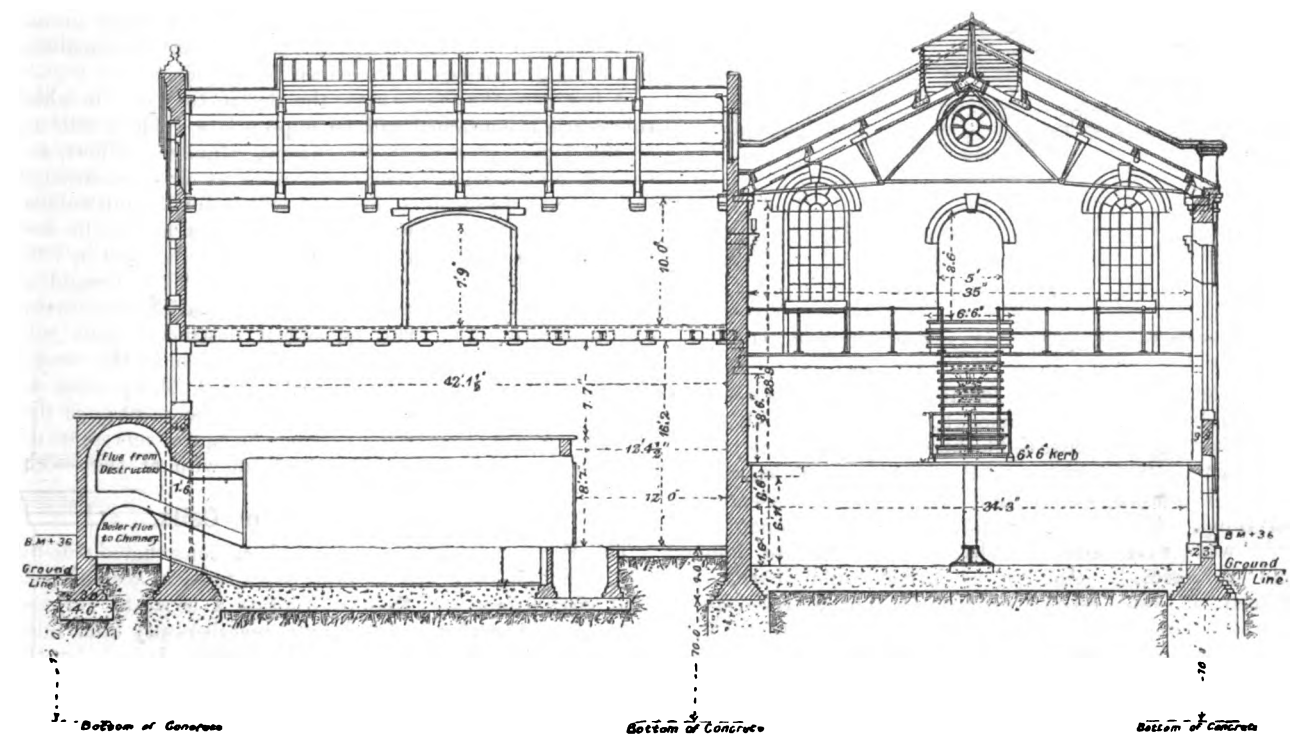
Transverse Section through Boiler House.

Longitudinal Section through Engine House.

has to be determined for the economical working of electricity works. Water obtained for this purpose from the Grand Junction Waterworks Company's mains would have been so expensive as to have rendered its use prohibitory. Consequently, Messrs. Bramwell and Harris suggested the use of the sewage effluent for steam condensing. So long ago as the year 1887, Messrs. Bramwell and Harris designed for the Metropolitan Board of Works specially arranged surface condensers to be connected to the sewage pumping engines at the Board's Crossness sewage station, the circulating water of these condensers being the effluent of the London sewage flowing from the tanks to the river. The condensers were constructed and erected to these designs by Messrs. James Watt and Co. in the above year, and have been working satisfactorily ever since. The quantity of effluent passing away from the Ealing sewerage works amounts to 600,000 gallons every 24 hours, the excellent condition of the effluent allowing of its being satisfactorily employed in this direction before leaving the station.

Novel Departure from Existing Practice.

Thus it will be seen that in these electricity works a most striking and novel departure has been made—a deviation, in fact, from existing practice in central-station work that will be watched with the keenest interest by both electrical and municipal engineers throughout the country. Of course, in recommending the Board to adopt this system, the consulting engineers did not suggest that electrical energy could be produced for practically nothing, as some unreasonable persons would try to make out. What they did contend—and we consider rightly so—was that the advantages which would accrue from the combined utilisation of the waste heat from the destructors and the sewage effluent for steam condensing purposes, would allow of considerable economy being realised. To put the matter in a nutshell, it was a question of either paying heavily for water for condensing purposes and all the coal required, or using the heat going to waste, together with some coal, at little expense, and the effluent passing through the station at no cost whatever. In deciding to make the departure indicated by



Longitudinal Section of Boiler House.

Transverse Section through Engine House.

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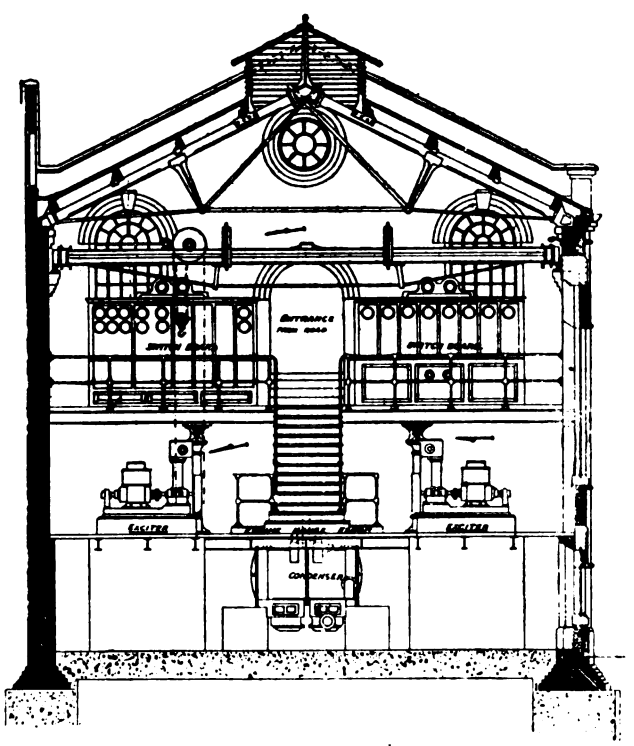
adopting the latter arrangement, the Board acted wisely. Not only so, but the actual working of the station will, as time passes away, determine from the practical experience gained—and this is what electrical engineers desire to ascertain reliable data upon—what economy is obtainable by the introduction of this combined system.

The Adopted System.

As already remarked, the site of the station and the large extent of the compulsory area of supply left no choice in determining the system of production of electrical energy. A low-pressure system, even with the use of sub-stations, was out of the question—at least, if the electricity works were to be operated with economy. Consequently, the only other resource was to put down a high-pressure alternating-current system in conjunction with transformer stations in different parts of the district for private supply, and high-pressure direct-current dynamos for public arc lighting.

Another interesting fact in connection with the scheme was that of public lighting. Hitherto, or at all events in recent years, the Local Board have paid to the Brentford Gas Company no less than £500 per annum for the illumination of those streets comprised within the compulsory area where mains had to be laid, whilst a further sum of



Transverse Section through Engine House, showing Generators and Switchboard in position.

£250 was expended annually for the lighting of the various public buildings. Naturally enough, by dispensing with gas and substituting the electric light, this sum would become available as part of the revenue of the electricity works, which from the beginning would thus become a money-earning undertaking. This fact was also impressed upon the Board, who were advised that 70 public arc lamps should be erected. As far as private illumination is concerned, it was estimated that within a reasonable period the probable demand would be equal to 5,000 8-c.p. lamps. Accordingly, the consulting engineers recommended the Board to put down plant for the supply of this number of lamps at a cost of about £21,000. The estimated revenue from public lighting was £750, and from private illumination for the whole of the 5,000 lamps installed £2,250, or a total of £3,000 per annum. The scheme was somewhat enlarged and the amount increased to £25,000.

As a result of the recommendations of the consulting engineers, the Local Board, as already stated, decided to carry out the scheme and to obtain a loan of £25,000 for the purpose. This decision was soon put into practice. Tenders were invited for the erection of the buildings, and for the supply of the steam and electrical plant. The following was the result.

Buildings: Wilkinson Bros., Finsbury Park	£7,381
Lancashire boilers and accessories: J. Watt and Co., Birmingham	1,875
Steam dynamos, alternators, transformers, switchboards, and condensing plant: Siemens Bros. and Co., Limited, London	7,450
Mains, lamps, etc., Callender's Bitumen Company, London	6,000
Wiring public buildings: Paterson and Cooper, London	795

The Destruction of Refuse.

Justice to the novel features possessed by the Ealing electricity works can only be done by a detailed description, which will be more readily understood by the aid of the accompanying illustrations; and in order to accomplish this object satisfactorily, we must follow each step from the commencement—that is, beginning with the disposal of sewage sludge and ashbin refuse at the works off South Ealing and Occupation roads. In this connection the following quotation from Mr. Jones's work, entitled "Refuse Destructors," may not be out of place:

"For some two or three years previous to the year 1883 considerable difficulty had been experienced in disposing of the sewage sludge, the Ealing sewage being treated by precipitation upon the milk-of-lime process. Whilst the surrounding lands were purely farm lands no difficulty arose, but gradually these assumed the character of market gardens, when considerable objection was raised to the material. We were next obliged to mix it with ashes, and instead of receiving 1s. and 2s. a load for it we had to give it away. At last the question became one of paying for its removal, and as we got more and more into the difficulty appertaining to its disposal, so did the market gardeners raise their prices, and in the end it cost some two to three hundred pounds to be rid of one year's supply. In the year 1882 I was at Leeds, attending a meeting of the Association of Municipal and Sanitary Engineers, and, amongst other objects of interest, saw for the first time the working of a destructor, and fully realised the fact that I had met with a contrivance which would enable me to set market gardeners at defiance. I laid the matter before my Board, and at once obtained their consent to the erection of a destructor, and in 1883 we commenced our burning. In 1885, the difficulty that arose in connection with the fumes, etc., was overcome by the cremator, and from that time to the present we have burned quite nine-tenths of our sewage and house refuse, the remaining tenth being transferred to our own farm lands."

A few remarks concerning the destructor cells in which this refuse is consumed will be appropriate. These cells are of the Fryer type, made by Messrs. Manlove, Alliott, and Co., of Nottingham. Two cells were at first constructed, this being in 1883, in conjunction with a small multitubular boiler and engine. Two years later three more cells were erected, together with a Jones "fume cremator," and in 1890 a further addition of two cells was made. This brought up the number of cells to seven, and the foundation for a further cell was also laid. This seven-cell destructor deals with about 24 tons of refuse daily, in addition to the sewage sludge arising from a population of some 23,000 persons out of a total population of 27,000. It may be mentioned that the difference between these two sets of figures represents the population on the northern incline dealt with at the sewage farm.

The Fryer Destructor Cells.

The Fryer cells at Ealing have been constructed side-by-side, although they can be built back-to-back, according to local circumstances. Each cell forms a separate furnace, comprising a cavity enclosed by a reverberatory arch lined with firebricks. The cell is provided with a hearth for the reception of the refuse to be burned, from which it passes into the furnace proper. The passage of the material to the front is facilitated by arranging the firebars in an inclined position, which also renders easy the removal of the clinkers. The top of the destructor constitutes a platform, an opening over each cell being provided for the reception of the mixture of sewage sludge and ashbin refuse, which is shot through the opening from small trucks. It will, of course, be understood that the opening for the admission of refuse is divided from that for the exit of gases, the division being formed by a wall, whilst a bridge is provided to prevent the refuse heaped on at each charge from getting into the flue immediately below. Special openings are provided for the direct

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introduction upon the burning mass of infectious mattresses, diseased meat, dead cats and dogs, etc. The furnaces, when once lighted, are kept at work by the refuse itself. In order to prevent inconvenience to the stokers through the fine dust being blown about, a concave pit is constructed under the furnace bars. This pit is partly filled with water, and the fine dust falling therein is removed when the fires are drawn. The clinkering is done at intervals of about two hours, and the quantities of clinker and fine ash vary in proportion to the kind of material burned. The average dust at Ealing is about 25 per cent., a good hard clinker, suitable for a variety of purposes, forming the residuum. This clinker is used in the manufacture of concrete, for tar paving, for building and path-making purposes, hard core for roads, artificial stone when ground up as sand, and for the construction of walls. Thus the clinker forms a valuable by-product. The whole of the concrete and mortar used in the erection of the buildings of the lighting station has been made from this clinker, either used whole or ground up into sand.

An automatic arrangement has been adopted for the purpose of maintaining as constant as possible the high temperature in the dust-chamber during the operations of feeding and clinkering. This is accomplished by means of a cast-iron hinged door which is placed over the opening leading into the dust-chamber, and is attached by a chain to the furnace door. The arrangement is such that when the furnace door is open the entrance to the dust-chamber has about four-fifths of its area closed, whilst when the furnace door is shut the flue door is open. As already stated, this method is entirely automatic, and the admission of cold air during the operations in question is reduced as much as possible, when the desired result of keeping up the high temperature which is essential for the proper working of the destructor is obtained.

The Fume Cremator.

The difficulty arising from the emission into the atmosphere of the gases and vapours from the destructor cells has previously been mentioned. It arose partly from the expulsion of the gases at too low a temperature, and partly from the vapours given off in the drying of the material in the first stage of burning. The idea occurred to Mr. Jones that by the employment of an additional and *independent* furnace—arranged between the destructor and the chimney shaft, and in which a very high temperature prevailed—the difficulty could be overcome by passing the gases through it, and thence into the atmosphere, practically innoxious. This idea was carried into practice by Mr. Jones in 1885, and since then no complaints have been made of offensive fumes from the chimney, which is 143ft. high. To this additional furnace Mr. Jones gave the name of the "fume cremator."

The fume cremator consists of a reverberatory arch with rings of firebricks placed in the direction of the gases. Ribs of firebricks projecting from the arch serve to deflect the gases and direct them on to *the top* of a red-hot mass of fire. This furnace is fired with coke breeze alone, or coke breeze and ashes screened from the refuse, and an intense heat, calculated at between 1,200deg. F. and 1,800deg. F., is maintained at little expense for fuel, a supply of air being provided below the fire-bars and a further supply to feed the vapours as they pass into the cremator. The passing over this bed of incandescent coke at this high temperature practically completes the partial distillation commenced in the destructor cells of the gases, vapours, and fine dust, and what then enters the atmosphere through the chimney shaft is odourless. Between the cremator and the shaft is arranged a multitubular boiler, in which steam is raised by the hot gases for the purpose of driving an engine and mortar mill in the sewage disposal works.

The method outlined in the foregoing remarks is that which has hitherto been followed at the sewage disposal works, which, now that the electric light station is completed, will doubtless be termed the combined sewage disposal and electric light works. But with the establishment of the latter this arrangement undergoes certain alterations. In the first place, the existing cremator and chimney shaft will fall into disuse; and in the second, the whole of the waste gases from the destructor cells will be passed through another cremator of the same type, and utilised for steam-raising purpose in the boilers laid down for operating the engines and dynamos in the adjoining electricity works.

Waste Gases for Steam-Raising Purposes.

We now come to the first novel and interesting application in connection with this central electric light station—namely, the utilisation of the waste gases and vapours from the refuse destructor for the purpose of raising steam in the boilers. As will be seen from the general plan, etc., of the works, the gases from the main flue of the destructor pass through a damper into a horizontal brick flue a distance of some 30ft., where they are led over the burning mass forming the furnace of the new cremator, which is constructed on practically the same lines as that already referred to as having been erected in 1885, and which has been at work continuously since that year. The complete distillation of the gases and vapour being practically accomplished by the fierce heat prevailing in this furnace, the odourless gases, now at a temperature ranging between 1,200deg. F. and 1,800deg. F., are dealt with in either of two ways: they are either allowed to escape from the cremator flue into the chimney shaft through the damper shown in the plan at the base of the shaft, in which case the connection between the cremator flue and the flue from the destructor built at the end of the boiler-house is shut off by a damper, or the damper at the bottom of the chimney shaft is closed and the gases pass into the flue from the destructor and thence round the boilers, in which event, as a matter of course, the path to the boilers is clear.

The former method may be regarded as only being necessary in case it becomes essential or desirable at any time for some reason or other to raise steam in the boilers in the usual way, as, for instance, when the destructor is shut down annually for about a fortnight for repairs. Of the three boilers, of which details are given further on, each and all are adapted for steam generation in the way indicated. It must not be inferred from this statement that it is intended to generate steam in all the boilers by means of hot gases, but rather that any boiler or any combination of the three can be made to produce steam in this manner as occasion may arise. As a matter of fact, when the additional destructor cell (the eighth) has been erected, it is expected that the total power obtainable continuously from the eight cells and cremator will amount to about 50 i.h.p., or, say, sufficient to satisfy the day load for some years to come. Thus the utilisation of the waste gases from the destructor is really an adjunct to the steam plant, which in itself is quite independent of the refuse destructor when such independence is necessary.

Coming now to the details of the arrangements for utilising the waste gases for the generation of steam, it will be observed from the cross-section of the flue from the destructor (or, rather from the cremator) and of the boiler flue to the chimney, that these pass back around the outside rear end of the boiler-house, and that the flue from the destructor surmounts the boiler flue to the chimney. The admission of the hot gases from the flue from the destructor to the boiler flues and the exit of the smoke and gases from the main boiler flue to the chimney are controlled by a double damper, which is arranged on the inner side of the rear end of the boiler-house wall, as shown. When this damper is raised, the gases pass round the boiler flues and underneath into the main boiler flue to the chimney. At the same time the hinged ashpit dampers fitted to the cast-iron fire-door frames in front of the boilers, in addition to ordinary closed fire-doors, are closed so that the fronts of the flues are sealed up airtight, whilst the waste heat alone is being utilised.

When the double damper is lowered, the connection between the boiler and the flue from the destructor is closed, and the boiler is ready for steaming in the usual way. The raising and lowering of the double damper is effected by means of leading pulleys, chains, and counterweights. The counterweights are arranged in front of the boilers, so that the double damper may be operated from the stokehole.

Further, as will be seen, the arrangement is such that hand or mechanical stoking of either or all of the boilers can be carried on simultaneously with the utilisation of the waste heat from the destructors.

The Boiler-House.

Subjoined are given illustrations of the station buildings. The contract for the boilers and accessories was placed

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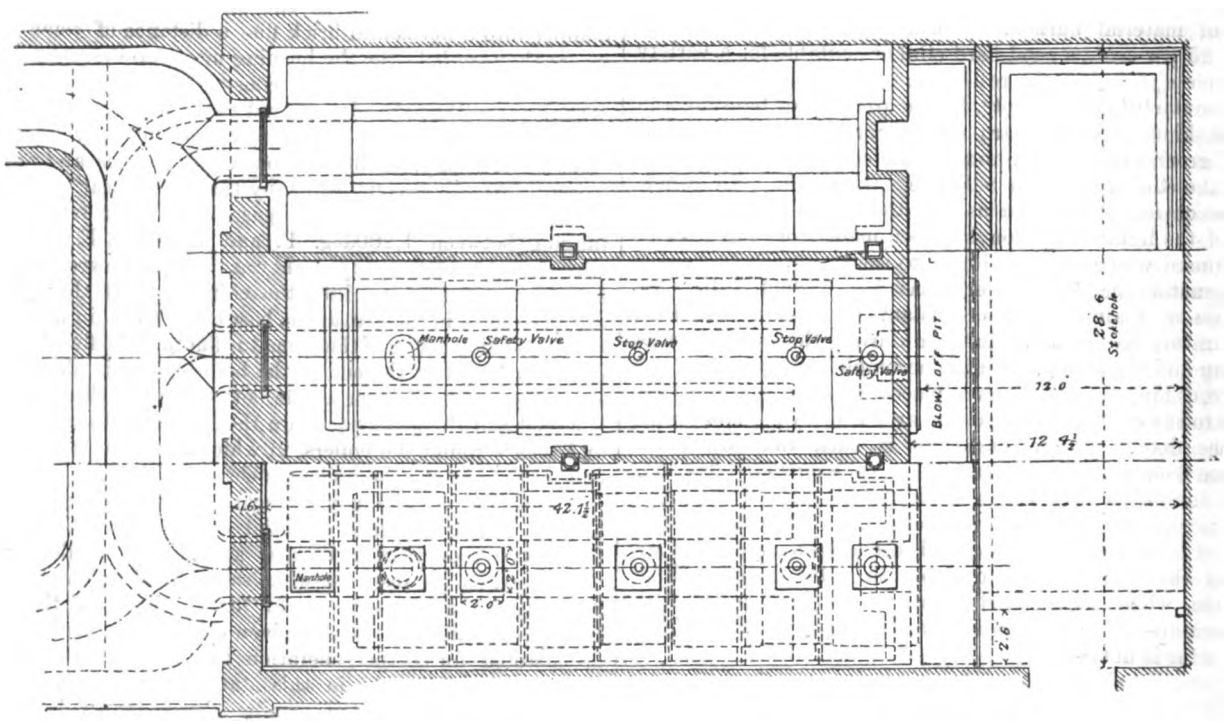
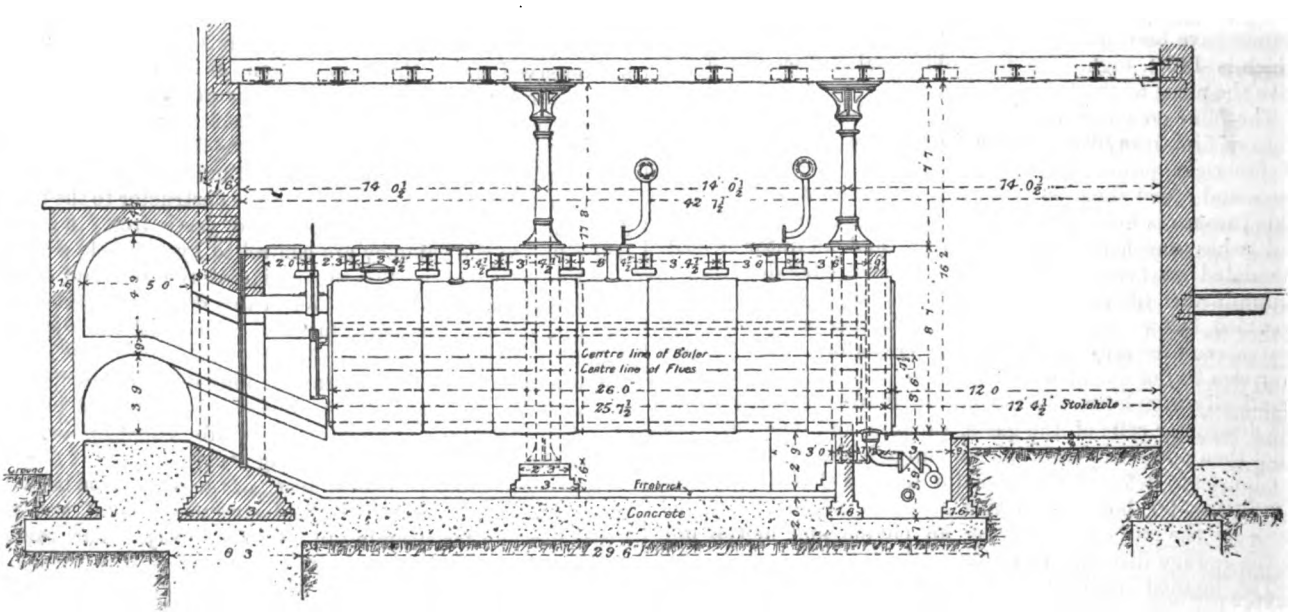
with Messrs. J. Watt and Co., of Soho Foundry, Birmingham. The boilers comprise three of the Lancashire type, constructed for a working pressure of 120lb. They are each 26ft. long by 7ft. in diameter, and are made of mild steel. Each boiler is provided with two flues, in each of which is arranged eight cross Galloway tubes of 10½in. internal diameter at the large ends and 5½in. at the small ends. Two of these tubes



Plan of Boiler House.

are placed in each of the parallel flue ring plates behind the furnaces. There are two manhole openings to each boiler: one is arranged in front of the boiler between the flues and below them, and the other is placed in the centre of the back row of shell plates at the top. The boilers are each provided with a double-lever safety valve and two screw-down stop-valves. The latter are bolted to fittings riveted to the top of the boiler, and each valve has a single right-angled branch,



Longitudinal Section of Boiler House.

which has bolted to it a copper bend to allow for expansion; this is turned upwards, and has its other flange bolted to the underside of two 6in. cast-iron mains, which are carried across the boilers at right angles to their length. These mains terminate at one end in a blank flange within 2ft. 6in. of the end wall of the boiler-house; they are at the other end taken through the wall into the engine-house, and finish in a flange to which the main steam-pipes to the engines are connected. Other flanges are provided for connecting the steam-pipes for the donkey feed pump, for the injector, and for the mechanical stokers. A Cowburn dead-weight safety valve is placed on the top of the boiler, and this, together with the double-lever safety-valve already referred to, is arranged to blow off when the boiler pressure reaches 130lb. In addition to these, each boiler is equipped with feed and scum valves, and with a Bourdon pressure gauge registering up to 160lb., and a set of Dewrance's water-gauge fittings.

The boilers, of which detailed illustrations are given herewith, are provided with a feed donkey pump of the Worthington horizontal duplex type; it is operated by steam from the boilers, to which it is capable of delivering 2,000 gallons of water per hour. A cast-iron flanged suction pipe is taken from the suction branch, and is connected to the water-tank in the tower, which is supplied with fresh water from the mains of the Grand Junction Waterworks Company. This tank was made by Messrs. Hunter and English, of Bow-road. The delivery from this pump is effected through a cast-iron flanged pipe connected direct to the feed main, arranged along the front of the boilers. The exhaust is either through the general condenser or into the atmosphere. An 8mm. Giffard injector is also provided, the steam supply

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being obtained from the 6in. cast-iron main already mentioned. The mechanical stokers, which are of the McDougall type, are driven by an arrangement of cams and cone pulleys from a countershaft actuated by two small engines, which are also of the McDougall type.

Above the boiler-house is a coal-store capable of holding 100 tons of fuel, shoots being left in the floor so as to feed the hoppers of the mechanical stokers direct. The store is on a level with Occupation-road, and is equipped with a five-ton weighbridge, made by Messrs. Avery and Co., Limited, of Birmingham.

The Engine and Dynamo House.

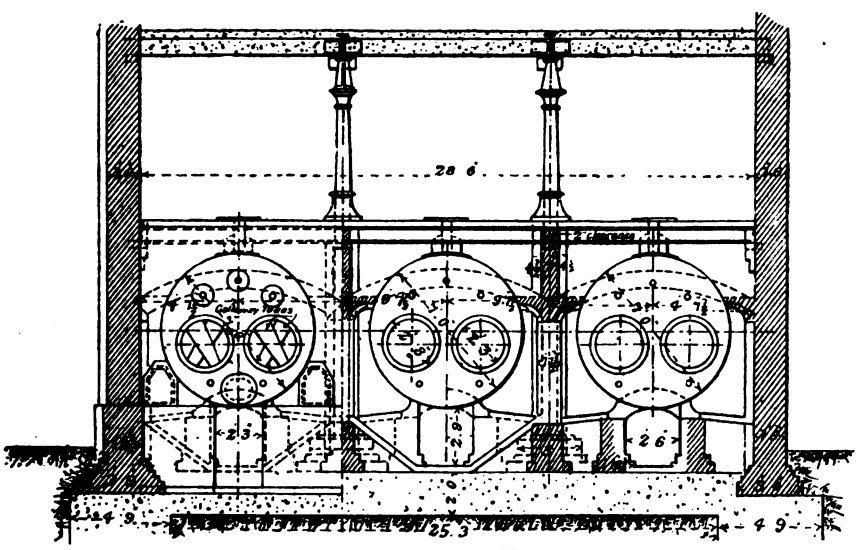
The main steam-pipes in the engine and dynamo room, which receive their supply from the before-mentioned couple of 6in. cast-iron mains, form a complete ring main, having copper expansion joints at the ends; whilst the exhaust pipes are arranged so that the engines can be run at high pressure, exhausting direct into the atmosphere when the general condenser is not in use. These steam-pipes, which are of cast iron, with flanged joints, are below the level of the engine-house floor, and the connecting pipes to and from the engines where they pass above this level are of copper, suitable bends being provided to allow for contraction and expansion.

The whole of the generating plant, comprising engines and dynamos, switchboards, condensing plant, and steam and other mains and pipes in the engine and dynamo room, has been provided under the contract entered into by Messrs. Siemens Bros. and Co., Limited, of Westminster. It is divided into two parts: one for public illumination, and the other for private supply. The plant for public lighting comprises three direct-coupled sets of Browett-Lindley engines, and Siemens constant-current dynamos; and for private illumination, four direct-coupled sets of similar types of engines and Siemens alternators, together with two sets of single engines by the same makers and Siemens exciters direct coupled. The engines and dynamos are laid on beds or piers of concrete surmounted by 18in. of stone.

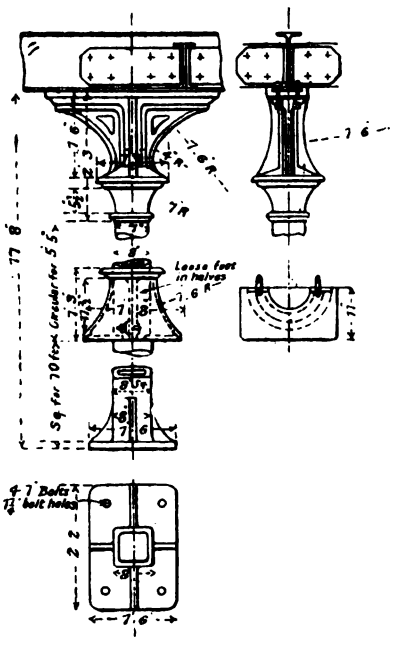
The three engines for public lighting are of the vertical compound condensing type, having cylinders 6in. and 10in., and a stroke of 8in. The crankshaft of each engine has cranks at right angles to each other; at one end it carries a heavy turned flywheel, and at the other it is coupled direct to the spindle of the dynamo by means of a flanged coupling. The engines are of 35 b.h.p., and run at 300 revolutions per minute. The generators to which these engines are direct coupled are Siemens H H D 32/13 dynamos, each giving 10 amperes at 1,800 volts for working a circuit of 40 arc lamps in series. This type of machine has a ring armature revolving in a double magnetic field circuit, and is provided with a regulator which automatically varies the voltage in proportion to variations in the external resistance, and thus maintains the current constant.

The four engines for private illumination are also vertical compound condensing, by Messrs. Browett and Lindley, and are direct coupled to their respective alternators. Two of the sets of engines are of 100 i.h.p., running at 200 revolutions a minute, and having cylinders 10½in. and 17in., and a stroke of 12in. These engines drive two Siemens W 24 alternators having revolving disc armatures and fixed magnets, and capable of giving 60 kilowatts at 2,000 volts at a frequency of 40 periods per second. The other two sets of engines are also of the Browett-Lindley compound type, each giving 50 i.h.p. at 240 revolutions per minute. The engines have cylinders 7½in. and 12in., and the length of stroke is 9in. These engines actuate two Siemens W 20 alternators having each an output of 30 kilowatts at the same pressure and frequency as the larger machines. These alternators are arranged for parallel running by connection with omnibus bars on the switchboard.

There are two exciting dynamos, these being of the Siemens H B 12/16 type, each giving 145 amperes at 66 volts. The output of these two machines is more than sufficient to excite the whole of the alternators simultaneously, they having, in fact, 33 per cent. excess of current over that required for the alternators. They are driven direct at 300 revolutions by two Browett-Lindley single-acting engines, each of 17 b.h.p., having a 8in. cylinder and a stroke of 8in



Cross Section of Boiler House.



Details of Pillars in Boiler House.

The Condensing Plant.

In describing this plant we come to the second novel feature in connection with this undertaking—viz., the use of the sewage effluent for condensing purposes. The condensing plant, which has been manufactured by Messrs. G. E. Belliss and Co., Limited, of Birmingham, is installed in the basement of the engine-house. The arrangement is compact, the air and circulating pumps, which are double acting, being supported on the condenser, and driven direct by a prolongation of the piston rods of the engines. The plant comprises a general surface condenser, to which is connected the main exhaust-pipe receiving the whole of the exhaust steam from the engines. This condenser and its pumps deal with the exhaust steam, not only from all the engines, but also with that from its own steam-pumps, which are vertical and direct acting. The cooling water for this condenser, which, as already mentioned, consists of the sewage effluent from the sewage settling tanks, circulates through the tubes, the steam playing outside them. The condenser has a cast-iron case or cover, and is fitted with solid-drawn tinned Muntz metal tubes ⅝in. diameter of bore 17 B.W.G. thick, secured in planed gun-metal plates. The area of the cooling surface afforded by the tubes, measured on their external face, is 1,500 superficial feet.

(Continued on page 362.)

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EALING.

It may be some of our readers will imagine that too much is made of this comparatively small installation, but it is well to have a complete description of what is to some extent a new departure. Refuse destruction is a phrase to conjure with among municipal engineers. They have, in the first place, to consider sanitary conditions, and from this point of view have to dispose of a large amount of refuse. How to do this safely and economically is the great problem of their lives. Advancing civilisation makes matters worse, in that a larger and larger population is congregating upon a given area. The tendency of modern municipal engineering is to utilise fire for the destruction of this refuse. Now, one of the properties that must belong to a furnace used for refuse destruction is that high temperature reigns supreme and the residual gases leave the furnace at a high temperature, hence there must be a certain amount of heat available for industrial purposes. So far as we know, Mr. W. B. G. Bennett, the engineer to the Southampton Corporation, was the first to make use of this heat to raise steam for the running of dynamos and the providing of electric light. Since his experiment many minds have been directed to the question, and in various places dynamos are run in connection with refuse destructors. Ealing, however, is the first authority to systematically tackle the question in its public lighting arrangements. Its engineer, Mr. C. Jones, is recognised as an expert upon all that pertains to refuse destructors, and no doubt his views mainly directed his authority in coming to the conclusion they have done. Mr. Jones is nothing if not progressive, and from an engineering point of view it would be difficult to find a suburban district more carefully looked after. The consulting engineers, Messrs. Bramwell and Harris, as will be seen from the description of the station, have accepted the idea of using the waste heat from the destructors as an aid to direct heating, and the experiment will be anxiously watched by the many engineers who have or will have the control of destructors. What the money value of that aid will be is a matter time alone will determine, but no doubt there will be an appreciable saving in coal, and again in using the sewage effluent for condensing purposes. It seems to us, then, that the Ealing station has some novel features worthy of close attention from the very first day of work. We have often heard Mr. Jones express his belief in works, not words, and as crediting actual results rather than theoretical conclusions. Time must show if the anticipations at Ealing are to be realised in practice.

INDIRECT ECONOMIES.

The statement of Mr. Whiteley as to the saving of £500 a year in less paint and whitewash by using the electric light must be taken for what it is worth. At any rate, even if the saving hardly reaches this figure, there is little doubt but that in large establishments of the kind the indirect saving must be

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considerable. Seldom do those who advocate the retention of gas admit of any except a direct comparison with gas as to cost. This is not fair as regards electrical work, for in many cases the indirect saving must be of paramount importance, and this must be considered in ascertaining the actual cost. Gradually this view of the case is being better understood, and as the result more householders are asking about the light. Thus while there may be no fear, even when the result is cost for cost, the inducement should ever be held out that the indirect benefit ought to ensure the installation of the newer illuminant.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE ETIQUETTE OF JOURNALISTIC ELECTRICAL ENGINEERING.

SIR,—Probably no one takes the leaders and notes in the *Electrical Review* seriously; unless one has plenty of time on one's hands, one usually skips both. They are generally written in a somewhat grandmotherly style, occasionally tempered by the acidity often attendant on the stage known as coppy and surly. Still, it is somewhat startling to find the *Review* claiming immunity from criticism for an inventor who is introducing a new apparatus, on the ground of the unwritten law of etiquette that rules with engineers. One feels tempted to asked whether the editors of the *Review* consider themselves engineers, or on what ground they claim to be freed from this etiquette? No technical journal more frequently disregards even the ordinary courtesies that should rule between the strongest opponents, or claims greater license for itself.

Is one at liberty to criticise an apparatus that an enthusiastic inventor wishes one to purchase? If one is a partner in a firm that is asked to take up some new apparatus, does this mysterious etiquette bar one from giving one's reasons for one's judgment, or should the enthusiast be allowed to exhaust his arts upon a silent audience? If one is a shareholder in an industrial concern in which there are few having any knowledge of some particular apparatus that the concern is desired to adopt, is one not to give one's fellow shareholders the benefit of one's knowledge; or should one keep silence and meekly pay one's share in case of failure? And what is a ratepayer of any particular town but a shareholder in the town and in the undertakings that may be entered into by the governing body of the town? And when, as too often happens, no one on the town council possesses the smallest knowledge of a new undertaking that is being carried out, is not any ratepayer possessing knowledge of the subject really performing a duty to his fellow townsmen in criticising the work, both in its inception and progress? Of course it is annoying to an inventor who can see no difficulties in his path that he cannot easily overcome, as he thinks, and who is accustomed to treat large sums of money as of no consequence so long as a certain object may possibly be accomplished, to have possible sources of failure pointed out. Supposing that by timely criticism a large sum of money may be saved to the ratepayers, is some abstruse theory of etiquette to cause the expert to withhold the information at his command?

But perhaps the strangest point of all in this odd claim set up by the *Review* is that in another part of the paper the same writer claims for himself—and freely exercises it, too—the right to criticise everything and everybody, and severely lectures members of the medical profession, in the good old motherly style peculiar to him, for not supporting him in a crusade he has undertaken in a matter in which he has no concern beyond the general interest taken by all who are electrical engineers in everything connected with electricity.

Some weeks since the *Review* devoted two and a half columns to criticising some remarks of the present writer's in a local paper. Where did this mysterious etiquette come in then? The present writer was solemnly warned against the danger of a little knowledge, and the bad end he would undoubtedly come to if he persisted in using his little knowledge; yet, apparently, the etiquette—was it of journalism or this unwritten one of engineers?—did not allow the editors to reply when their arguments were shown to really prove the points the present writer had brought forward.

Would it not be as well for the editors of the *Review* to study courtesy in their own columns and in the work of their own pens, and leave such mysterious etiquette to take care of itself? Do they not see that while they themselves are claiming the fullest freedom in their criticisms, they are doing their little best to stifle criticism in others?

Yours, etc.,
SYDNEY F. WALKER.

A DEFINITION OF E.M.F.

SIR,—It is indeed astonishing that no author seems to define in a really unobjectionable manner a so fundamental conception as that of E.M.F. The general use of defining it as a difference of potentials is a more or less misleading one, for an E.M.F. may exist even without a difference of potentials, and sometimes it cannot be reduced to that form by opening the circuit. Moreover, such a definition is circuitous—it explains an unknown thing in terms of an equally unknown and not very different one.

Very abstruse and unpractical is the definition of E.M.F. as the line-integral of the electric force, and it leads to uncertainty in some cases; it is inelegant, as being founded on a preliminary electrostatic knowledge, which is rather extraneous to the understanding of electrodynamical phenomena. Profs. Anthony and S. P. Thompson define E.M.F. on purely dynamical base, but in too vague terms, for they do not give any means of reckoning the quantity defined.

I think a proper definition of E.M.F. may be expressed in the following terms, with no other previous knowledge supposed, except that of electric current (quantity of electricity naturally follows, being the product of the current into time.)

Every current flowing in a circuit has always to overcome some oppositions, because in its flow it always generates some kind of work; therefore, it cannot be maintained unless some exterior factors, acting on the circuit, assist the flow by supplying to the current the energy it is spending elsewhere. Everyone of these agents is called a source of E.M.F. It is incorrect to speak of them as sources of electricity, because electricity, like matter, cannot be generated or destroyed, but only set up into circulation.

A source of E.M.F. applied to a circuit is therefore everything that forces or tends to force electricity into a certain motion along the same, and in so doing it necessarily impresses a power when this motion really takes place. The strength of the source, or its capability of determining the flow of electricity, is properly reckoned* by the work it is doing when a unit quantity of electricity is displaced along the circuit, or by the ratio of its activity, K (*i.e.*, power, or rate of doing work), to the intensity, C, of the current flowing at the same time. To this value $E = \frac{K}{C}$, we give the name of E.M.F.

Similarly, every opposition raised against the current is called a source of counter E.M.F., or of negative E.M.F.; for it has a negative activity, and absorbs power from the circuit. It is to be understood that a source of E.M.F. is not necessarily an external one, for the work given out may be supplied from the energy stored in the current itself. Therefore, the impulse given to the current by a diminution of the stored energy is to be accounted for as an intrinsic E.M.F., and the opposition raised by its increase, as an intrinsic counter E.M.F.

The above definition holds true in every case, and it presents no difficulty to be understood. It enables us to write down easily the equations of current in every circuit, as a consequence of the conservation of energy.

* I think no difficulty will be found in this assertion; if so, it could easily be proved.

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Thus, knowing the work done by a current, c, in a voltameter during a time dt is $p\,q\,c\,dt$ (where p is the electrochemical equivalent, q the specific energy of formation of the electrolyte), we see immediately that the counter E.M.F. of the voltameter necessarily equals $e = \frac{p\,q\,c\,dt}{c\,dt} = p\,q$, according to a well-known law.

The term E.M.F. is not, as claimed, an unfortunate one; on the contrary, it is properly chosen in perfect harmony with the most scientific terminology of modern dynamics. Indeed, according to the generalised theory of Lagrange, in every system whose actual condition depends upon the values of n variable quantities, we mean by "component *force* applied by an exterior agent to the element x" the energy communicated by this agent to the system per unit increase of x, when the other variables remain unchanged.

In a linear circuit the only variable is the quantity, q, of electricity displaced along it, and the energy impressed by an exterior agent per unit increase of q is what we have termed E.M.F. Of course, not all forces are of the same kind. An electromotive force and a Newtonian (or ponderomotive) force are of a quite different nature, for the one acts on electricity, and the other on matter; but the *work* done by the one in displacing electricity, and by the other in displacing matter, are absolutely of the same kind, and may be expressed in terms of the same units. It is the capability of generating a work, measurable in ergs, which enables us to assign to something the character of a force.

Yours, etc.,
G. GIORGI.

Rome, September 17, 1894.

THE ELECTRICITY WORKS AT EALING.

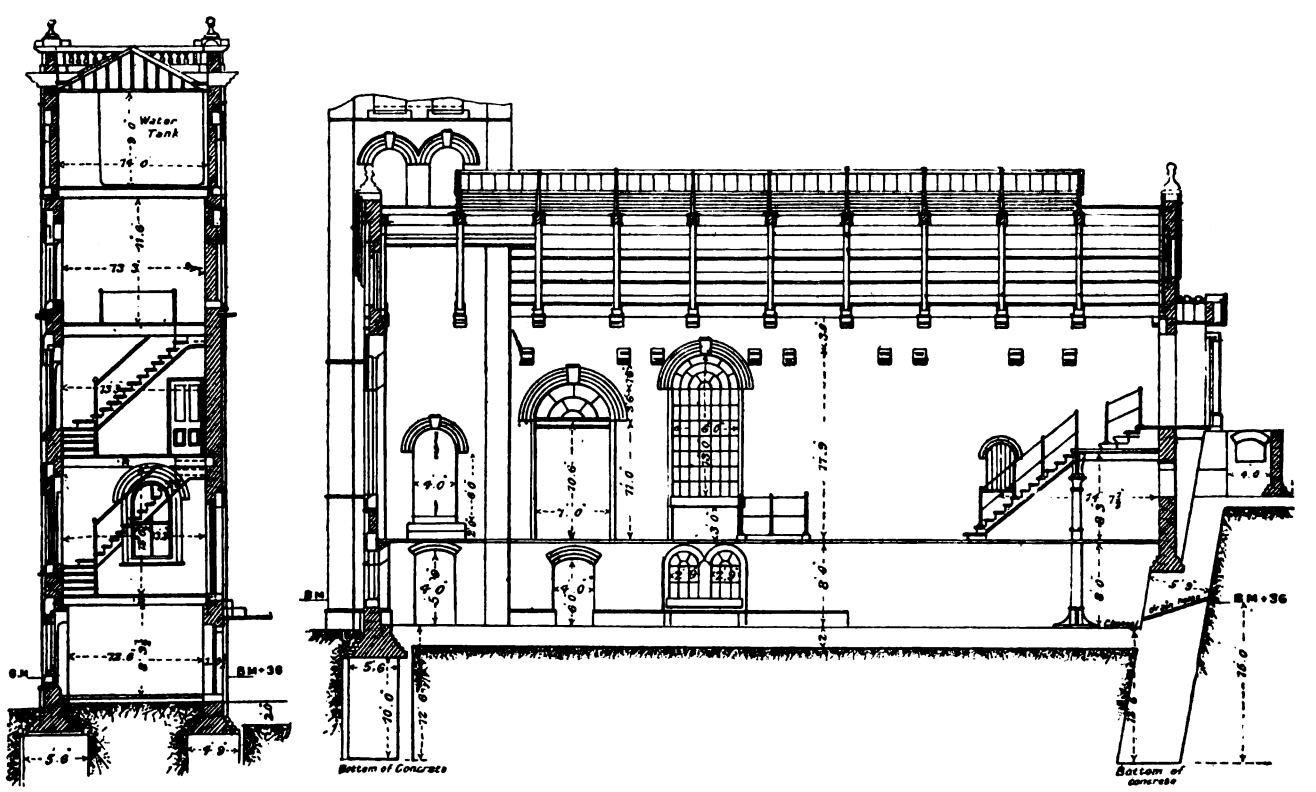
(Continued from page 359.)

The circulating pump suction and delivery pipes are connected to the sumps in the effluent outfall passing through the works. The air-pump suction is connected to the condenser, and its delivery is connected to one of the side plates of a cast-iron close-topped tank or hot-well 4ft. square internally, placed on the floor of the coal-store above the boiler-house. This tank is constructed of six cast-iron ribbed plates, with planed flanges bolted together, and is provided with a planed facing cast on one of these plates to take the flanges of the suction pipe to the boiler feed pump; and with a planed facing on the top plate to take a 4in. wrought-iron open top standpipe, which is sufficiently long to pass through the roof of the boiler-house, delivering there into the roof gutter, and with a facing to take a 3in. cast-iron overflow pipe. Arrangements are provided for emptying this tank when desired.

The placing of the generating plant in position has been facilitated by the employment of an overhead traveller, made by Messrs. Marshall, Fleming, and Jack, of Motherwell. This traveller, which has a span of 35ft., runs on wheels carried on rails secured to stone corbels built on the side walls. It consists of two 12in. by 6in. by 6in. rolled steel joists, trussed underneath, these joists having upon them a four-wheeled travelling carriage supporting an eye for the hook of a self-supporting half-chain pulley block. The traveller is also equipped with traversing gear, so that it may easily be moved the whole length of the engine-house. A plan, elevation, and cross-section of the traveller are annexed. The makers have supplied travellers for other central stations in the kingdom.

The Switchboard Arrangements.

The main switchboard, which is arranged on a stone platform at one end of the engine-house as shown, is divided into two parts. The part on the left-hand side controls the machines and arc light circuits, and that on the right carries the switches, ammeters, and fuses for the seven high-tension feeders. In a future issue we hope to illustrate and describe the board in detail. For the present it may be mentioned that a separate enamelled slate panel is provided for each alternator and feeder. Each of the four panels to the extreme left controls one alternator, and is fitted with a voltmeter, ammeter, two fuses, a double-pole main switch, a switch for breaking the field through a non-inductive resistance, and a field regulating switch. The four field regulating switches are geared together, so that the voltage of all the machines can be raised at the same time, or, when required, each machine can be varied separately by disconnecting the gear. On the panel, to the right of these four alternator panels, is mounted the apparatus for controlling the two exciters; each exciter is furnished with an ammeter, voltmeter, pilot lamp, double-pole main switch, which is interlocked with a field switch, a field regulating switch, automatic cut-out, and two fuses. This panel also contains a double-pole switch and two fuses for the station lighting current, which is supplied by the exciters, and synchronising apparatus, with switches to put the synchroniser on the omnibus bars and on to any machine. The next panel controls the constant-current arc



Longitudinal Section through Engine House.

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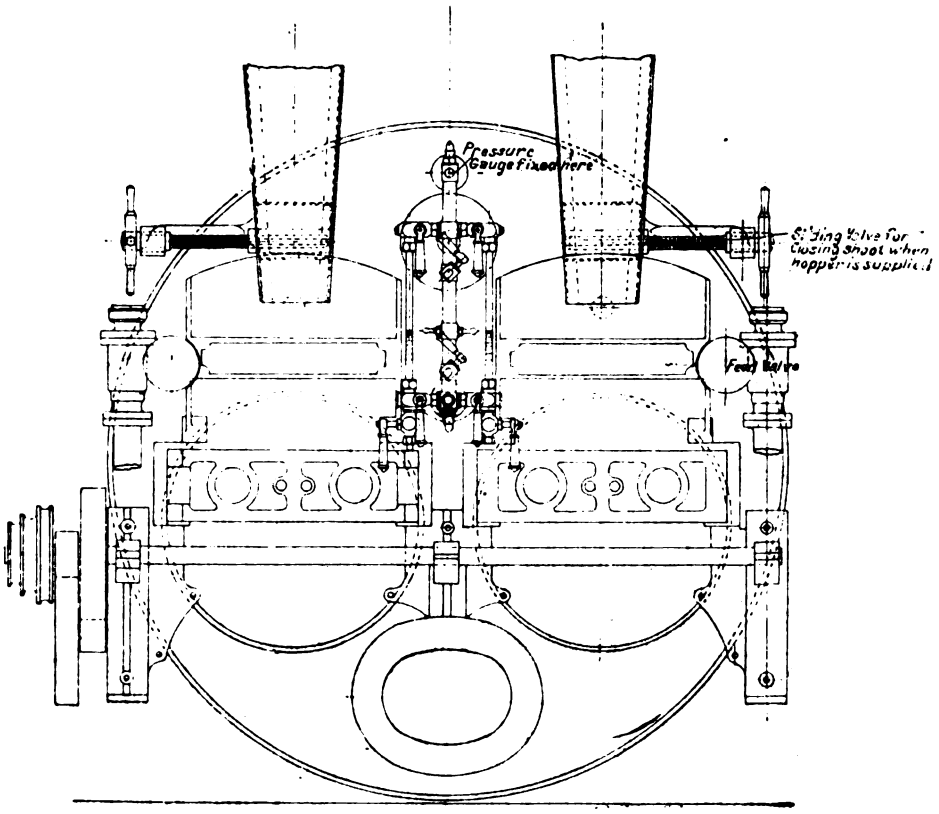
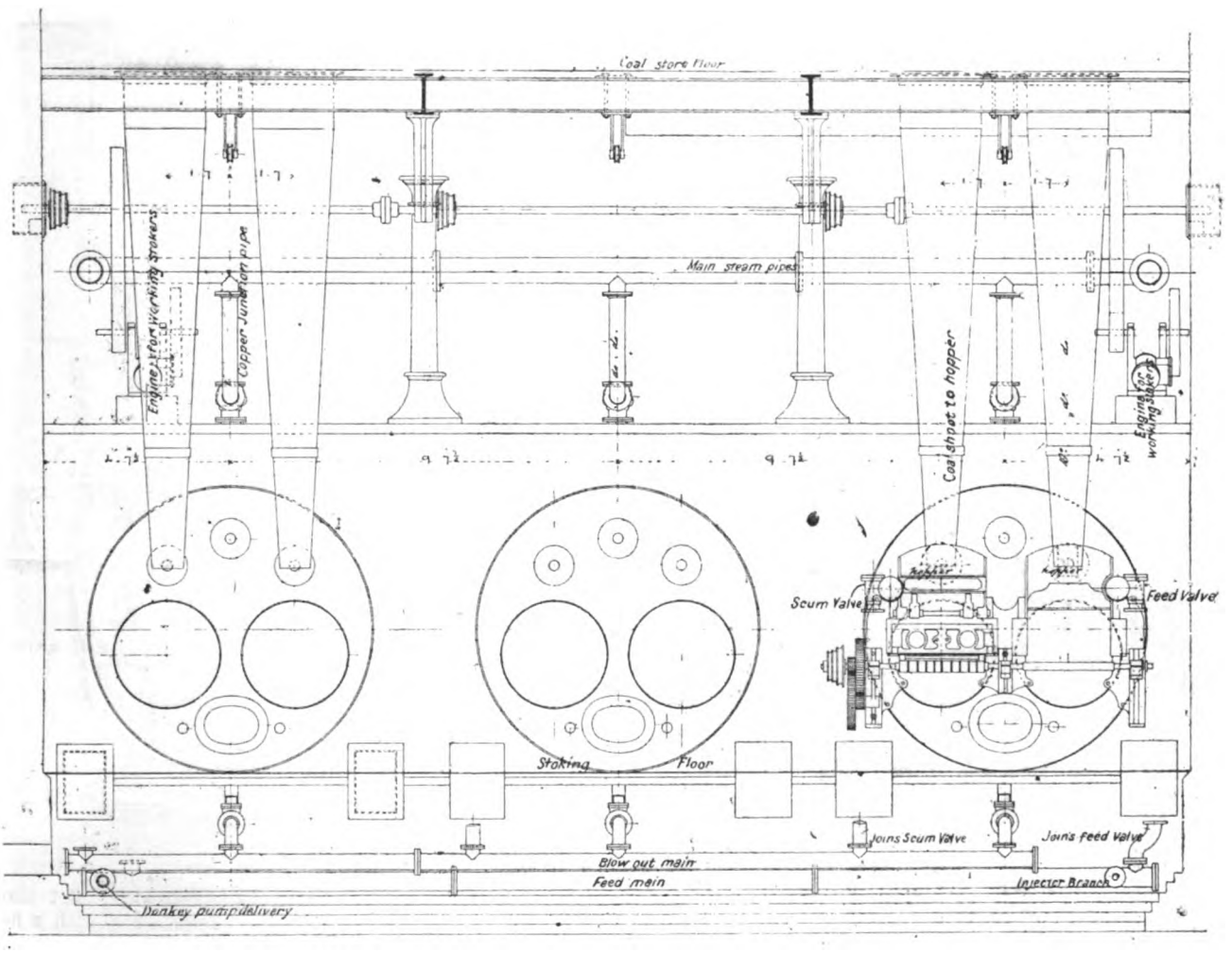
lighters and circuits. It carries for each of the three machines an ammeter, voltmeter, a switch for short-circuiting the field, and a switch for connecting the machines to either of the arc light circuits. Two multiple-way switches are arranged below the feeder panels for connecting the two pilot voltmeters at the top to the various feeders on the other part of the switch-board. The cables for the electrical connections are carried on the rolled joists supporting the engine-house floor, the mains being placed under this floor except where they turn upwards to connect with the dynamos or switchboards.



Elevation of Boiler Front.



Front Elevation of Boilers.

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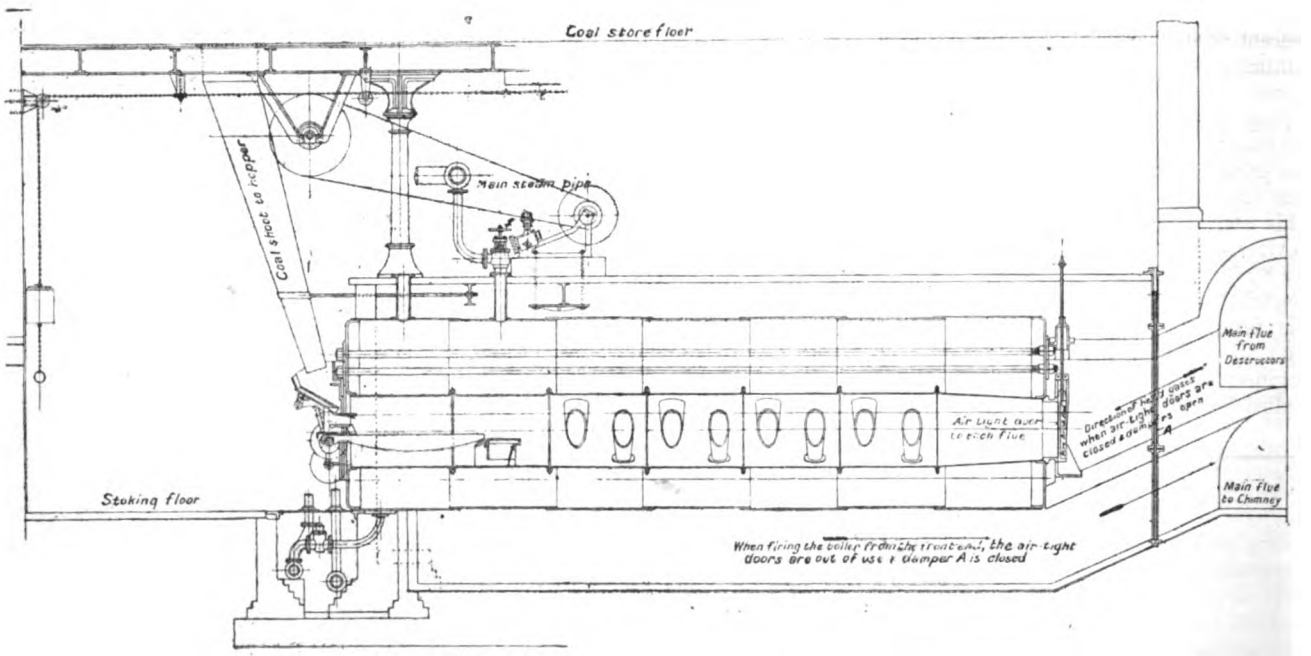
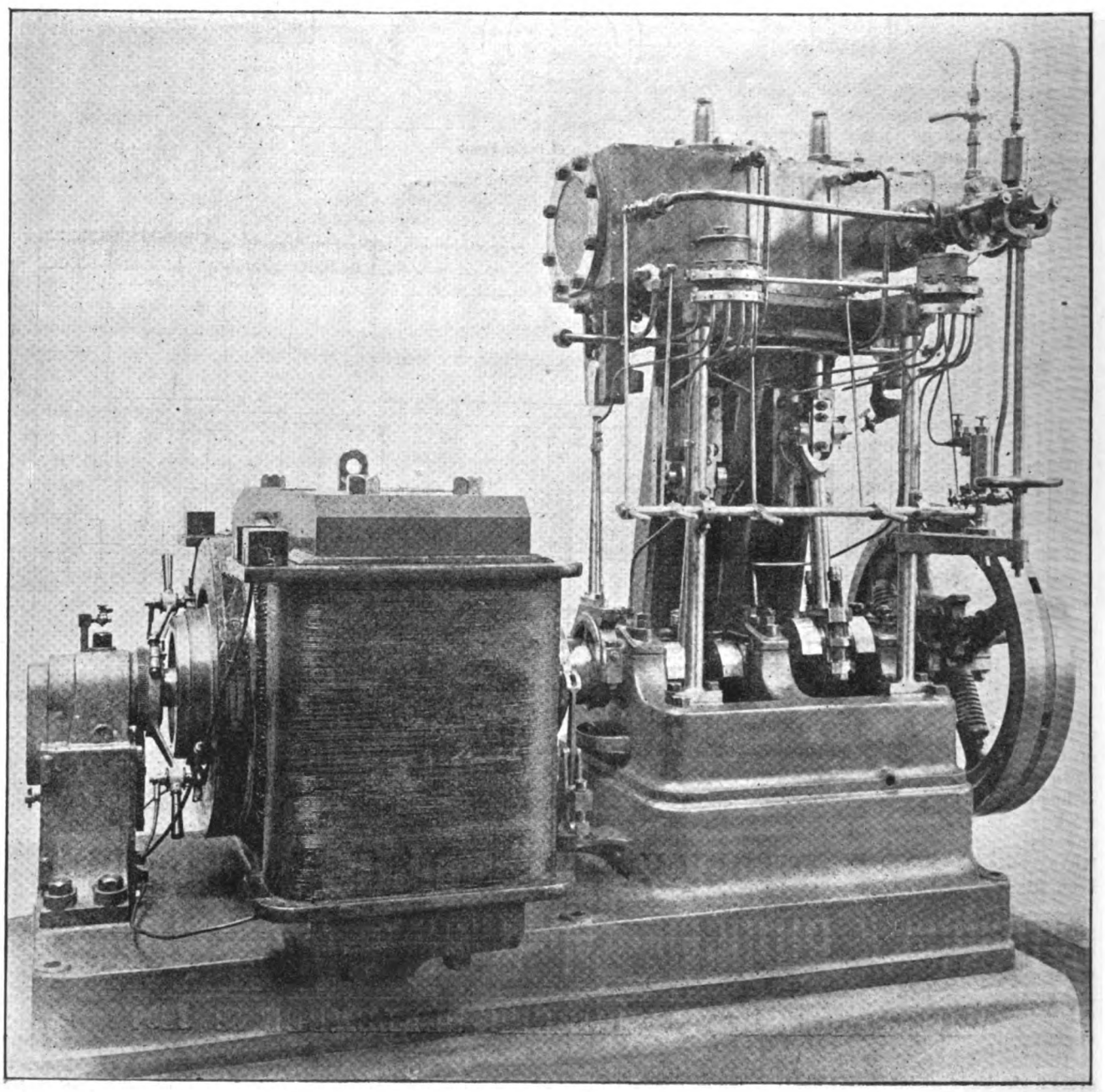

Coal store floor
Coal shoot to Hopper
Main steam pipe
Main flue from Destructors
Air light over to each flue
Stoking floor
Main flue to Chimney
When firing the boiler from the front end, the air-tight doors are out of use & damper A is closed

Longitudinal Section of Boilers showing Coal Shoot to Hoppers, etc.



Direct-coupled Siemens Arc Light Machine and Browett-Lindley Compound Engine.

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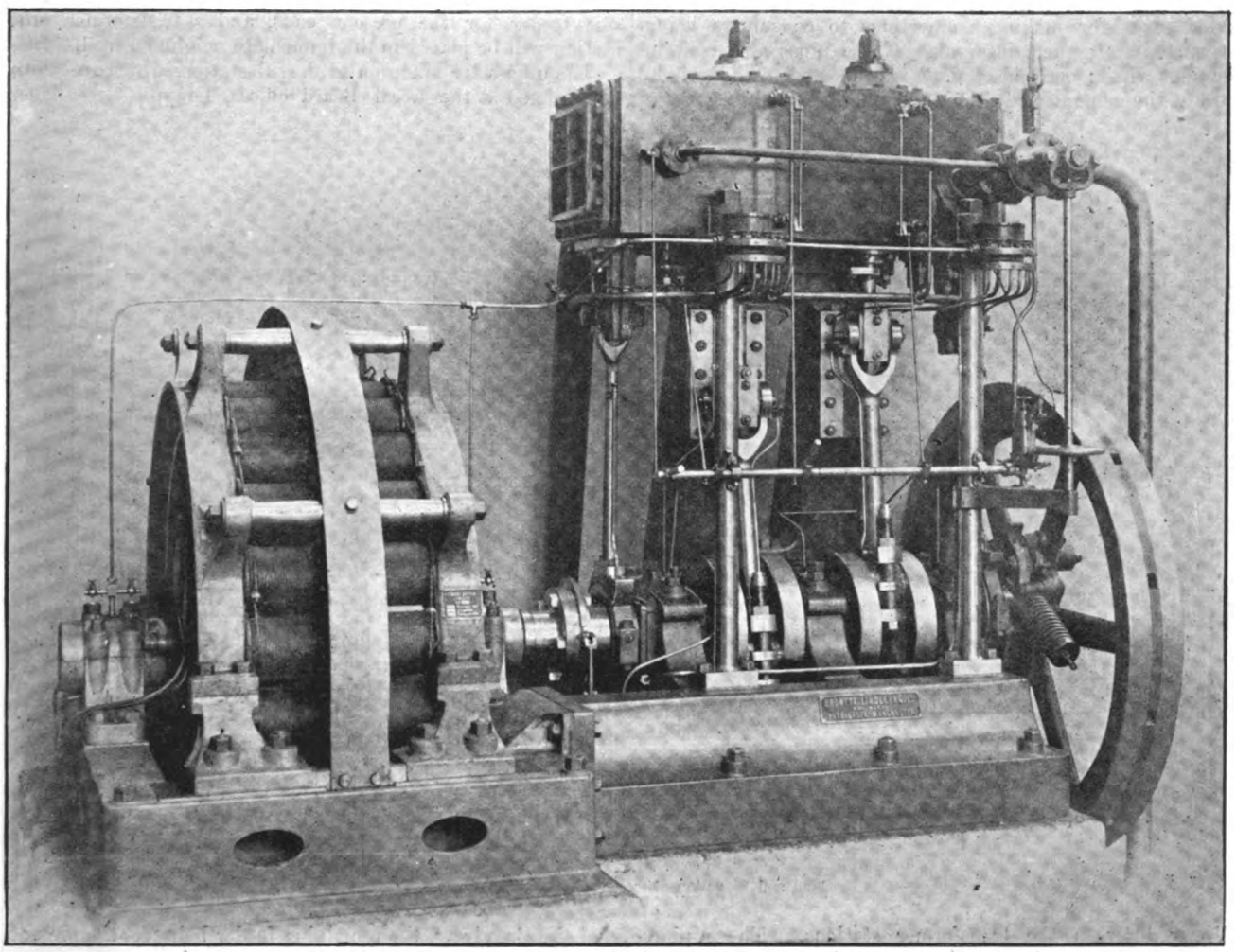
The arc lamps in the sewage and electricity stations are fed from the direct current of the exciters, whilst the incandescent lamps are on the alternating-current circuit, thus minimising the probability of all lights being out in the station in case of breakdown of any machine. For the purpose of supplying these incandescent lights a pair of leads is taken from the board to the engine-house basement, and there connected to the primary circuit of a transformer contained in a cast-iron case supported on brackets secured to the engine foundations. This converter, which is fitted with the necessary earthing devices, transforms from 2,000 volts to 100 volts the current for 80 16-c.p. lamps for the illumination of the sewage works, electric light station, and premises generally. The leads from the terminals of the secondary circuit of this transformer pass to a switchboard placed in the office of the resident engineer, where the lighting of the combined works is controlled by three switches.

underground, at a depth of 2ft. 6in., have a sectional area of copper of ·0225 square inch in each circuit. The arc lamps, which are of the Brockie-Pell type, made by Messrs. Johnson and Phillips, of London and Charlton, are capable of burning for 32 consecutive hours without the necessity of being retrimmed, and taking 10 amperes at from 45 to 50 volts. The arc lamps are suspended at a height of 24ft. from the ground by means of brackets arranged at the top of iron standards, rising 27ft. from the ground level, and cast by Messrs. A. Handyside and Co., of Derby and London.

The Feeder and Distributing Method for Private Lighting.

The "feeder" mains passing out of the generating station at the "main outlet" for the transmission of the high-pressure alternating current to the primary circuits of the transformers are also of the concentric lead-covered armoured



Direct-coupled Siemens Alternator and Browett-Lindley Engine.

The Distributing System for Public Lighting.

Another noticeable feature in connection with the Ealing electricity works is the number of public arc lamps placed in Uxbridge road, the Broadway, High-street, the Green, down to St. Mary's Church, and thence down the South Ealing-road to the generating station. The whole of the work in this direction, as also in the case of supplying and laying the feeders and distributing mains, junction-boxes, etc., for the supply to private consumers, has been undertaken by Callender's Bitumen, Telegraph, and Waterproof Company, of 101, Leadenhall-street, E.C., as previously mentioned. The lighting of these thoroughfares is accomplished by means of 70 10-ampere arc lamps arranged in series and energised from two circuits, the length of each of which is 7,000 yards. These lamps are arranged on alternate circuits, so that in case of accident to one circuit the lamps on the other are still available.

The arc light mains are concentric, lead covered and armoured, have an external waterproof covering, and are laid directly in the ground. These mains, which are laid

type, and similarly to those for the public supply, so also are these placed direct in the ground at a depth of 3ft. There are five feeder circuits, each of which has a sectional area of copper in each main of ·352 square inch, but provision has been made for two more. These mains have an insulation resistance of at least 1,500 megohms per mile at 60deg. F. and between conductor and conductor, and 750 megohms between the outer conductor and earth.

There will eventually be at least six transformer stations, as shown on the map of the compulsory area, but at present only five have been provided. At these stations the 2,000-volt current is transformed down to 102 volts. One of these is situated in the public buildings in Uxbridge-road, where are installed two Siemens converters, each of 21 kilowatts capacity, and capable of supplying some 600 lamps of 8 c.p. Three of the other transformer stations will be arranged in the base of three of the arc light standards. Each transformer-box is equipped with Cardew earthing devices with proper earth-plate. The connections for each transformer-box from the feeder mains to the primary circuit of the transformer, and

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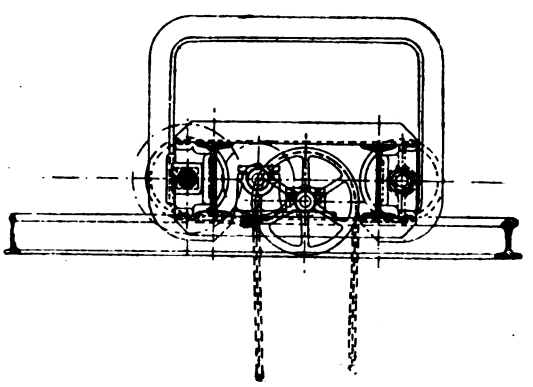
from the secondary circuit to the distributing mains, are brought through a separate underground box containing the necessary resistance and fuses, and by means of double-pole switches any one transformer may be put out of work, either through its primary circuit, secondary circuit, or both together. By this arrangement it will be evident that it is not necessary to open the transformer-box to cut out any converter, etc.

The distributing or service mains passing out of these transformer stations are insulated with vulcanised bitumen, taped, braided, and waterproofed, and are connected to the secondary circuits of the transformers and to each other so as to form a complete ring distributing main, in a manner similar to that which is in such successful use in the Derby installation. From these mains the connections to the customers' wires are made. These mains, which have a sectional area of copper of ·428 square inch, carry the low-pressure 102-volt current. They are laid underground in earthenware drain pipes at a depth of about 2ft. 6in., service boxes for making connections to consumers being constructed at frequent intervals. These pipes also contain four pilot wires; one end of these is connected to the switch-board at the generating station, and the other end to a point half-way between the transformer stations. These pipes range from 4in. to 6in. in diameter, and are socketed and jointed in Portland cement mortar. In a few cases, however—*i.e.*, where the pipes are laid beneath roadways—cast-iron socket pipes of the same diameters are used.

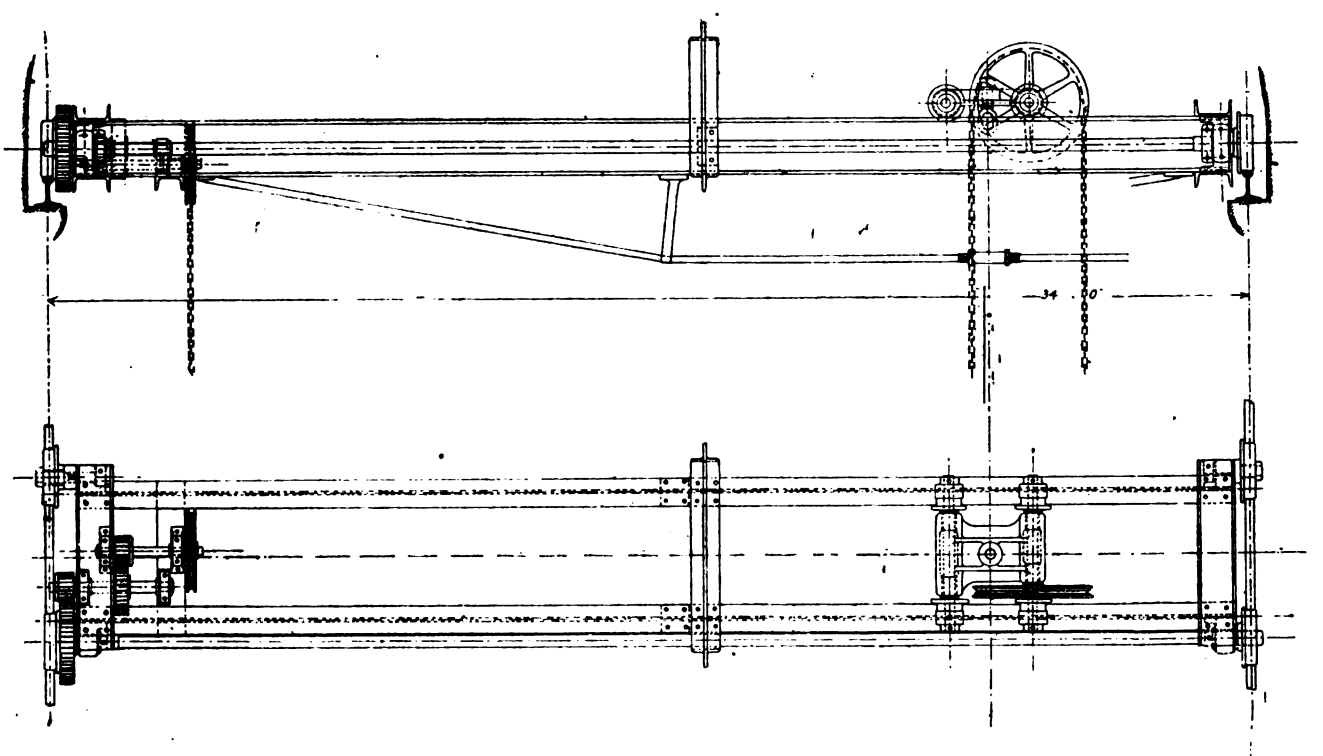


Section of Overhead Traveller.

So far as the mains are concerned, we may enter into a few more details. The entire contract outside the central station was placed in the hands of the Callender Company, and it includes not only the underground mains, but also the lamp-posts, arc lamps, and the various accessories required for the proper working of the apparatus.

The mains are of three classes—one to carry the high-pressure current to the various transformer sub-stations, known as feeders; a second for use on the arc lighting circuits; and a third to supply the consumers with a current of electricity at low pressure, this network being fed into at frequent intervals by the transformers. The feeders consist of lead-covered concentric cables with a dielectric of bitumenised fibre. The lead sheathing is served with a coating of yarn, then armoured by a double layer of steel ribbon, yarned over all, and finally waterproofed. Special precautions have been taken both in the manufacture and laying of these cables to ensure their long life and freedom from injury. They are five in number, and are laid in one trench from the generating station at the southern sewage works, along South Ealing-road and St. Mary's-road to the Greenview Corner. Here one feeder for the present ends, and a transformer sub-station will be placed in the immediate neighbourhood.

The others are taken on to the sub-stations which are being constructed at the Local Board offices, Drayton Green-lane,



Plan and Elevation of Overhead Travelling Crane.

and the Broadway, the remaining feeder being for the present left at the Feathers Hotel for future extension.

For the arc lighting, two concentric cables have been laid in the same trench as the feeders. These are exactly similar in manufacture to the feeders, and are laid along South Ealing-road, St. Mary's-road, and the High-street to the Broadway, and branching there east and west, will be carried without delay to the Acton and Hanwell boundaries. The feeder and arc cables are supplied in 500 yards lengths, and joined throughout in Callender's special cast-iron boxes for concentric work. About seven miles of feeder cables and six miles of arc cables are being laid.

Of the 70 lamps to be put up, one-half is now in position. These are connected alternately to either main by means of branches taken out of boxes specially designed for this work. Brockie-Pell lamps and switches are being used, and a new form of carrier has been got out for the Ealing contract. The lamp columns, as already stated, have been cast for the Callender Company by Messrs. Handyside.

The distributors consist of pairs of cables, the type of which is so largely used for low-tension work all over the country. These are drawn for the most part into 4in. pipes, stoneware under footways, and

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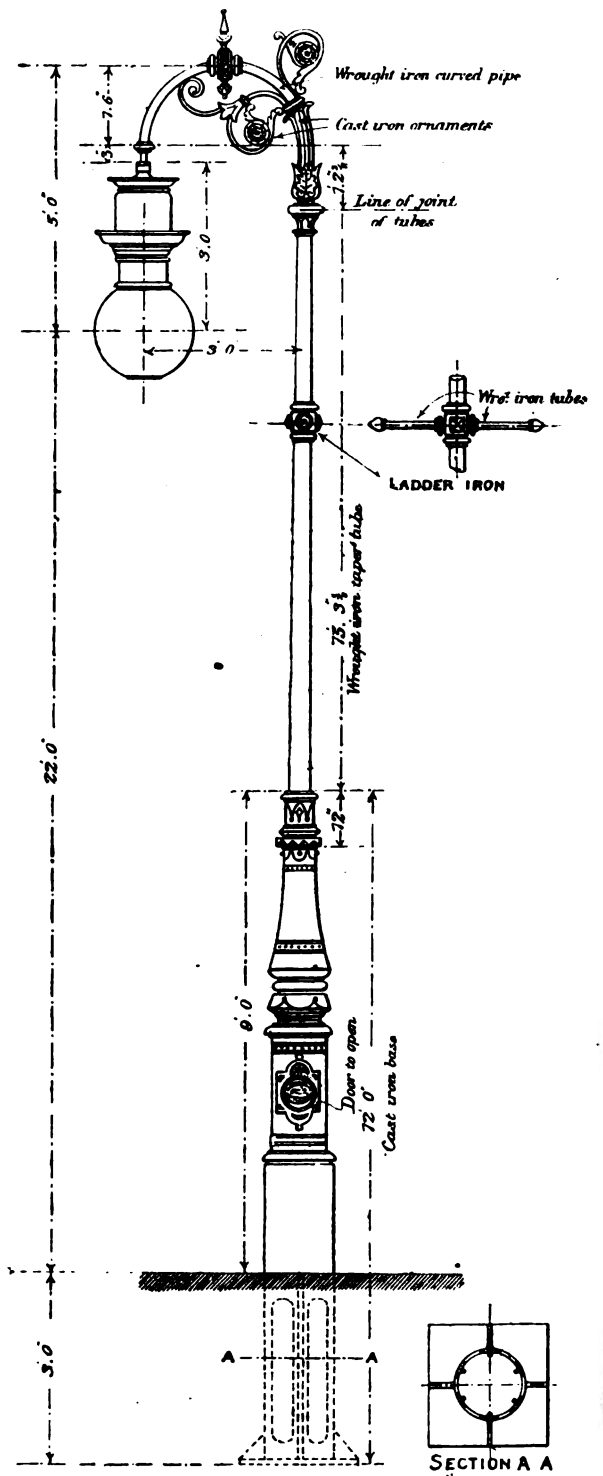
iron under the roadway. In the Uxbridge-road, however, where the mains are laid for nearly a mile under the roadway, 6in. cast-iron pipes are provided for the distributors. Brick pit boxes are constructed on the pipe line at suitable intervals, as is usual on a drawing-in system. The roadway manhole covers are Brown and Wood's patent, and the footway covers are of the Callender type.

The house connections are made by inserting a small brick pit on the pipe line and running a branch pipe from it into the consumer's premises. The service cables are connected to the distributing mains by joints thoroughly insulated.



Elevation of Arc Lamp Standard.

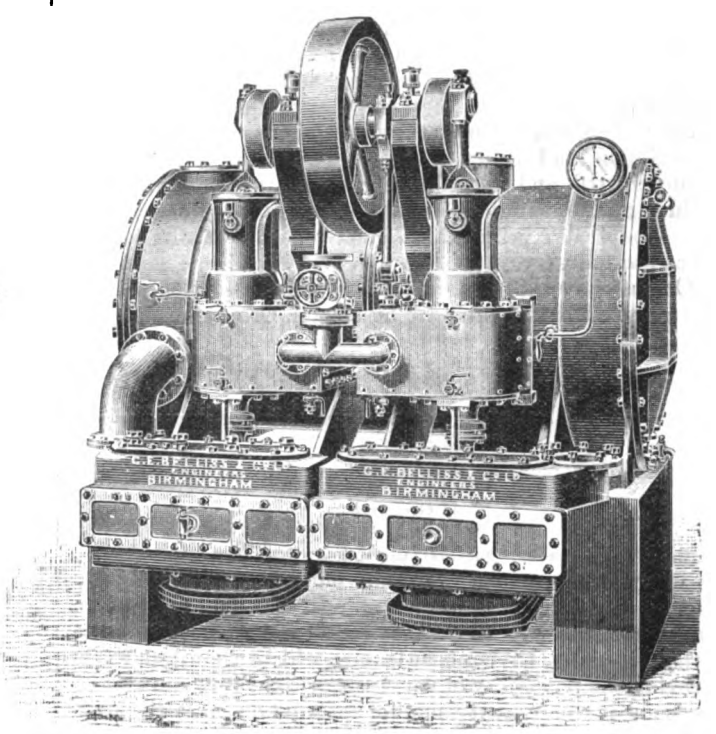
In addition to the electric light mains, a complete system of telephones with metallic circuits has been put down in the same trenches to connect the fire station with various points. These cables are lead covered and armoured, and are laid direct into the ground, branch boxes being provided to connect up the different buildings. This part of the work was commenced under the superintendence of Mr. H. Schiassi, and is being completed by Mr. F. E Procter for Messrs. Callender.

Lighting of the Public Buildings.

The work of wiring the various public buildings owned by the Local Board has been undertaken by Messrs. Paterson and Cooper, of Dalston, N. A portion of these buildings is centred in the structure in the Uxbridge-road, embodying the Public Offices, Victoria Hall, and the Public Library, whilst the remainder comprises the Baths, Fire Station and Stables, and the Fever Hospital, the latter being situated some 180 yards distant from the generating station. In each case the connections from the Board's supply mains to the interior of these buildings have been executed by the Board, who have also provided the main cut-outs and meters for measuring the current used. The contractors' work has been to wire the buildings in question, and to provide the main and branch switchboards, instruments, pendants, and fittings, and to adapt the existing gas fittings in certain cases.

Conclusion.

As already stated, the streets in the compulsory area are lighted by means of 70 arc lamps, and the number of applications sent in by private consumers for lamps is already equivalent to about one-third of the possible output. The charge for current to the public is 6d. per Board of Trade unit for lighting purposes and 4d. per unit for motive-power purposes, the current used being measured through Shallenberger meters. The local gas supply is furnished by the Brentford Gas Company at 3s. 3d. per thousand, and at this rate the inhabitants of Ealing should find it advantageous, both from the point of view of a superior illuminant and from that of a light which is more healthy, and not destructive to wall papers, ceilings, curtains, books, and other household effects, as is the case with gas lighting, to discard gas and substitute the electric light. The sooner the Ealingites take up the whole output of the station, which, as mentioned in the early portion of this description, has a capacity of 5,000 8-c.p. lamps, the better will it be for them directly and also indirectly by allowing the profits of the undertaking to be devoted either towards local improvements or to the relief of the rates. There is every prospect of this period being almost immediately reached, and of extensions of the generating plant being required.



Belliss's Horizontal Condenser.

In concluding this article we must congratulate Messrs. Bramwell and Harris on the thoroughness with which the Ealing electricity works have been designed, equipped, and brought to the present position. Not only this, but the boldness and strikingly original characteristics of the works reflect great credit upon them, and also upon the Ealing Local Board, advised by their engineer, Mr. Jones, who had the courage to adopt and introduce a scheme possessing such

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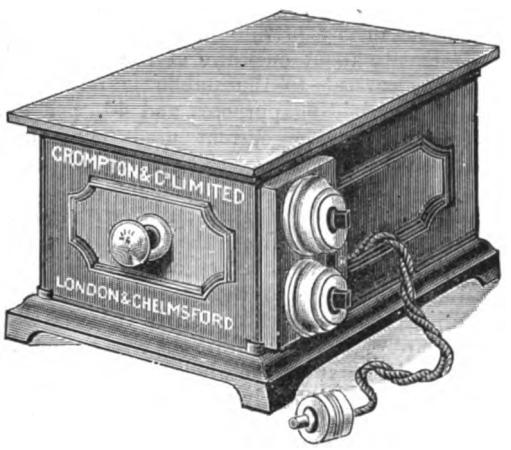
novel and interesting features as are embodied in the electric light station now set in operation. Our thanks are due to the consulting engineers for the plans and information placed at our disposal; to Mr. Ford Moore, their superintending engineer at the works, for his kind assistance; and also to the firms who were engaged in the different parts of the works now completed. The only remark necessary to terminate this article is to tender our best wishes for the success of the undertaking, and to hope that the extensions now foreshadowed may speedily become necessary.

ELECTRICAL EXHIBITION AT EALING.

An electrical exhibition in connection with the inauguration of the electricity works of the Ealing Local Board, of which a fully illustrated description is given in another part of the present issue, will be opened in the Victoria



Breakfast Cooker.

Hall, Uxbridge-road, on Wednesday next, and will be continued for 10 days. Apart from the exhibits made by various firms in the practical applications of electricity in the directions of lighting, heating, and working, and for motive power purposes, interesting attractions will be provided by demonstrations of the electrophone, the phonograph, search-light, and lectures. A large attendance of the public is anticipated, and the exhibition should not only result in inducing the inhabitants to take up a supply of electricity, but should also bring about good business results to the electrical industry.

One of the most novel features of the exhibition will be the electrical buffet, provided by Messrs. Crompton and Co.,

Electric Frypan.

Limited. The catering department here will be supplied with heat for cooking and warming purposes exclusively by electricity. This is the first instance that we aware of in which electricity has been used for such a purpose. Large urns, hot-plates, hot-cupboards, etc., will be shown at work, proving the possibility of using electric cooking apparatus, as made at the present time, for catering on a fairly large scale. The absence of smell from the usual gas arrangements and of danger of fire will be noticeable features.

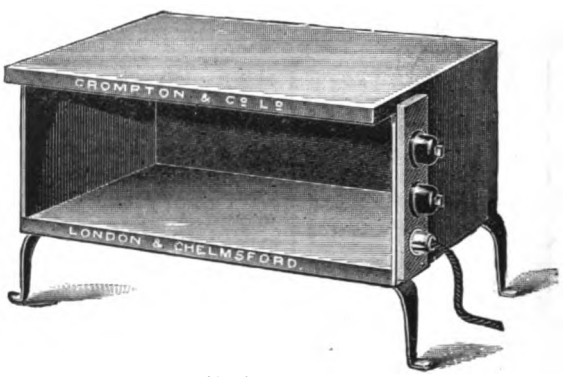
Messrs. Siemens Bros. and Co., Limited, of 12, Queen Anne's-gate, S.W., who have been prominently connected with the electrical plant for the Ealing central station, will show an assortment of samples of cables for laying underground, and samples of indiarubber wires for housework. In addition to these, a display will be made of a variety of switches, cut-outs, dry batteries, etc.

Mr. Harry South, of 10 and 12, Garrick-street, Covent Garden, W.C., will demonstrate a collection of high-class electroliers, brackets, standards, etc. These goods are made in London, and are highly finished with particular attention to detail.

Messrs. Crompton and Co., Limited, of Mansion House-buildings, E.C., and 148, Brompton-road, S.W., who will demonstrate the latest applications of electricity for domestic use, will make a prominent feature of their

Electric Hot Plate.

electric heating and cooking appliances, from electric kettles and saucepans to electric ovens, similar to those that will be used to cook the dinner on the opening night. Some of these appliances are illustrated herewith. The



Hot Plate Stand.

difficulty as regards finish in the earlier applications has been overcome, and the greater part of the apparatus is plated and highly polished. Various types of kettles will be on view fitted with electric heating arrangements at the

Electric Heater.

bottom, and no bare terminals are shown. The electric frypans consist of steel pans copper cased, and the connecting wires are brought to terminals at the handles, and

Electric Flat Iron.

large saucepans are made on the same principle. By avoiding soldered joints, the most frequent cause of failure of the apparatus is eliminated. Hot-plates of various sizes

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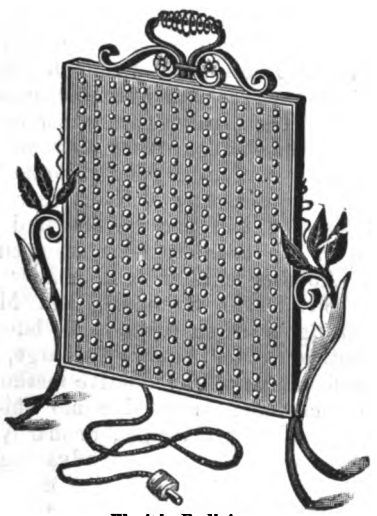
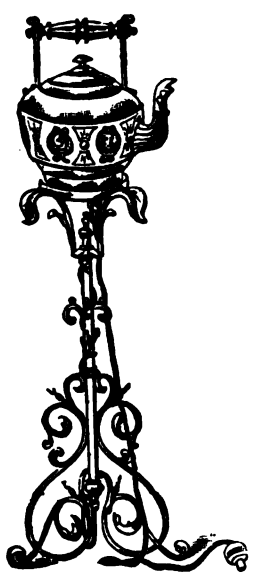
will be also exhibited, some being fitted with regulating switches arranged so that various degrees of heat can be obtained. This is not done by means of external resistances, a very wasteful method, but by putting on or off one or more of the heating resistances attached to the plates. In this way the circuits in use are always kept working at their highest efficiency. The hot-closets noticeable are most useful appliances. They consist of two electric hot-plates mounted one above the other, and fixed in a planished iron frame. The whole is placed in a handsome oak or mahogany cabinet with doors Switches are arranged to give almost any heat required for keeping

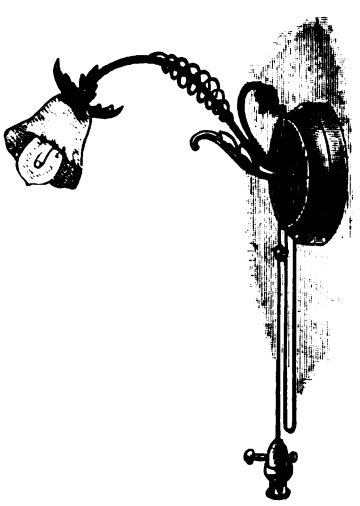


Electric Radiator.

food warm. These hot-cupboards are more suitable for dining-room use, and we understand that a number are already in use, particularly in France, where the new system of heating and warming by electricity is much appreciated. A current of six amperes is sufficient to keep the hot-closet at the proper temperature, and often half of this may be switched off when only pastry is to be kept warm. If the cost of using this arrangement were twice as much, many who could afford to use it would still do so on account of its being so convenient, cleanly, and useful. There is nothing in use at the present time which can compare in any way with



Electric Heater on High Stand with Kettle.



Electric Cigar Lighter with Lamp and Bracket.

this hot-cupboard. Gas is out of the question in the dining-room, spirit is costly and dangerous, and hot-water dishes are only a troublesome makeshift. Messrs. Crompton inform us that they have orders on hand for a number of hot-closets, some of which are of large size. It is probably in warming arrangements of this description, where electricity can beat all its competitors, that most business will at first be done. Heating apparatus will be represented by radiators of various kinds and sizes. Small radiators, suitable for small rooms or as auxiliaries in warming large ones, as also large heaters requiring as much as 10 amperes to fully heat them, will be on view. Small electric heaters are now being used in bedrooms for a couple of hours or more before retiring to rest. They take the chill off the atmosphere, and do not burn or vitiate the air in doing so. The electric heater may be placed close to the bed with perfect safety, and for this reason it is possible to feel warmer with the production of far less heat than would be required with the fire at the other end of the room. It may be mentioned that large heating chambers are now being made to dry wheat for South America, where fuel is dear but water power abundant. Other warming and heating arrangements, such as laundry irons, which appear to be coming rapidly into use, billiard irons, etc., will be exhibited on this stand. With regard to electric power, motors of various powers will be seen at work driving fans, coffee grinders, sewing-machines, etc. In this connection a new gear will be shown with a Cuttris motor, which makes the application of small motors to sewing-machines a simple matter. The motor is fixed on a tilting bedplate, so arranged that when a lever is pulled down by the pressure of the operator's foot the motor is tilted so that its pulley (provided with a rubber or leather covering for friction drive) is brought up to the sewing-machine wheel and drives it. The action of bringing the motor into position switches on the current, and the reverse action cuts it off. A brake is at the same time applied to the machine, which stops it at once, but the motor being released, the armature is allowed to run free.

Electric Urn.

This is a good arrangement, and its completeness recommends it. It is particularly good for alternating currents, as the motor starts free. In addition to the above there will be exhibited incandescent lamps of various candle-power, hammered iron fittings, and the new safety connector. The latter will be shown applied to the cooking and heating apparatus and for electric lighting purposes.

Messrs. Ronald A. Scott, Limited, of Acton-hill, W., will exhibit both finished dynamos and dynamos in course of construction, together with search-light gear. Apart from this a search-light will be fixed and operated from the roof of the building.

Messrs. Rashleigh Phipps and Co., of 102, Oxford-street, W., have been allotted a separate room on the first floor, where a tasteful selection of artistic electric light fittings will be shown, besides a large variety of electric heating, cooking, and ventilating apparatus, all of which will be shown in action. In connection with these the latest developments of electricity as applied to domestic use are made manifest. Cooking demonstrations will be given daily, at which the value of cooking by electricity will be fully displayed. The electric curling-tongs heater should prove of especial interest to the fair sex, who alone are able to appreciate the luxury of curling tongs heated without any of the blackening which is produced by other methods of heating this adjunct to a lady's toilet.

The Waltham Electrical Engineering Company, of Great Chapel-street, Westminster, S.W., will display a combina-

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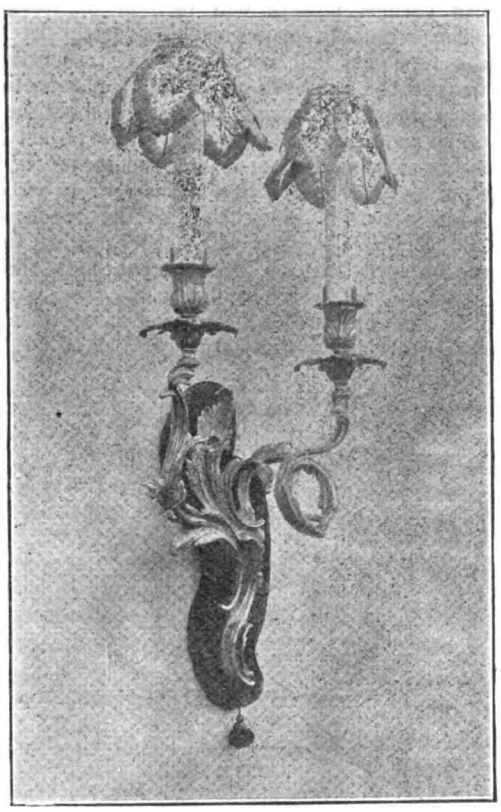
tion bracket fitting, of which an illustration is annexed. The fitting is highly chased and is fitted with the firm's new tassel switch and sliding connections. This combination is mounted on slate and other insulating material. It will be seen that this arrangement entirely dispenses with screws through the bracket, and allows of the bracket being lifted off the base without breaking any joints. The fixing is very rigid and makes sure contact. The working parts are concealed from view in the base, the tassel only being visible, and each successive pull of which turns the light alternately on and off. The tassels and plush mounts are made in any colour to suit existing decorations of the room. This fitting, with others of the firm's own make, may be seen on the walls of the refreshment-room.



Combination Bracket Fitting.

Messrs. Strode and Co., of 188, Piccadilly, W., will show a variety of fittings. Among these may be mentioned a wrought-iron dining-room sliding-shade light, and four new-pattern electroliers. In the centre of the stand will be arranged their bronze group of "Victorious Cupid" adapted for electric light. They will also show other bronze figures, and silver and gilt candlesticks of different patterns (some antique copies) fitted with electric candles, etc. Other exhibits will comprise several novelties in cast and wrought brass and silver wall lights, and a few ordinary wrought-iron pendants suitable for halls, etc. A showcase will also be found containing many different kinds of incandescent lamps for different purposes, clear, and coloured, and frosted, and many combinations of colour for fancy twisted lamps (in small bulbs, the peculiarity of which is that they can supply 110-volt lamps in same bulbs as 50 volts by old method). A few new patterns in table standards, fitted with small silk shades, etc., and one or two handsome French (Louis XV., XVI.) gilt sconces will likewise be found at this stand. The foregoing, with a selection of switches, sockets and plugs, ceiling roses, etc., will complete the exhibits, with the exception of pieces of work which have gained first prize at previous exhibitions.

Messrs. Pyke, Harris, and Co., Limited, of 34-36, New Tothill-street, Westminster, S.W., will display high-pressure apparatus and conduct various experiments with them. These will include the following: (*a*) Illustrating various degrees of illumination produced in vacuum tubes under similar inductive influence, the gaseous vacuum being different in each case. This experiment is worked by their inductive method of parallel coupling. (*b*) Showing the bearing of various degrees of exhaustion of two vacuum tubes, in one of which the current is passing and the other lit by approximation thereto. (*c*) Showing the varied brilliancy produced in vacuum tubes connected in series, each being of a different degree of exhaustion. These tubes are numbered similarly as regards their relative degrees of exhaustion as those in experiment (*a*). It will be noticed that tubes of the degree of exhaustion which in experiment (*a*) gave the most satisfactory results, in this case are the least brilliant. (*d*) Sundry other experiments. It has hitherto not been possible to work any considerable number of vacuum tubes from one generating source, as a tension sufficiently high could not be obtained suitable for working a very large number in series. The vacuum tubes are lit by parallel connection, which is effected by their method of interposed condensers, the E.M.F. employed being about 100,000 volts; but although this current is of so high a tension there is no danger from it, as its quantity is so very small. The high-tension transformer (Pyke and Harris's patents) shown depends for its insulation and cooling on the circulation of a dehydrated liquid insulator, and can be worked continuously without fear of heating or damage to insulation, and may be operated anywhere by connection with the ordinary alternating-current electric light wires. Another exhibit is a small "combination" transformer (Sir David Salomon's and Mr. L. Pyke's patent) which lights three tubes with bunch electrodes, specially constructed for heavy discharge, the coupling being by the firm's parallel inductive method. The final exhibit is an alternating-current dynamo which is designed to work on the inductor principle, primarily designed by Faraday; it embodies the following advantages: both the inducing and the induced current coils, together with the inducing magnet and its cores, are stationary, and the closed magnetic circuit ensures a larger amount of magnetism in comparison with the exciting current.

Messrs. Paterson and Cooper, of Pownall-road, Dalston, N.E., will show, among other exhibits, an interesting model of Penn and Lowndes's patent armature which will commend itself to builders of dynamo machinery. The novelty consists in corrugating the armature plates, rendering them perfectly rigid, and ensuring a good drive. Being self-supporting, the objectionable notches and bolts or ribs which are the cause of sparking and armature heating in so many machines are dispensed with.

THE BOARD OF TRADE STANDARDS AND STANDARDISING LABORATORY.

The recent official adoption of certain electrical standards for providing arbitrary units to which all electrical measuring instruments in this country may be—and all such as are used commercially should be—referred, has very naturally attracted considerable attention on the part of electrical engineers, as well as many of the general public, who wish to know something of the arrangements and details that have been employed in fixing the standards and finally settling the units upon which all our electrical calculations are based, and we therefore think it desirable to publish some particulars of the laboratory and instruments at Whitehall which, under the rule of the Board of Trade, now stand at the head and front of English electrical measurement. In carrying out this proposal, we have to acknowledge the ready assistance and courteous goodwill of the chief officials, Major Cardew and Mr. J. Rennie, to whom we are indebted for the illustrations and details contained in the article.

The object of such a laboratory as that under notice may be considered as twofold. In the first place, it constructs, with the utmost possible care, not only the arbitrary standards which are taken as the units of measurement, but also maintains methods by means of which these units may be at any time verified or reobtained; and, in the second place, it provides facilities under which instruments of a commercial type constructed outside may be properly tested as to their fitness for use and consequent authorisation for service under Parliamentary powers.

Both these objects are carried out at the Whitehall laboratory, as will be seen after reading this article, and the equipment for the duties thus involved is of a nature

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and completeness probably not to be found in any other country whatever.

For the purposes of laboratory work it is obvious that not only must the sources of such current as may be required in testing, etc., be reliable, but it is necessary, in addition, that they should be absolutely steady. The mains of at least two electric light companies pass along the street outside the Whitehall offices, but it has been thought advisable to depend entirely upon plant erected on the premises, not only to be perfectly sure of obtaining current at any time and always, but also to allow of greater variations in current requirements with absolute ease of regulation after any desired manner.

The generating plant thus erected comprises a 6-h.p. Otto gas-engine, by Crossley Bros., driving by means of belts one or other of two Kapp dynamos, built by Messrs. Johnson and Phillips. The latter are designed respectively to give 38 amperes at 130 volts, with a speed of 1,100 revolutions per minute, and 200 amperes at 12·5 volts with a speed of 950 revolutions.

From these machines current is taken to a battery-room containing two sets of E.P.S. cells, 54 in each, and four very powerful Crompton-Howell 61-plate cells for heavy discharges. Switchboards are provided both in the engine and battery rooms for measuring and connecting up, etc. To get a more equal discharge from the Crompton-Howell battery, the current is taken in each case from the centre of the cell instead of one end.

The battery-room is connected directly, by means of a concentric cable, with the "verification" room, where instruments intended for Board of Trade testing with a view to official sanction undergo a very complete series of tests, both electrical and mechanical.

Very heavy copper-strip connections are also led from the Crompton-Howell battery—the cells of which may be coupled either in series or parallel—into the "standards" room, close adjacent, and are there connected with a large Ferranti concentric main running round two sides of the room. From this main cable connections are taken downwards to the "sub-standards" mounted on benching round the walls. Before entering the standards room, however, one of the copper-strip mains is cut in such a way that adjustable carbon resistances may be inserted so as to vary the current passing.

The remaining machinery used for developing current is placed in one of the basement rooms, and includes a B_2 Victoria motor coupled direct to an alternating machine of very special type, constructed by the Brush Company, and arranged with a large number of different combinations both in the field and armature. From a pulley, mounted on the common shaft of these two machines midway between them, is driven with belting a C_2 Victoria high-pressure continuous-current dynamo giving 2,000 volts. When it is desired to run the alternator, this belting is thrown off the motor which is run from the battery; if the high-pressure continuous-current machine is required the belt is slipped on to the pulley again, the alternator fields are cut out of circuit, and its armature then runs as a fly-wheel on the motor spindle.

A number of different transformers are used in obtaining various pressures and periodicities: among them may be cited two of the Brush type, 2,000 watts each; one by Ferranti, for potentials ranging up to 10,000 volts; a Westinghouse, up to 2,000 volts; and a smaller one of the Brush type giving 40 amperes at 100 volts, or 8 amperes at 400 volts.

(To be continued.)

THE INSTITUTION OF CIVIL ENGINEERS.

The council of the Institution of Civil Engineers invites original communications on the subjects included in the following list, as well as on any other questions of professional interest. This list is to be taken merely as suggestive, and not in any sense as exhaustive. For approved papers the council has the power to award premiums, arising out of special funds bequeathed for the purpose:

The arrangement of boilers and engines best adapted for electric light stations under different conditions. Steam locomotion for passenger traffic on common roads. The application of oil and gas engines to tractive purposes on tramways and on common roads, and to marine propulsion. The losses that occur in gas-engines and means for reducing them, with special reference to "after-burning." The relative merits of the several cycles in gas-engines. The theory and development of the compound steam turbine. Mountain railways: their laying out, construction, and working by cables, rack engines, etc. The buoying and lighting of tidal rivers and estuaries. The purification of sewage by filtration, precipitation, electrolysis, and otherwise. The theory and practical working of single and multiphase alternate-current motors, illustrated by examples of existing installations. Alternate *versus* continuous electric currents for (*a*) electric lighting and (*b*) transmission of power. The forms of electrical conductors for lighting, stationary power, heating, and tractive purposes. The utilisation of electric lighting plant during hours of small demand. Electric lighting and haulage plant in mines and collieries. The application of water power, and its transmission to a distance by electricity. Electrical motors for (*a*) inland navigation and (*b*) ocean vessels. The use of electrical motors for driving machine tools in engineering workshops. The effect of small quantities of impurities in commercial copper as regards its use in electrical work. The electrolytic deposition of copper. Aluminium: its manufacture, properties, uses, and alloys. The arrangement of engineering workshops, with descriptions of modern machine tools and appliances.

From the detailed list of the awards made for original communications submitted during the past session we extract the following:

For papers read and discussed at the ordinary meetings—Telford medals and Telford premiums to James Henry Greathead, M.I.C.E., and Francis Fox, M.I.C.E (of Westminster), for their joint paper on "The Liverpool Overhead Railway." A George Stephenson medal and a Telford premium to Thomas Parker, M.I.C.E. (of Wolverhampton), for his narrative on "The Electrical Equipment of the Liverpool Overhead Railway."

WEBBER'S APEX CONNECTOR.

The annexed illustration shows the "Webber connector," as used for joining up a table-standard lamp at the apex of its shade; the flexible in such cases would hang from a ceiling rose, and be hooked out of the way when the standard is not in use. Major-General Webber claims that for such a connector, all that is really necessary for safety is to have the heads of the sockets, into which the plugs have to be pressed, made short of the surface of the

insulating disc which closes the opening into the socket. The only way to cause a short-circuit in the socket cap of his connector would be by inserting a staple in the holes, or some such determined means. The whole connector can be made of hard wood, and has no spring in it or any screwed parts, which is an obvious advantage. Major-General Webber claims that the new safety connector illustrated in our issue of the 21st inst., and brought out by Messrs. Crompton, was anticipated in several of its features by himself in January, 1893, and that to his arrangement Mr. Crompton has added a disc which revolves on its axis actuated by a spring which holds it in the position of covering the heads of the contact tubes.

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COMPANIES' MEETINGS.

EDMUNDSONS, LIMITED.

The sixth annual meeting of this Company was held at 19, Great George-street, Westminster, on the 13th inst., Mr. Joshua W. Edmundson, one of the directors, presiding. The report and statement of accounts were taken as read.

The **Chairman**, in moving the adoption of the report, congratulated the shareholders upon a satisfactory year's working. He said that although the profits for the past year were not so large as in several previous years, they were satisfactory when the great depression in trade and the large amount of competition were taken into account. He considered that the outlook for the present year was satisfactory, as they had a larger amount of work in progress than was the case at the same time last year, including, among other installations, the lighting of Warwick Castle, for the Earl of Warwick; Duncombe Park, for the Earl of Feversham; Elveden Hall, for Lord Iveagh; Copped Hall, for Mr. E. J. Wythes; Nidd Hall, for the Hon. H. E. Butler; Wood Hall, for Mr. J. W. Hutchison; and the new asylum for Sunderland. An important contract had also just been signed for lighting a portion of the town of Shrewsbury, provision being made in the first instance for 5,000 lights, and the directors hoped they would be able to extend the Company's operations in this class of work.

The report and accounts were adopted, and a resolution was passed directing the payment of a dividend at the rate of 6 per cent. per annum on both preference and ordinary shares.

Mr. Henry Wigham, the retiring director, was re-elected, as were also the auditors, Messrs. May and Street.

DIRECT SPANISH TELEGRAPH COMPANY.

The half-yearly meeting of the Direct Spanish Telegraph Company was held last Friday at Winchester House, Mr. E. Etlinger in the chair.

The **Chairman** moved the adoption of the report, and said that so long as trade was depressed they could not expect their returns to be very high. The actual decrease in the receipts was £868, against which there was a saving of £284 in debenture interest and £43 in working expenses. Quite recently there had been a marked increase in traffic, and things seemed to be better. It looked to him as if trade had made a start upward. It might be due to the settlement of the tariff in America, and, as far as the directors knew, things were reviving in American trade.

Mr. J. D. Pender seconded the adoption of the report, which, after some discussion, was agreed to.

COMPANIES' REPORTS.

BRUSH ELECTRICAL ENGINEERING COMPANY, LIMITED.

Directors: J. B. Braithwaite, jun., Esq. (of Messrs Foster and Braithwaite), chairman; Arthur Ayres, Esq., M.I.C.E.; Aymor H. Sanderson, Esq.; Colonel Frederick George Steuart; B. H. Van Tromp, Esq.; Edward Woods, Esq. (past-president, Institution of Civil Engineers). Joint managers: John S. Raworth, M.I.E.E.; R. Percy Sellon, M.I.E.E.

Fifth annual report to be presented to the shareholders at the general meeting of the Company to be held at Cannon-street Hotel, London, E.C., on Monday, October 1, 1894, at 3 p.m.

The directors herewith submit the balance-sheet and profit and loss account for the year ended June 30, 1894. The profit and loss account shows a gross profit of £57,157. 19s. 4d. After deducting general charges, maintenance of buildings, plant, and patents, interest on debenture stock, and sundry costs of removal, which the directors consider should be written off the year's profit, there remains a net balance of profit amounting to £27,280. 12s. 1d., to which must be added the sum of £815. 5s. 3d., the balance brought forward from last account. After providing the full dividend on the 6 per cent. preference shares for the year, and an interim dividend at the rate of 5 per cent. per annum which has already been paid on the ordinary shares for the half-year ended December 31, 1893, the directors recommend that a further dividend, at the rate of 5 per cent. per annum, be paid on the ordinary shares for the six months ended June 30, 1894, leaving £3,788 9s. to be carried forward. During the year the sum of £3,710. 13s. 7d. has been expended on the purchase of additional plant and extensions at the Loughborough works, where the whole of the regular home manufacturing work of the Company is now concentrated and carried on. The volume of business which the Company has been called on to undertake during the year is again in excess of that in any previous period of its existence. The prevalent industrial depression has, however, brought with it increased competition and a general fall in prices, with consequent diminution in the rate of profits obtainable. The Company's Vienna factory has yielded improved results during the past year, and shows a fair return upon the capital employed. Important central-station contracts have been successfully carried out, and others are in course of execution. The glow lamp department has during the year largely increased its output, and is now manufacturing at the rate of half a million lamps per annum. The Australian branch of the business has laboured under great disadvantages, arising out of the financial crisis through which the colonies have recently been passing; under these circumstances the directors are glad to be able to state that the bad debts incurred during the year amount to less than £50, and consider that great credit is due to the careful management with which the business has been conducted. The works of the Company are at present fully employed, and the prospects for the coming year are satisfactory. The progressive change in the character of the industry from the lighter class of electrical engineering involved in numerous and isolated installations to the heavier and more considerable works following upon the extension of electricity supply from central stations, is undoubtedly favourable to this Company. The contract with the City of London Electric Lighting Company for the supply and erection of generating plant and accessories for public and private lighting in the City of London has made satisfactory advance during the year. Contracts have also been entered into with the County of London and Brush Provincial Electric Lighting Company for the supply of plant and equipment of central-station undertakings for the districts of St. Luke's, Wandsworth, and elsewhere. Mr. Arthur Ayres, M.I.C.E., has accepted a position upon the Board to fill the vacancy created by the death of the late Duke of Marlborough. Mr. A. H. Sanderson and Colonel F. G. Steuart retire by rotation, and, being eligible, offer themselves for re-election. The auditors, Messrs. Cooper Bros. and Co., also retire and offer themselves for re-election.

BALANCE-SHEET, JUNE 30, 1894.

Dr.	£ s. d.	£ s. d.
Authorised capital	750,000 0 0	
Capital issued—viz, 90,000 6 per cent. preference shares of £2 each	180,000 0 0	
90,000 ordinary shares of £3 each	270,000 0 0	
		450,000 0 0
4½ per cent. perpetual debenture stock		125,000 0 0
Creditors—Sundry creditors	62,237 2 1	
Bills payable	10,087 12 11	
		72,324 15 0
Loan from bankers on security		25,000 0 0
Provision for depreciation on property, patents, and goodwill account — Transferred, see *per contra*	9,000 0 0	
Deduct balance of cost of Manchester and Cardiff stations closed during the year	3,614 17 11	
		5,385 2 1
Reserve account, as per last account, less £554. 13s. 5d. applied during the year		1,058 12 0
Profit and loss account—Balance as per last account	815 5 3	
Balance of profit and loss account	27,280 12 1	
	28,095 17 4	
Less interim dividend paid on preference and ordinary shares	12,157 8 4	
		15,938 9 0
		£694,706 18 1

Note.—Contingent liability in respect of uncalled capital on shares in other companies and on bills receivable discounted, £39,697.

Cr.	£ s. d.	£ s. d.
Property, patents, and goodwill as per last account	280,270 0 11	
Amount previously written off transferred to provision for depreciation *per contra*	9,000 0 0	
	289 270 0 11	
Additions to plant	3,710 13 7	
Purchase of new patent	75 0 0	
	293,055 14 6	
Deduct property and plant disposed of during the year	5,237 13 5	
Amortisation of lease	733 6 10	
		287,084 14 3
Stock—Goods in hand in process of manufacture, work in progress and materials in London, at Loughborough, and other places		114,681 1 5
Debtors—Sundry accounts	156,244 12 11	
Bills receivable	2,446 18 9	
		158,691 11 8
Cash at bankers and in hand		12,965 3 9
Shares and debentures in other companies		42,914 16 7
Liquidators' balances and suspense accounts		2,110 12 2
Balance of foreign and colonial branches accounts, being excess of assets over liabilities		76,258 18 3
		£694,706 18 1

Dr. APPROPRIATION ACCOUNT.	£ s. d.
Further dividend on preference shares at the rate of 6 per cent. per annum, and on ordinary shares at the rate of 5 per cent. per annum	12,150 0 0
Balance carried forward	3,788 9 0
	£15,938 9 0

Cr.	£ s. d.
Balance	15,938 9 0
	£15,938 9 0

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PROFIT AND LOSS ACCOUNT YEAR ENDED JUNE 30, 1894.

Dr.	£	s.	d.
General charges—viz :			
Directors' fees	1,994	15	10
Auditors' fees	105	0	0
Salaries	8 303	3	6
Staff bonuses	2,190	18	7
Law charges	267	1	7
Insurance	770	2	5
Postage, stationery, and printing	1,177	0	0
Travelling, carriage, and freight	1,093	11	7
Advertising, agency, and sundries	4 072	12	0
	19 974	5	6
Cost of removal to Loughborough	632	0	8
Cost of removal from Hammersmith	107	19	7
Maintenance of buildings and plant	3,393	12	10
Maintenance of patents	144	8	8
Interest on debenture stock to June 30, 1894	5,625	0	0
Balance, profit carried to balance-sheet	27,280	12	1
	£57 157	19	4
Cr.	£	s.	d.
Gross profit	57,157	19	4
	£57,157	19	4

BALANCE-SHEET OF THE FOREIGN AND COLONIAL BRANCHES—Being the Balances of the Following Accounts: Vienna (made up to December 31, 1893), Australia (made up to April 30, 1894)

Dr.	£	s	d.
Creditors—Open accounts and bills payable	46,045	17	1
Unpaid balance of purchase price of land secured by mortgage	7 250	0	0
	53,295	17	1
Lamp reserve account	499	4	4
Balance of assets over liabilities transferred to general balance-sheet	76,258	18	3
	£130,053	19	8
Cr.	£	s.	d.
Property—Freehold and leasehold lands, buildings, plant, tools, fixtures, etc., at Vienna and in Australia	47,189	5	2
Stock—Goods in hand, in process of manufacture, and materials	42,938	18	6
Debtors—Sundry accounts (after provision for doubtful debts) and bills receivable	36,281	9	7
Cash at bankers and in hand	2,801	8	7
Australian suspense items	842	17	10
	£130,053	19	8

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

London, W.—The Great Western Railway Company invite by October 8 tenders for the supply, among other stores, of india-rubber goods, telegraph instruments, telegraph apparatus, copper wire, G P. wire, etc., telegraph ironwork and tools, telegraph drysalteries, and arc light carbons.

Stroud.—Tenders are invited for supplying, fixing, and maintaining fire-calls and telephones for the volunteer and Local Board fire brigades, for the Stroud Local Board, in accordance with the specification prepared by the surveyor, which may be inspected at his office. Tenders, marked "Tender for Fire-calls," should be sent to Mr Percy Witchell, clerk, by October 2.

St. Pancras.—The Vestry are prepared to receive tenders for the following works in connection with their new central station at King's-road, Camden Town, and several sub-stations: main switchboard, electrical instruments, etc., motor transformers and accessories, wiring and lighting certain buildings. The drawings can be inspected, and specifications, schedules of quantities, and general conditions can be obtained at the offices of Prof. Henry Robinson, 13, Victoria-street, Westminster, on payment of 5s. Tenders are to be sent in by Thursday, October 11.

South Shields.—The following tenders are invited for the supply and erection of the following plant, for the Corporation: Section A—boiler-house plant, including boilers (marine type), fittings, pipes, chimneys, etc. Section B—pump-house plant, including double-acting, slow-speed, circulating and feed pumps, cast-iron tank, pipes, and fittings in connection therewith. Section C—engine-house and sub-station plant, including 100 and 25 kilowatt steam alternators, with double or triple compound engines, steam exciter, circulating pipes, switchboard and instruments, sub-stations, and transformers. Section D—underground work, including rubber-covered cables, cast-iron pipes, boxes, switches, and trenching. Section E—arc lamps, lamp-posts, switches, and transformers. Section F—meters. Firms tendering are at liberty to tender for any section or sections, or for the whole of the sections, but not for part of a section. Copies of specification, including plans, conditions of tender, and contract, can be obtained at the Borough Electrical Engineer's Office, South Shields, on and after 17th inst., on payment of £3. 3s., which sum will be returned on receipt of a *bonâ fide* tender. Tenders, sealed and marked "Tender for Electric Lighting," to be delivered to Mr. J. Moore Hayton, town clerk, Court Buildings, South Shields, by October 31.

BUSINESS NOTES.

Portsmouth.—The Sailors' Home is to be lighted electrically.

Belfast.—The premises of the Cornhill Cloth Company are to be lighted by electricity.

Shoreditch.—The Vestry have shelved the electric lighting scheme for six months.

Hull.—The post office is to be lighted electrically, as are St. Mary's and St. Charles's Churches.

Kingswood.—The Local Board are talking of extending the electric lighting of the district at some future time, but nothing is to be done at present.

Eastern Telegraph Company.—The Board announce an interim dividend of 2s 6d. per share for the quarter ended June 30, payable on October 15.

Steamer-Lighting.—Messrs. Ramage and Ferguson, of Leith, have launched a passenger and cargo boat, the "Sofia" for the Eastern Mediterranean trade. She is lighted electrically.

Stroud.—The Board of Health are advertising for tenders for providing electric calls for both the volunteer and town fire brigades, in accordance with the surveyor's specifications.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending 23rd inst. amounted to £955, as compared with £687 in the corresponding week of last year.

Fulham, S W.—The Fulham Vestry have adopted the Electric Lighting Acts, and have decided to provide all the necessary plant for street-lighting and the supply of private consumers.

Western and Brazilian Telegraph Company.—The receipts of the Company for the past week, after deducting 17 per cent. payable to the London Platino-Brazilian Company, were £3,598.

Gas-Blowers.—Mr. H. F. L Orcutt, of 145, Cannon-street, E.C., has issued an illustrated list of gas-blowers and hardening and melting furnaces made by Messrs. Ludwig Loewe and Co., of Berlin.

Newport (Mon.).—The question of lighting the free library by means of electricity has been referred by the General Committee to a sub-committee. The estimates showed a total annual cost of £101. 7s.

W. T. Henley's Telegraph Works Company.—This Company are making the armoured and unarmoured cables for the Glasgow Corporation's electric lighting extensions, which we hear are considerable

Macclesfield.—Mr. W. R. Brown, Mill-street, is lighting Messrs. Felton's Hovis Flour Mills electrically There will be about 150 lights. The premises of Mr. R. Robinson Brown, draper, are also to be fitted up by him.

Store-Lighting.—The Indestructible Ignition Tube Syndicate, Limited, of 100c, Queen Victoria-street, E.C., have just completed an installation at Everett's Stores, Walthamstow. The lamps comprise 16 arcs and 16 incandescents.

Acton.—The Works Committee have reported to the Local Board that they had deferred to their next meeting the consideration of two letters from electrical engineers as to the proposed transfer of the Board's electric lighting order.

Fort Augustus.—Water power has replaced steam power for the electric lighting of the monastery at Fort Augustus. The water is led from the River Turiff to a dam about three-quarters of a mile distant, and the turbine is designed for 45 h.p.—probably the most powerful of the kind in Scotland.

Lymington.—In discussing the question of the lighting of the street lamps some of the Town Council have suggested the introduction of the electric light, Admiral Earle pointing out that many towns smaller than Lymington had the electric light, and it was found to effect a saving for the ratepayers.

Appointments.—Two assistants to Mr. J. E. Stewart, the Derby borough electrical engineer, have been appointed, the chief being Mr. Gwerrier and the second Mr. Lister. Mr. H. Street, of the Exeter Electric Light Company, has been appointed assistant to Mr. T. Wilmhurst, the Derby borough electrical engineer.

City and South London Railway.—The receipts of the Company for the week ended September 23 were £835, against £775 for the corresponding week of 1893, or an increase of £60. The total receipts for the current period of the present half-year amount to £10,237, as against £9,681 in the corresponding period of 1893.

Award.—Messrs. E. Green and Son, Limited, of Manchester, Wakefield, and New York, have again received the highest award for their improved fuel economiser, the diploma of honour having just been granted to them at the Antwerp Exhibition. In all, 16 medals and awards have now been gained by this firm for their apparatus.

Brechin.—There has just been made to Brechin, through Councillor Laing, an offer by Mr. Robert Duke, of the firm of Messrs. D. and R. Duke, Denburn Works, to supply from the dynamo of their works current to light St. Ninian's-square, the improvements of which are now almost completed. The town will, of course, have to bear the cost of erecting the lamps, etc., for the installation.

Poplar, E.—The Works Committee of the Board of Works have recommended that a circular should be issued to and enquiries made from residents and manufacturers and the trustees of public buildings in the district asking if they would take electric light, if established by the Board, at 6d. per unit for lighting and 4d. per unit for power. Mr. Ben Johnson moved the adoption of the recommendation, which was carried.

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Bacup.—An application from Mr. Alex. Wright has been submitted to the Town Council for permission to stretch two wires (together) across Burnley-road, from the Liberal Club to his new office opposite, to supply his office with the electric light. It was resolved that Mr. Wright be informed that the Corporation could not consent to overhead wires for electric lighting purposes, but that such wires must be laid underground.

Anglo-American Telegraph Company.—At a meeting of the Board of Directors, held on Friday last, it was resolved, after placing £6,000 to the credit of the renewal fund, to declare an interim dividend for the quarter ended September 30 of 9s. per cent. on the ordinary stock and 18s. per cent. on the preferred stock, less income tax, payable on November 1 to the stockholders registered on the books of the Company on September 30.

Brighton.—At the beginning of the month the Lighting Committee of the Town Council held a meeting at which a letter was read from Mr. H. J. Burgess, suggesting that two arc lamps should be erected at the bottom of New England-road during the time the drainage works are being carried out there. It was resolved that the committee deem it inexpedient at present to adopt the suggestion. This has now been confirmed by the Town Council.

Carbon Syndicate, Limited.—This Company has been registered with a capital of £100,000 in £1 shares. The object is to carry into effect an agreement with Mr. C. P. Shrewsbury and others, and to carry on business as manufacturers of carbon plates, slabs, rings, crucibles, rollers, bars, rods, pipes, and other articles for electrical and electrolytical and other purposes; as electricians, electrical engineers, metallurgists, colliery owners, metal founders, fitters, etc.

Luton.—On the motion of Councillor Wilkinson, seconded by Councillor Dillingham, the following motion has been unanimously passed: "That the Highways and Lighting, or a specially appointed committee, do consider and bring up a report upon the question of applying for and ultimately obtaining a provisional order for the supply of electricity for public and private purposes in the borough of Luton, and that they ascertain the cost of obtaining such order and supply."

Stirling.—A special meeting of the Stirling Town Council has been held to consider whether they should apply this year for a provisional order to supply the burgh with the electric light. Bailie Lawson said it was a great undertaking, and he did not think the Council should go into it. The better way, he thought, would have been to allow one of the companies to get the order. It was, however, agreed to proceed with the application, Bailie Lawson and Councillor M'Diarmid dissenting.

Manchester.—The Moss Side School Board have received a report from Mr. J. Nasmyth, showing the comparative cost of lighting the Board's new schools by gas and by electricity. The Chairman moved and Dr. Fraser seconded, that the recommendation of the Sites and Buildings Committee be adopted—namely, that a system of electric lighting by private installation be adopted. As, however, the desire was expressed to discuss Mr. Nasmyth's report at a full meeting of the Board, an amendment was adopted on the motion of the Rev. Dr. Neilson, seconded by Dr. Baynes, that the recommendation be considered at a future meeting.

Altrincham.—An installation has been put up on the premises of Mr. J. B. Wilson, Station-road. The motor comprises a 2-h.p. gas-engine, which drives a dynamo capable of supplying 40 incandescent lamps. The gas-engine has been provided and fixed by the National Gas-Engine Company, of Ashton-under-Lyme. Mr. Joseph Bickerton, Albert-road, Hale, who is connected with the firm named, personally superintended the whole of the arrangements. The establishment is furnished with about 40 lamps. The Altrincham Electric Supply propose commencing the supply of electric light in the Altrincham and Bowdon districts in October. The price which will be charged is 8d. per unit, subject to a discount.

Sunderland.—The Corporation has issued circulars to tradesmen and private residents informing them that the Corporation will be in a position towards the end of the present year to supply electricity in the following streets and thoroughfares: Dunning-street, High-street West (from Villiers-street to Hind's Bridge), Union-street and Waterloo-place, Bridge-street, North Bridge-street (to Wheat Sheaf corner), Fawcett-street, John-street, St. Thomas-street, West Sunniside, and Borough-road (from Norfolk-street to Crowtree-road in Holmeside). The circular affords intending customers every information as to charges. The Corporation strongly impress on customers the importance of having the work of installation done by thoroughly competent contractors.

Fareham.—The award of the arbitrators (Messrs. J. A. Fleming and A. H. Preece) in the matter of the purchase of the Fareham Electric Light Company's works by the Local Board, has been received by the latter body. The arbitrators place the present value of the undertaking as a going concern at £4,866. In addition to this, the transfer, if proceeded with, will involve the spending of £700 on the purchase of land, £1,000 for laying the wires underground and for obtaining an additional engine, £175 for arbitration and loan expenses, and a small item connected with the laying of the wires and the cost of a few new standards will make the total amount required about £7,000. Formal application is to be made to the Local Government Board for power to borrow this amount.

Swansea.—In connection with the report of the Streets Committee of the Swansea County Council, Mr. F. Rocke said that a letter had been received from the gas company declining to light the four lamps which have been erected on the road leading from Upper Bank to Llansamlet on account of the great distance apart thereof. It appeared that the gas company insisted upon their rights to have the lamps 50 yards apart. Incidentally, Mr. Rocke asked what was being done with reference to the important question of electric lighting, in which the ratepayers evinced considerable interest. Many of them were anxious to use the light in their premises. Alderman Richards said a meeting of the Electric Lighting Committee had been held, and there was a probability of the scheme under consideration being put into effect.

Bath.—The Surveying Committee have been considering the subject of the electric light. Alderman Bright thought the electric lighting company ought to switch on the current a little earlier in the evening for the lighting of the streets. They had had several nights lately when if it had not been for the lights in the tradesmen's shops, Southgate-street would have been in darkness. Alderman Sturges explained that their agreement with the company provided for an average lighting throughout the year of 10 hours for each night It was found impossible, however, so to arrange the lighting as to make this average cover the darkness all the year through, and he admitted the justice of Alderman Bright's complaint, which was referred to the Lighting Committee. Mr. Bartrum remarked that it was of no use for the matter to go to the Lighting Committee unless they were prepared to pay more money.

Ulverston.—The clerk to the Rural Sanitary Authority has read the correspondence with the urban authorities of Ulverston, Dalton, and Grange on the subject of the electric light, from which it appeared these Boards had appointed deputations to confer with the special committee of the Authority respecting the intended application to the Board of Trade by the Windermere District Electric Light Supply Company for an order empowering them to supply electricity for public and private purposes in this district. Mr. Holme suggested that if it would not then be too late to take any action that might be necessary, the subject should be deferred for the consideration of the new District Council. Mr. Harrison thought it would be as well to give formal notice of opposition, so that the Authority might have a *locus standi*. Mr. Mason: The proposal at present is simply that this conference be held. On the motion of Mr. Haines, seconded by Mr. Dickson, it was resolved that the clerk arrange with the other bodies for a suitable day for the conference.

Cambridge.—During the vacation considerable additions have been made to the supply of current for house, shop, church, but chiefly college lighting. Ten colleges are connected, and consume large amounts of energy, whilst in Caius and Sydney the light has been installed throughout in place of gas, including courts, staircases, and men's rooms. The new Sidgwick Hall of the ladies' college at Newnham is wired throughout, and current will be available by the beginning of the term. Holy Trinity Church has adopted the light, and the demand for private house-lighting is largely on the increase, a mile of main being laid in the growing residential district of Newnham. The wiring has been executed by the local firm of Messrs. Baily, Grundy, and Barrett, Limited. Street-lighting is in abeyance beyond a limited amount, the gas company having a contract running for some little time to come. To meet the increased demand a new Parsons steam turbine alternator is being fixed for the winter months. The sub-station equipped by Messrs. Parsons and Co. is rapidly replacing the house-to-house transformers.

Country-House Lighting.—Mr. R. Clifford Smith, of Ashford Hall, well known in the Midlands, has decided to have his mansion lighted throughout by electricity. The work has been entrusted to Messrs. Drake and Gorham. No doubt the fact that Chatsworth, the well-known seat of the Duke of Devonshire, which was designed and carried out under the personal supervision of Mr. Bernard Drake, was a great factor in deciding to whom the work should be given. The plant will consist of a dynamo driving a water turbine, and a storage battery of the D.P. type will be installed to provide current when the plant is not running. This battery will permit of double or treble rates being taken from it for short periods without the slightest deleterious effect—a matter of some importance in the case of country houses. The installation will contain a Neville automatic accumulator switch to prevent any possibility of the current discharging itself through the machine, and will be provided with many other conveniences in connection with mansion-lighting, in which Messrs. Drake and Gorham have had such a large experience.

Bilston.—The question of the lighting of the market house having been referred to the General Purposes Committee by the Estates Committee, the Bilston Town Commissioners were recommended to accept the tender of Messrs. Fowler, Lancaster, and Co., Limited, of Birmingham, who offered to do the work for £550. Mr. Davies, in introducing the recommendation, said that the tender of Messrs. Waring and Co., of Liverpool, was accepted as being the most suitable, but subsequently that firm demurred to the terms of the Board. Correspondence had passed on the matter, and Messrs. Waring appeared to have given up the idea of tendering for the work, and the General Purposes Committee recommended the acceptance of the next tender, which was Messrs. Fowler and Lancaster's. It had been intimated that Messrs. Waring were willing to accept the terms offered, and they were now asked to decide between the two. Messrs. Waring's was the lowest tender. Some discussion arose upon the subject, and ultimately Messrs. Waring and Co.'s tender was accepted.

Fermoy.—The clerk has read to the Town Commissioners communications from the town clerks of Bray, Carlow, and Kilkenny

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concerning the cost for electric lighting in these towns. In these places the electric lighting is run by private companies at their own risk. The town clerk, Bray, said that the cost of lighting the town, for both public and private lighting, would be about £650 a year, if the Commissioners borrowed the money. That amount he made up as follows: interest on loan of £8,000, for plant, etc., at 4 per cent., £320; wages and all other incidental expenses, £330; total, £650. The Board, having discussed the matter, came to the conclusion that putting the cost of public lighting at present, including wages of watchmen, etc., at £150, it would leave a balance of £500 to be derived each year from private consumers. The opinion of the Commissioners was that the gas company derived at least £2,000 per year from the latter source, and the clerk was directed to ask the engineers of the Kilkenny and Bray Electric Lighting Companies on what terms they would come to Fermoy to confer with the Commissioners on the subject, and prepare an estimate of the cost.

Aberdare.—A provisional order having been obtained for the lighting of the centre of Aberdare by electricity, steps are being taken to form a local company for the purpose of carrying the project into execution. At a preliminary meeting held a short time ago, a deputation was appointed to visit Pontypool to inspect the machinery and mode of lighting there. The deputation, which consisted of Messrs. D. Williams, high constable of Aberdare; G. George, J.P.; Thomas Lloyd, grocer; M. R. David, Rock Brewery; L. N. Williams, Cambrian Lampworks; T. Rees, Swan Hotel; D. Hughes, Boot Hotel; D. Tudor Williams; D. J. Gwyn, Metropolitan Bank; E. Arnott, Danygraig; D. P. Richards, Blaengawr, etc., were accompanied by Mr. J. C. Howell (Messrs. J. C. Howells, Limited, Llanelly), in whose name the provisional order was obtained, and Mr. P. T. Rhys, solicitor for the promoters. At Pontypool they visited the electric lighting station, where Mr. J. C. Howell, and the engineer, Mr. Stephens, explained to them in detail the working of the machinery, cost of production, etc. After dinner a visit was paid to the market place, which was lighted by electricity for the occasion.

Chester.—The Town Council on Wednesday of last week met to consider the adoption of a proposed site for the electric light station. The town clerk (Mr. Sam. Smith) read the minutes of the Electric Lighting Committee, who on September 7 considered a report of the sub-committee as to the various sites, including Frodsham-street, land adjoining the sewage works, Tramway-street, Leadworks Field, Water Tower View, the old county gaol, and Herbert's-court, Crook-street. The matter was adjourned for further enquiries until September 13, when he (the town clerk) reported that he had seen Alderman Williams, who would not put a price on his land, but suggested the Corporation should have it valued and make him an offer. Mr. T. A. Fletcher, solicitor, on behalf of the late James Parry's family, offered the Commercial Hall, Frodsham-street, containing 1,804 square yards, but he also had not put the land on a price. As to the other site in Frodsham-street, belonging to the Charity Trustees, a letter was received from the Rev. J. W. Clark, intimating that the Queen-street Chapel trustees would do all they could to discourage its use, as the proposed buildings would be "very prejudicial to them as a religious community, detrimental to their buildings, and injurious to the neighbourhood." Coming next to the Tower Field gardens, the property of the Corporation, it was suggested that there was a very suitable site adjoining Crane-street, and immediately behind the railway embankment as it would be when widened. After discussion, it was moved by Alderman Charles Brown, seconded by Mr. J. W. Huke, and unanimously resolved: "That it be recommended to the Council that the Water Tower Gardens, belonging to the Corporation, be the site for the proposed electric light generating station, and that the committee be authorised to proceed to establish the installation, submitting tenders, or terms of any proposed contract, to the Council in the usual way." Mr. W. C. Deeley, chairman of the committee, moved the adoption of the recommendation, which after some discussion was carried.

Huddersfield.—The Huddersfield County Council have approved of the following proceedings: The Rates and Rents Sub-Committee met, in accordance with the resolution of the Electric Lighting Committee of August 1, to consider the desirability of rearrangements in the charge for electricity in the following directions, or some of them—(1) reduction of rates, (2) adoption of graduated scale, (3) reduction of meter rents. It was resolved that no reduction be made in the charge for the supply of electrical energy, but that the following discounts be allowed—viz.:

On consumption exceeding for half-year.	Discount.	On consumption exceeding for half-year.	Discount.
1,000 units ...	2½ per cent. ...	2,600 units ...	6½ per cent.
1,200 ,, ...	3 ,, ...	2,800 ,, ...	7 ,,
1,400 ,, ...	3½ ,, ...	3,000 ,, ...	7½ ,,
1,600 ,, ...	4 ,, ...	3,200 ,, ...	8 ,,
1,800 ,, ...	4½ ,, ...	3,400 ,, ...	8½ ,,
2,000 ,, ...	5 ,, ...	3 600 ,, ...	9 ,,
2,200 ,, ...	5½ ,, ...	3,800 ,, ...	9½ ,,
2,400 ,, ...	6 ,, ..	4,000 and over ..	10 ,,

And in addition, if the consumption per half-year per 8-c.p. lamp (or equivalent) fixed upon the consumer's premises shall be: above 15 B.T. units, 10 per cent. discount; between 10 and 15 units, 7½ per cent.; between 8 and 10 units, 5 per cent.; between 6 and 8 units, 2½ per cent. It was decided that the revised scale of charges for meter rents as now decided upon be adopted; that the supply of electrical energy for motive and domestic purposes other than lighting be charged at the rate of 4d. per unit; and that the following revised scale of meter rents be adopted: meter and switch rental (30-watt lamps)—1 to 25, 12s. 6d. per annum; 26 to 50, 15s.; 51 to 100, £1; 151 to 200, £1. 7s. 6d.; 201 to 300, £2. 10s.; 301 to 400, £3; 401 to 500, £3. 10s. The Electric Lighting Committee met on August 29, and adopted the recommendations of the sub-committee, the reduction of the charge for electrical energy for motive and domestic purposes other than lighting to 4d. a unit to take effect as and from July 1 last. The engineer submitted applications from Mr. John Sykes, of Acre House, Lindley, and Mr. F. W. Sykes, of Green Lea, Lindley, for an extension of the main from Wellfield to their respective houses, at an estimated cost of £430; estimated revenue, £100. It was resolved that the applications be granted, and the mains extended as early as possible. It was recommended that 3,000 yards $^{7}/_{16}$ cable be ordered from Messrs. Calvert and Co, Folly Hall; and that Mr. Percy Lunn, now engaged as draughtsman at the electric supply station, be appointed junior assistant engineer at a yearly salary of £55.

Dewsbury.—The Corporation in 1891 obtained a provisional order from the Board of Trade, such order defining a compulsory area, in which electrical mains were to be laid. Although, in view of the considerable initial expenditure it would involve, it was with a certain amount of reluctance that the Dewsbury Corporation made their application to the Board of Trade, yet they felt bound, in the interests of the ratepayers whom they represent, to prevent any company setting itself up in the town as a powerful competitor with the public gasworks. The line of argument the Corporation took was something like this—if the people of Dewsbury prefer electricity for lighting purposes, why should not we supply them ourselves, and derive the benefit of their custom, rather than allow a company to come in to utilise what profits might accrue to swell the dividends paid to their shareholders? But it was not so much, perhaps, the hope of future financial gain as the fear of considerable loss of custom, that prompted the Dewsbury Corporation to take the steps they have. The Corporation are making preparations for the changed conditions, and the worst thing that can now happen to them is a mere transfer of custom from their gasworks to their electric lighting station. Of course, a new undertaking of this character could not be commenced without considerable capital, and this the Corporation provided by obtaining legal borrowing powers to the extent of £25,000. It was not anticipated at the time these powers were obtained that the whole of this large sum of money would be required, at any rate, for some considerable period. In fact, the expenditure, so far, does not amount to half this sum; but in municipal, as well as in domestic matters, it is always well to be prepared for an emergency. The new lighting station is a substantial structure, consisting of engine-room, boiler-house, and battery-room. It is situated on the site of the old gasworks in Bradford-road, and has been erected at a cost of a little over £3,500. Mr. Mark Scott, of Earlsheaton, is the contractor. Two 100-kilowatt machines and one 50-kilowatt machine have been supplied by Messrs. Crompton, London, the dynamos being coupled direct to the engines. A local firm—Messrs. J. and J. Horsfield—have put in the boilers. The mains have been laid by Messrs. Siemens Bros. and Co., London, their contract amounting to £3,856. The area in which the Board of Trade, by their provisional order, made it compulsory for the Corporation to lay mains comprises the Market-place, Daisy-hill, Long-causeway, Church-street, Northgate, a portion of Bradford-road, and Wellington-road to the top of Nelson-street. The low-tension three-wire system is the system that has been adopted. Mr. W. H. Preece devised the scheme, which, partly under his own superintendence, and partly under the superintendence of Mr. A. K. Greener, A.I.E.E., has now almost been carried out. It is the intention of the Corporation to supply through meter at 6d. per unit.

Hampstead.—The Electric Lighting Committee have presented two reports to the Vestry, in which they stated that they had appointed Messrs. W. Bathurst, O. Hansom, and E. Sayer as assistant engineers at the electric lighting station at a salary of £104 a year each, such appointments to be determined by one month's notice at any time; E. Kerrison as storekeeper at a salary of 25s. a week, such appointment to be subject to a week's notice at any time; and W. C. Bishop as clerk at a salary of 25s. a week, such appointment to be subject to a week's notice at any time; and that they had empowered Mr. Chattock, the engineer, to engage three drivers at £1. 10s. 4d. per week each, three firemen at £1. 9s. 2d. each, three regulators at £1. 9s. 2d. each, three trimmers, two at £1. 4s. 9d. each, and the other at £1. 5s. 8d., a fitter at £1. 18s., two labourers at £1. 4s. 9d. each, an engine cleaner at £1. 4s. 9d., and a wireman at £1. 11s. 6d. per week, the total amount of the wages, exclusive of the first engineer's salary, being £32. 14s. 11d. per week. They had also accepted the following tenders: Messrs. Radford and Co., for the preliminary supply of 50 tons of best Welsh smokeless slack coal at the electric lighting station; Messrs. Burford and Son, amounting to £57. 15s., for fitting up the offices, stores, etc.; Messrs. Maple and Co., amounting to £64. 19s. 10d., for supplying the furniture for the offices; and Messrs. Yerbury and Sons, amounting to £38, for providing an iron hurdle fence with gates at the entrance to the electric lighting station, for providing five electric bells, and for cutting through wall and erecting a new gate on public footpath adjoining, in accordance with the plan prepared by the engineer and to his satisfaction. The committee recommended the Vestry to advertise for the supply of coal to the electric supply station for 12 months, and also to effect an insurance of the station and plant. They also

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recommended that the following cheques be drawn : Messrs. Yerbury and Sons, twelfth instalment under contract for the erection of the central electric supply station, as per certificate of architect, £500; Messrs. Siemens Bros. and Co., fourth instalment under contract for supplying and fixing electric lighting plant, as per certificate of engineer—viz , steam dynamos, £962. 16s., arc lamps and posts, etc., £110—£1,072. 16s. ; total, £1,572. 16s. Mr. Churchwarden Thwaites, chairman of the Electric Lighting Committee, in the course of the discussion upon the reports, said that the men would work in three shifts of eight hours each, and, though the whole of the staff would be required soon, they had only appointed for the present work three assistant engineers, three drivers, three firemen, one regulator, one lamp trimmer, one engine cleaner, one clerk, one store and time keeper, one fitter and his labourer, the wages for whom would amount to £24. 9s. 11d. per week. The idea of the committee was to work as economically as possible, but they hoped that they would soon be warranted in employing the whole staff enumerated in the list put forward by the committee.

Cardiff.—The Property and Markets Committee and Lighting Sub-Committee reported at a meeting of the Cardiff County Council on Monday having considered the subject of installing the electric light at the Town Hall and market buildings, and for this work they proposed the acceptance of a tender by Messrs. Fergusson and Co., of Cardiff, at £523. 10s. The committee also proposed that the chairman of the Property and Markets Committee (Alderman David Jones), and the chairman (Councillor Vaughan) and vice-chairman (Alderman Carey) of the Lighting Committee be sent to London to select electric light fittings for the Town Hall, etc Councillor Vaughan moved the adoption of the report, and Alderman Carey seconded, the latter remarking that it was satisfactory that a local firm had secured the contract, and pointing out there was great discrepancy in the tenders, one being as high as £1,784. Alderman Carey added that they would have the electric light in the town before long, and it was necessary to make some show in their own Town Hall, for they could scarcely ask the public to take the electric light unless they were prepared to show what could be done with it. Councillor Vaughan said that they were only waiting for some gunmetal tubing which had been ordered. All else was ready. By the end of the week the engines would be at work, and they hoped to have the light in a week or two. It was not the intention of the Lighting Committee to supply fittings. The Mayor's name was added to the deputation for the selection of fittings, and the report was adopted. In view of the early completion of the Cardiff Corporation electricity works, the Lighting and Electrical Committee have issued a pamphlet containing a few particulars for the guidance of intending users of the electric light, and they strongly recommend that the wiring of premises be put in hand at once. At the outset the committee state that the current will be alternating at a periodicity of 40 per second and the electrical pressure will be 100 volts. The price for current by meter will be 6d. per unit. After giving the forms of requisition by owners and occupiers and forms of agreement the committee give certain general conditions which are to be observed. The Corporation will provide free of cost a main cut-out and two terminals for supplying electrical energy to the consumers' premises, and also a suitable meter, on conditions somewhat similar to those of a gas company. The rental for meters will be as follows : for every 100 lights, 8 c.p., or proportion of same, £1 per annum. For cut-outs and terminals the charges will be : up to 25 lights of 8 c.p. and 16 c.p., 5s. per annum ; above 25 lights and up to 50 lights, of 8 c.p. to 16 c.p., 10s. per annum ; above 50 lights and up to 100 lights, of 8 c.p. to 16 c.p., 15s per annum ; above 100 lights and up to 150 lights, of 8 c.p. to 16 c.p., £1 per annum ; above 150 lights and up to 200 lights, of 8 c.p. to 16 c.p., £1. 5s. per annum ; above 200 lights, by special agreement. The Corporation will make the necessary connections with the service wires and meter and main cut-out at their own cost, provided the run of branch mains does not exceed 60ft., but the cost of connecting to the internal wiring shall be borne by the consumer.

PROVISIONAL PATENTS, 1894.

SEPTEMBER 17.

17668. **Improvements in connecting dry batteries without the aid of either terminals or wires.** Henry Nehmer, Ferdinand Nehmer, and Thomas Adolphus Reynolds, 27, Sekforde-street, Clerkenwell, London.

SEPTEMBER 18.

17737. **Improvements in or relating to the manufacture and insulation of electric cables.** George Hinde Nisbett, 6, Lord-street, Liverpool.

17741. **Improvements in or relating to galvanic batteries.** William Phillips Thompson, 6, Lord-street, Liverpool. (Albert Lessing, Germany.)

17761. **Improvements in electric arc lamps.** James Brockie, 28, Southampton-buildings, Chancery-lane, London.

17774. **Improvements in electrical signalling apparatus.** The Phonopore Company, Limited, and Edward Wythe Smith, Faraday House, Charing Cross-road, London.

SEPTEMBER 19.

17789. **Improved driving gear for actuating dynamo-electric machines.** George Twigden, Bristol Bank-buildings, Bristol.

17808. **Improvements in electric arc lamps.** Henry Lyon, 87, St. Vincent-street, Glasgow.

17845. **Improvements in electric arc lamps.** James Devonshire, 24, Southampton-buildings, Chancery-lane, London. (Elihu Thomson, United States.) (Complete specification.)

17846. **Improvements in electric arc lamps.** James Devonshire, 24, Southampton-buildings, Chancery-lane, London. (Elihu Thomson, United States.) (Complete specification.)

SEPTEMBER 20.

17922. **Improvements in electric arc lamps.** Michael Immler, 3, Fynes-street, Vincent-square, Westminster.

SEPTEMBER 21.

17968. **Improvements in supporting insulators for electric wires.** Lauren S. Beardsley, 38, Chancery-lane, London.

SEPTEMBER 22.

18032. **Improvements in electric stop motions for machines for preparing and spinning fibrous materials.** Edmund Tweedale, Samuel Tweedale, and Joseph Smalley, Castleton, near Manchester.

18057. **An improved carbon regulator for arc lamps.** Leon Zausmer, 97, Newgate-street, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1891.

4757. **Electric reduction of aluminium, etc.** Willson. (Second edition.)

1893.

16307. **Electric meters.** Swinburne.

17025. **Electric glow lamps.** Sharp.

22131. **Electric switches.** Lowrie. (Second edition.

23177. **Electric time switch, etc.** Jolly. (Richmond.)

1894.

12861. **Electrical fishing apparatus.** Poppowitsch and Wustenfeld.

13756. **Electrolytic cells.** Waite.

14455. **Electric railways and vehicles.** Johnson. (Wheless.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	5	5¼-5⅝
Bournemouth Electric Company	—	—
Brighton and Hove Company Original	100	210-215
—— "A" Ordinary	—	162-166
Brush Company, Ordinary	8	2⅜-2⅞
—— Nom. Cum., 6 per cent. Pref.	2	2⅜-2⅝
—— 4½ Debenture Stock	100	109-112
Charing Cross and Strand	5	4¼-5¼
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	13-14
—— 6 per cent. Cumulative Pref.	10	14½-15
—— 5 per cent. Debenture Stock	115	130-132
City and South London Railway, Consolidated Ordinary	100	36-38
—— Debenture Stock	100	121-123
—— 5 per cent. Pref. Shares	10	12½-13½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1⅞-2¼
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	95-100
Electric Construction, Limited	2	⅛-¼
—— 6 per cent. Debentures	—	87-92
—— 7 per cent. Cumulative Pref.	2	1⅞-2¼
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1⅛-1⅜
Elmore's French Company	2	3/16-5/16
Elmore's Wire Company	2	1⅛-1⅜
Fowler-Waring Cables	5	⅛-1⅛
W. T. Henley's Telegraph Works, Ordinary	10	7½-8½
House-to-House Company, Ordinary	5	1-1⅛
—— 7 per cent. Preference	5	5¼-5¾
India Rubber and Gutta Percha Works	10	23½-24½
—— 4½ per cent. Debentures	100	102-104
International Okonite, Ordinary	—	—
Kensington and Knightsbridge	5	4⅞-5¼
—— 6 per cent. Pref.	—	6¼-6⅝
Liverpool Electric Supply, Ordinary	5	6¼-7
—— Pref.	—	—
Liverpool Overhead Railway	10	7⅞-8¼
—— Pref.	10	12⅞-13
—— 4 per cent. Mortgage Debentures of £100	100	111-113
London Electric	5	—
Metropolitan Electric Supply	10	9¼-10
—— 5 per cent. Reg. Debentures, 1-10,000 in Bonds of £10, £20, and £40	—	—
National Telephone, Ordinary	5	4⅞-5¼
—— 6 per cent. Cum. First Pref.	10	14½-15⅛
—— 6 per cent. Cum. Second Pref.	10	14-15
—— 5 per cent. Nom. Cum. Third Pref.	5	5⅛-5⅜
—— 4½ per cent. Deb. Stock	—	109-112
Notting Hill Company	10	5-6
Oriental and Electric Company, £1 shares	1	1-1⅛
—— £5 Shares	—	7-7½
—— £4½ shares	—	5⅜-6¼
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7-7½
—— 7 per cent. Pref.	5	8¼-9
Swan United	—	—
Telegraph Construction and Maintenance	12	41-43
—— 5 per cent. Bonds	100	103-105
Westminster Electric Supply, Ordinary	5	6¼-6⅝
Yorkshire House-to-House	4½	4¼-4⅜

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NOTES.

"Professor" Preece.—Such is the title given to Mr. W. H. Preece by the *Daily Chronicle.*

An Extraordinary Complaint.—The *Globe* complains that in many of the London streets the arc lights are far too brilliant.

Electric Light and Gas.—A correspondence is going on in the *Sheffield Telegraph* on the subject of the respective merits of the electric light and the Welsbach gas-burner.

Teignmouth.—The gasworks of the Local Board are in debt to the extent of £1,160. What position would they be in if a company started the supply of electric light?

Fire.—Early on Wednesday morning a fire broke out on the premises of Messrs. Andrews and Co., electrical engineers, 15, Morsham-street, Westminster. The building was practically destroyed.

Electric Light Carbons.—It is stated that the Allgemeine Elektricitäts-Gesellschaft, of Berlin, will shortly manufacture carbons on the principle invented by Messrs. F. Hardtmuth and Co., of Vienna.

Telephony in the Austrian Army.—Provision is made in the Austro-Hungarian budget for a sum of £2,000 for 14 sets of telephone apparatus, etc., for the establishment of communication in the field.

London Gas.—A conference was held on Tuesday at Hammersmith to complain of the London charges for gas, and formulating other complaints about the form of illuminant which is now passing away from us.

Telegraphy in Mexico.—In a recent message to the local legislature, Governor Villada, of the State of Mexico, says he has devoted attention to the encouragement of public works such as the erection of telegraph and telephone lines.

An Electric Ballet.—On Monday, 15th inst., "The Carnival Electrique" will be transferred from Blackpool to the Oxford Music Hall, London. It is stated that the *finale* is a scene in which the flashing of numerous lamps is cleverly worked.

Junior Engineering Society.—The annual general meeting of this society will be held this (Friday) evening at the Westminster Palace Hotel. To-morrow afternoon a visit will be paid to the gigantic wheel works, Earl's Court Exhibition.

Telephony in Germany.—Telephonic communication will shortly be established between Berlin, Cassel, and Frankfort-on-the-Maine. On Monday telephonic connection was opened between Bremen, Berlin, and Hanover, and also between Cologne and Hamburg.

An Acknowledgment.—We beg herewith to acknowledge the strict respect paid to journalistic etiquette by *Kuhlow's German Trade of Review*, of Berlin, which constantly scissors electrical paragraphs and articles from the *Electrical Engineer*—without any acknowledgment whatever.

The "Electrical Engineer" Testing Set.—Bearing the title of the "Electrical Engineer" resistance-box and the "Electrical Engineer" galvanometer, Mr. W. Turvey, of Notting Hill-gate, has introduced a complete portable testing set, which we hope to illustrate in a future issue.

Telephony in Hungary.—The Hungarian Minister of Commerce proposes to establish telephonic communication between all the larger towns of the kingdom and Budapest. The system is primarily intended for administrative purposes, and secondly for public use. The work is to be carried out within two or three years.

Personal.—Mr. Ernst Thurnauer, general manager in Europe of the General Electric Company, of the United States, and a director of the Compagnie Française pour l'exploitation des Procédés Thomson-Houston at Paris, and of the Union Elektricitäts-Gesellschaft at Berlin, has joined the Board of the British Thomson-Houston, Limited.

Electric Lighting in Switzerland.—The new electric light station at Lotzwyl, which has been carried out by the Zürcher Telephon-Gesellschaft, Aktiengesellschaft für Elektrotechnik, is proving very successful. About 300 16 c.p. lamps can be supplied, and most of these have been taken up. Power is obtained from turbines.

Institution of Civil Engineers.—A recently issued list of members, corrected to September 6, 1894, shows that there are now on the roll of the society 19 honorary members, 1,837 members, 3,597 associate members, and 358 associates—together, 5,811. The students attached to, but not forming part of the corporation, now number 782.

Electric Traction in Hungary.—Mr. Koloman Gulàcsy has received the concession for an electric tramway between Ofner, Kettenbrückenkopf, Gachsenfeld, and Promontor. A project has been prepared by Mr. Alois Bernaczik, of Bielitz, and Mr. Max Déri, of Vienna, for an electric railway between Bielitz and Ober-Ohlisch, in Austrian Silesia.

Telephony in France.—M. G. Fribourg has published in *Le Génie Civil* some statistics as to progress of telephony in France. On September 1, 1889, there were 6,255 telephone subscribers in Paris and 5,185 in the provinces, making a total of 11,440. On May last the numbers had risen to 13,060 in Paris and 12,798 in the provinces, making a total of 25,858.

Electricity in the Transvaal.—The general manager of the Transvaal Gold Exploration and Land Company reports in connection with their new plant that the turbine has been completed, and that work is being continued on the foundations for the dynamo and electric motor. The electric transmission cable has arrived and the cable poles are being delivered.

Russian Military Electrical School.—According to *L'Invalide Russe*, the Czar has issued an order creating in St. Petersburg a military electrical school, the object of which is to prepare engineering officers for special functions where electricity is employed, to form instructors for the men in the engineers, and to study electrical inventions which may prove useful in military service.

The Trans-African Telegraph.—A Reuter's cablegram states that the first section of the trans-continental telegraph is now open as far as Blantyre, and, prior to his departure from Salisbury, Mr. Rhodes received a telegram of farewell from Mr. Sharpe, the administrator. This despatch was sent by a native operator, and was received by Mr. Gordon, a nephew of the late General Gordon, the officer in charge of the Salisbury-Tete section of the telegraph.

New Swindon.—The report of the Electric Lighting Committee was read and approved at the last meeting of the General Purposes Committee of the Local Board. The committee recommended that application be made to the Board of Trade for a provisional order for lighting the district of New Swindon by means of electric light. It has been resolved to make the necessary application, and to take all the necessary steps forthwith to carry out the recommendation.

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Electric Lighting in Russia.—The central electric light station in St. Petersburg, for which Mr. Smirnhoff has obtained a concession, will be supplied with plant by Messrs. Gantert Bros., of Moscow, the Russian representatives of the Oerlikon Works, and of Messrs. Escher, Wyss, and Co., of Zurich. There will be four alternating-current Oerlikon dynamos, each of 200 kilowatts, each being driven by a vertical triple-expansion engine of 350 i.h.p., made by Messrs. Escher, Wyss, and Co.

German Electro-Chemistry. — The first annual general meeting of the German Electro-Chemical Society is to be held in Berlin to-day and to-morrow. Among the papers to be read are the following: "J. W. Ritter, the Founder of Electro-Chemistry," by Prof. Ostwald; "The Practical Utilisation of Ozone," by Dr. Fröhlich; "Experiments in the Utilisation of the Chemical Energy of Coal as Electricity," by Dr. W. Borchers; and "The Boundaries of Electrolysis," by Dr. le Blanc.

Peculiar.—Sir Augustus Harris has introduced incandescent gas lamps in Drury-lane Theatre. This is a peculiar proceeding, but the Strand Board of Works are probably accountable for it. Their Lighting Committee have recommended that the application of the Charing Cross and Strand Electricity Supply Corporation for leave to lay mains in the parish of St. Paul, Covent Garden, for the purpose of supplying electric light to Drury-lane Theatre be refused. The Board of Works have agreed to the same.

Telephony in Denmark.—Reuter states that the projected State telephone between Copenhagen and Fyen will probably be constructed during the present autumn, and credits are now demanded for the establishment of a telephonic service between Fyen, *vid* Jütland, to the German frontier. This line is intended to form a link in eventual telephonic communications between Copenhagen, Hamburg, and Kiel, from Copenhagen to Nykjöbing, on the island of Falster, and in Jütland from the German frontier to Aarhuus.

Cardiff.—The Public Works Committee of the Town Council have considered a letter read by the town clerk from Mr. Lynch-Blosse, Conway-road, objecting on behalf of himself and sister to the extension of Mr. Sidney Walker's electric works close by; also a letter from Mr. Walker, enclosing a memorial from residents of Conway-road and Severn-road who were in favour of his application. He also stated that he had gone into the matter, and found that the committee had no power to prevent Mr. Walker building on the ground selected, but the ground landlord might.

Telephony in the Eastern Counties.—The trunk telephone line which has been erected by the Post Office authorities between London and Chelmsford, Colchester, and Ipswich, has been opened for public use. A "silence cabinet" has been erected in the Ipswich post office, and three minutes' conversation may be had with Colchester for 3d., with Chelmsford for 6d., with London for 1s., and with Brighton for 1s. 6d. Connections will shortly be made through London with other great towns of the United Kingdom, and the officials have already spoken with Paris.

Electric Transmission of Power in Switzerland.—The Lucerne Municipality have appointed a commission of experts to enquire into the further utilisation of water power for the electric transmission of power for small motors. The utilisation of water power in Switzerland for the electric transmission of power is making constant headway. A large central station is being established in Wynau by Messrs. Siemens and Halske on behalf of the local authorities of Langenthal, who will charge £4 per annum for 1 h.p., and cheaper rates for larger quantities. Another station is to be erected at Rappoldingen by Messrs. Brown, Boveri, and Co. There is 2,700 h.p. available.

Where was Moses?—According to a local paper, a singular incident occurred at St. Nicholas's Church, Bristol, on Sunday. The preacher, selecting a text for the times, dwelt upon the present phase of unbelief, and spoke of one of those phases having developed a disinclination to believe anything which could not actually be seen. "Picture," said the preacher, "the blind telling us that the things around us with which we were familiar were not in existence because the blind themselves could not see them!" The preacher had uttered the words, "there are things around us which we cannot see"—when out went the electric light, leaving the place in utter darkness as there came from the preacher's lips the context—"although we are sure they are there."

A Prize Competition.—The Société Industrielle d'Amiens, 20, Rue de Noyon, Amiens, have decided upon the subjects of the competition for 1894-5: a gold medal for a mechanical or chemical generator of electricity fulfilling the most economical and efficient conditions; a gold medal for the best electric light installation at work for over a year in an industrial establishment, the installation being more economical than gas, the basis of comparison being a works having 300 to 500 burners and manufacturing its own gas; and a gold medal for a new and economical application of electro-chemistry in the district. Foreigners are allowed to compete, but all papers must be written in French. Manuscripts or machines are to be sent in by the end of April next.

Suggested French Cables.—According to Dalziel's Paris correspondent: "Now that the mission to Madagascar is being so much talked about, and the probability of a military expedition discussed, attention is once more being drawn in the Press to the fact that all the confidential communications which M. le Myre de Vilers will have to make to his Government will pass over an English cable, and stress is laid on the great harm this may cause to France. The matter is even considered so important that an agitation is being got up with the view of inducing the Government to organise independent cables all over the world, and to see if one of the great French telegraph companies cannot be induced to lay one immediately for use during the approaching military operations, which are now looked upon as unavoidable."

Electric Traction in Germany.—The Berlin local authorities have decided to call upon the Grand Berlin Horse Tramway Company to proceed at once with the work of laying a tramway from Reichenbergerstrasse to Treptow, as otherwise the project will be passed over to another company. A tramway is also to be constructed in Berlin from the Wienerstrasse *vid* Wienerbrücke and Köpenicker Weg to Treptow. The Berlin Municipality have sent a deputation to Dresden to see Mr. Langen's electric tramway there. The Berliner Elektricitäts-Gesellschaft has formulated a scheme for the erection of an electrical station at Harburg for working an electric tramway, as well as for the supply of current for lighting and motors. The Elektricitäts-Gesellschaft "Union," of Berlin, have been negotiating with the Elbing Municipality to build an electric tramway in that town.

Telephony at the Law Courts.—It is stated that by permission of Lord Chief Justice Russell an interesting experiment in telephony is being made at the Royal Courts of Justice in the Strand. This is the adoption of the system which has been tried in theatres and in churches, by which

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the subscribers to a telephone exchange are able to hear what is going on in the particular room with which the telephone wire is connected. The experiment is being made in the court of the Lord Chief Justice, where advantage is being taken of the recess to fit a receiver close to the bench, a second at the desk of the clerk of the court, or associate, as he is called there, and a third at the counsels' bench. The idea is that solicitors and others who are interested in any case may, by having their telephones connected with the court of the Lord Chief Justice, listen in their own offices or residences to the legal arguments which are advanced on the one side or the other, as well as the decision of the judge. If successful, the system will be introduced into the other courts.

Transmission of Power in Italy.—An installation of the electrical transmission of power from Pale to Foligno is now being carried out, this being the first plant of its kind in Italy where polyphase currents will be used. The power will be obtained from the Menatre, in the proximity of Pale, and the water will be conveyed to the turbines at the generating station in Pale by means of a canal and conduits. There will be installed three turbines, each of 100 h.p., and each coupled direct from its horizontal shaft to a polyphase generator giving current at 2,000 volts. The length of the primary conductors, which are divided into two circuits, is 4·34 miles. One of these circuits will energise transformers for the supply of current for lighting purposes, and the other for motive power. The distributing station is situated in the centre of Foligno. From here the high-pressure current will pass to nine transformer stations, where the current will be distributed to consumers. The electrical plant emanates from the Oerlikon Maschinenfabrik, and the turbines from the Società Italo-Svizzera, of Bologna.

An Electrical Accident.—Last Sunday afternoon two employés of the Brush Company were repairing one of the switch pillars which stand about 20ft. apart along the switch gallery of the station of the City of London Electric Lighting Company, Limited, at Bankside. One of the men, a fitter, was at work behind the pillar, about 5ft. from the gallery floor, having used a ladder for getting up. His labourer, a man named Hearne, took the ladder away unnoticed, placed it against an adjacent pillar which was "alive" at the time, and went up to the top, where the only exposed contacts are. The first intimation that anything was wrong was conveyed by a scream from the injured man, and on the fitter coming round to the front he saw his mate lying on the gallery. He jumped down, and with the assistance of the station hands, who were soon on the spot, tried to resuscitate the man, but their efforts were unavailing. A doctor arrived shortly after the accident, but he immediately pronounced life extinct. The deceased had been employed on work of the same kind for about two months, and knew thoroughly the danger of touching anything. Only 15ft. from where the accident occurred a notice was displayed absolutely forbidding anyone to do the very thing which led to the man's death. The pressure was 2,000 volts alternating. No burns or discolouration were noticed either on the skin or clothing of the man, but there was an ugly wound on the back of his head caused by the fall against the gallery railing.

Electric Lighting in France.—The company which has undertaken to light the streets of Gucret electrically has commenced to lay the mains; the work is to be completed by January 1. Action has been taken by the owner of the gasworks at Bar-le-Duc against the Municipality for having granted a concession for electric lighting to Mr. Goret. An agreement has been come to between the Biarritz Municipality and the local gas company by which the latter will supply the electric light to the town. Mr. Charton, of Charlieu (Loire), has proposed a scheme for the erection of a central electric light station, which is under the consideration of the authorities, but there is the difficulty in the way that the gas company hold a concession which does not expire until 1911. The electric light is making good headway at Dijon. The local company was formed in 1891, and the following year supplied 1,000 lamps. The figure has now gone up to 8,000 lamps. A central station has been opened at La Terrasse (Isère). Power is obtained from the Carre cascade. The plant has been furnished by Messrs. Alioth, of Basle. Longuyon (Meurthe-et-Moselle) has had the streets hitherto lighted by oil, but will now adopt the electric light. The work will be carried out by Mr. Charles Brézol, of Charleville. At St. Rambert (Ain) a central electric light station is to be established, power being obtained from the stream about a mile and a quarter distant, where about 120 h.p. is available. Seven tenders have been received for electric lighting the port and canal of Caen, and a special committee has been appointed to look into them. The railway station and town of Capdenac are to be lighted by electricity. A committee has been appointed by the Neauville Municipality to enquire into the subject of introducing the electric light. At Aix-les-Bains the local authorities are pressing the gas company for a speedy reply as to whether they are or are not prepared to supply the electric light. Various offers have been made to the Municipality, who desire to have the electric light. Offers have been made to Cosne-sur-l'Œil (Allier), a town of 2,000 inhabitants, for a double scheme of water and electric light supply.

The Waterloo-City Electric Railway. — The *Standard* has now discovered that an electric railway between the City and Waterloo is in course of construction. In the course of an article, it says: The new line has unbroken continuity of more than a mile and a half from the great terminus of the London and South-Western line—a length sufficient for the keenest competition with the omnibuses. Great relief to the street traffic will be afforded by an underground circular subway surrounding the great central underground station, with its booking offices, lifts, and passenger platforms. This will occupy all the space between the ends of Queen Victoria-street, the Poultry, Princes and Threadneedle streets, Cornhill, and Lombard-street. Further interest attaches to the new line of being the first to enter into the longest and most important underground central station of the busiest locality in the world. The circular subway will have its floor at 10ft. below the present surface, and will be itself 8ft. in height, there being 2ft. of roof above it. Access will be had to it by stairs at the angle corner of Queen Victoria-street and the Poultry; at the angle of the Union Bank with Princes-street; at the opposite corner of the Bank of England; in front of the Royal Exchange; at the angle of Cornhill with Lombard-street; at the side of the Mansion House in Walbrook; and at the angle of Walbrook with Queen Victoria-street. By it passengers can pass to or from any of those points without being exposed to the dangers of crossing the busy traffic, or the surface above ground. These stairs have been planned in the slackways which vehicular traffic always leaves near the corners of the streets, so that they will not interfere with the horse roads or the footways. At the Waterloo end the arrangements are planned with special regard to the convenience of passengers arriving or departing by the trains of the South-Western Company. The electric railway will enter at the arches on which the terminus is built, and at right angles to the whole of the numerous

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arrival, departure, and suburban platforms, from each of which descent by stairs will give access to the platforms of the new railway. The work is being carried on under the joint engineering control of Mr. Galbraith, of the South-Western, and Mr. Greathead. The contract for the two parallel tunnels has been let, and the caissons which will form the means of access to the borings have already been sunk under the staging at Blackfriars Bridge to a depth of 50ft. As soon as the depth of the floors of the intended tunnels (65ft.) is attained, the four protecting shields and the mechanical excavators will be lowered into position, and the driving of the tunnels will be carried on simultaneously in both directions. The site of the generating station has not been fixed upon, but it will probably be at the Waterloo terminus. There will have to be reviewed the question of short trains and short intervals, or long trains and long intervals, although the nature of the traffic arriving by railway main-line trains and by suburban trains will be an essential factor in its determination on the Waterloo and City line.

Laying of New Mains.—The Highways Committee of the County Council reported on Tuesday they had during the recess sanctioned, subject to certain conditions, the laying of electric lighting mains by the Notting Hill Electric Lighting Company, the House-to-House Electric Light Supply Company, and the Woolwich District Electric Light Company. The County of London and Brush Provincial Electric Lighting Company gave various notices under the County of London (North) Electric Lighting Order, 1892. There is, however, one most important point connected with the system of supply proposed to be adopted by the company to which the committee directed special attention. The company proposes to lay high-tension mains from the generating station to transformer-chambers and thence by means of low-tension cables to the consumers. These transformer-chambers, of which under these notices more than 50 would be constructed, and each of which would according to the plan submitted by the company occupy a space of about 13ft. deep, 12ft. long, and 7½ft. wide, the company proposes to place under the surface in the public thoroughfares; and the committee are strongly of opinion that, as it is quite possible for the work of distribution to be carried on if the necessary accommodation were provided in premises adjoining, the Council should hesitate before acceding to the proposition that the public thoroughfares shall be used for the purpose. They have directed that the attention of the Board of Trade shall be called to this matter, with a view to its consideration in connection with the approval or otherwise of the company's system of supply. They accordingly recommended that the sanction of the Council be given to the laying of the mains, and the construction of the small drawing-in and junction boxes, but not the transformer-chambers; that the mains be laid under the footways wherever it is found practicable to do so; that the low-tension mains be placed 9in. below the underside of the paving, and those of high tension at least a foot lower; that no street boxes shall be constructed until full details shall have been submitted to and approved by the Council's chief engineer; that separate boxes be used for the high and low tension mains respectively; and that, as an additional precaution against accident through defective insulation of the mains, each of the high-tension street boxes be provided with an inner as well as an outer cover, the two insulated from each other as far as practicable, and that the outer cover be efficiently connected to earth; and that the Council do formally signify its disapproval of all the works referred to in the nine notices, other than the laying of the mains and the construction of the small drawing in and junction boxes, in the area shown upon the plan No. 198 submitted with the notices. Notices have also been received from the same company under the Wandsworth Electric Lighting Order, 1892, from the Kensington and Knightsbridge Electric Lighting Company, the Vestry of St. Pancras, the St. James's and Pall Mall Electric Light Company, the Charing Cross and Strand Electricity Supply Corporation, the Westminster Electric Supply Corporation, and the Vestry of Islington.

Feeder and Main Patent.—Judge Acheson, of the United States Circuit Court of Appeals in Philadelphia, has given a decision in the case of the Edison Electric Light Company against Westinghouse, Church, Kerr, and Co. The suit was brought for injunction and damages because of the alleged infringement of the Edison feeder and main patent. In the United States Circuit Court for New Jersey last March an interlocutory degree granting the injunction was granted by Judge Green. An appeal was taken to the Circuit Court of Appeals. Judge Acheson's decision is in favour of the defendant, and in his opinion the judge said: "This patent does not deal with the complicated general problem of the distribution of electricity and the subdivision of the current for the purpose of domestic illumination. The patent is not for an incandescent lamp or for a dynamo for generating electricity, or for the arrangement of the lamps in multiple arc, or for indicating and regulating devices for controlling the current from a central station, singly or combined. The patent deals with the one particular difficulty of drop in tension or fall in pressure—loss of E.M.F.—due to the resistance of the conductors to the electric flow. To remedy the evil effect therefrom, the patentee provides special conductors for the transmission of electricity extending from the generator to the main conductors, with which the lamps are connected and from which they are served. The patent is for a specific arrangement and proportioning of the two sets of conductors, which, together, constitute the complete circuit." After a long review of the controversy, the judge continued: "The plan of electric distribution covered by the claims in question is not 'the creative work of that inventive faculty which it was the purpose of the constitution and patent laws to encourage and reward.' To sustain these claims would be to sanction a monopoly in that which belongs to the public." In conclusion, the judge said: "The appellant maintains that, under the ruling of the Supreme Court in the case of Miller *v.* Eagle Manufacturing Company, the first, second, and third claims of the patent in suit are void, because of the grant of an earlier patent to Mr. Edisen . . . . which dealt with the evil of drop in tension, and provided a remedy by feeding conductors, having no lamps therein, connected with the mains of the consumption circuits arranged in sets concentrically around the central generating station, and so proportioned as to secure equal electrical pressure throughout the entire system. It is contended that the invention described and claimed in the earlier patent is for one form of the alleged invention described in the later patent and covered by the three first claims thereof, and that no one could use the invention of the earlier patent without infringing these later claims. The question thus raised is a serious one; but we do not deem it to be necessary to consider it, inasmuch as the views we have expressed upon the other branch of the case are decisive. The decree of the Court below is reversed and the cause is remanded, with directions to enter a decree dismissing the bill of complaint with costs."

Wonders of Science.—A scribe, writing under the initials of "J. H. R.," has been endeavouring to enlighten the readers of *Black and White* on the "wonders of

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science—a forecast." The illustrations accompanying the article are not bad, but as they bear the artist's name under date of 1892, *Black and White* must have kept them in stock a long time. It is a pity that "J. H. R.,' before writing the forecast in question, did not make himself properly acquainted with what has been done in regard to electric fire-engines and submarine boats. The two leading makers of steam fire-engines have already constructed electric fire-engines, but they have wisely refrained from using storage batteries, simply mounting an electric motor on the engine to actuate the pumps, the current being obtained from a street main. But the idea of storage battery fire-engines seems to be wide of the mark. Even the one illustrated appears to travel so slowly that the boys running in front of it are taking it easy. As to submarine boats, possibly "J. H. R." has never heard of the French "Gymnote" and one or two other submarine electric boats experimentally tried by the French and Italian Governments. However, let "J. H. R." speak for himself: "In the department of electricity alone the question is, where are we going to stop? The lessons learnt from the City and South London electrical subterranean railway, which may be taken as a typical development, have been many and various. There are some half-dozen projects of the kind in view, and we may reasonably look forward to a complete metropolitan network of cheap and speedy subterranean railways—a consummation the contemplation of which would have positively shocked our grandfathers, who were so much astonished at the "Puffing Billy" of the not very remote past. Two of the accompanying illustrations deal with electric motors for the road and the sea. In the former is shown the storage battery at work on the useful 'bus, the fire-engine and the 'trike' all illuminated by the electric light. Although the other day Londoners had the opportunity of witnessing a vehicle propelled by such means running through Cheapside, not so much public attention has been paid to electrical road traffic as the subject deserves. It is true that, as regards surface rail and tramways, marked advances have been made, notably in the North of Ireland and at Walsall, to go no further than these islands. It is always easier, however, to obtain encouragement (and capital) for a big enterprise which appeals to the imagination than to secure support for a purely industrial undertaking, even though the latter may promise to revolutionise our everyday doings. But considering what we know and have done already, it is not at all unreasonable to assume that the horse will be superseded for rapid traffic in our cities, while the electrical tricycle suggests wonderful possibilities. With regard to sub-aqueous enterprise, the limit at present is found in the submarine engine of war, which is looked upon for various reasons as little more than a dangerous toy. But what possibilities have we not here? It may be supposed that no one would be found to argue that a passenger service of the kind illustrated could not be conducted across the Channel. The main question to be considered is not one of possibility from the point of view of the boat, but whether it is worth while financially to engage in such an undertaking, coupled with the necessary consideration whether the Channel on account of depth and traffic is fit for it."

Indo-European Telegraph Tariff.—The Chamber of Commerce at Madras has addressed the following letter to the Government of India: "The Chamber has from time to time pressed upon Government the necessity felt for a reduction of the telegraph tariff between India and Europe. A lecture delivered recently before the Society of Arts by Mr. E. O. Walker, C.I.E., late of the Telegraph Department, has again drawn the attention of the Chamber to the matter, and in view of the approaching international telegraph conference, which will assemble in 1896, I am desired to solicit that the Government of India, in furtherance of the object, will use its influence to secure instructions being given to the Indian delegate who will attend the conference to press for a reduction. Setting aside the probability of an increase of traffic following upon a reduction in charge, which has generally been the case, it is thought that the profits made upon foreign telegrams at present are sufficiently large to admit of at least a tentative reduction. For Indo-European messages the share of the Indian Government amounts to something like Rs. 6,00,000 per annum. In addition, the tolls in transit of messages to and from the Far East bring in a rather larger amount. These earnings must amply meet the interest on capital outlay on the circuits, the cost of maintenance, and the wages of the staff employed to deal with foreign telegrams in India, as well as the expense of check, account, and audit; and it is in this view that the Chamber feels that there is a strong case for the consideration of Government. The Telegraph Department may naturally wish to show good results by massing inland and foreign message revenue, charges for railway telegraphs, and receipts from other sources; but the Chamber respectfully submits that when returns begin to exceed the expenses in any particular direction, the branch of the community which contributes to those returns should receive some remission of charges. It is believed that this aspect of the case will commend itself to Government. As regards the financial result to the Telegraph Department, the Chamber believes that if the tariff were lowered yearly by eight annas per word to Rs. 2, or even less, there would be no loss. This opinion is strengthened by the fact that it has been possible to reduce, since May 1, 1891, the rate between England and the Australian colonies (Queensland excepted) by nearly one-half, and the additional traffic attracted by a lower charge has at the present time compensated for the estimated loss of revenue. At first it would appear that a sacrifice was made, but this occurred, doubtless, from too large a reduction in tariff (one-half) being effected at one time. The Chamber advocates a gradually descending scale. Again, when the minimum chargeable unit for telegrams with Europe was reduced on January 1, 1876, from ten words to one word, in the year following, although the average value of such messages decreased 12 per cent., private senders despatched 22·44 per cent. more messages, and the gross value of the traffic increased by 5·34 per cent. In the year following that again the number of messages increased by 38·14 per cent., and the gross value 27·28 per cent. To take another instance which illustrates the contention of the Chamber. Up to January 1, 1882, a telegram in India cost a minimum of one rupee. On that date the 'deferred' class was introduced. In the year 1881-82 private messages in India numbered 1,035,137, and were valued at Rs. 13,16,851. In the year following (when the eight-anna telegram was sanctioned) there were 1,539,975 telegrams, valued at Rs. 26,18,298. Some years ago, the Chamber is aware, the Indian Government had to consider, in connection with foreign tariff, the loss accruing from the Persian lines and cables—that is, of the Indo-European Telegraph Department—but that loss has now disappeared. As regards the Eastern Telegraph Company and the Indo-European Telegraph Company, the dividends now being paid are so good, and their reserve funds laid by out of earnings so large (over £600,000), that the Chamber thinks that these companies may with propriety be asked to share the risk of a reduced tariff."

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EALING ELECTRIC LIGHTING.

The installation described in our last issue was formally opened on Wednesday last by Mr. E. M. Nelson, J.P., chairman of the Local Board, in the presence of a goodly assemblage of invited guests. As we have already described the work, we have only briefly to refer to the proceedings of the evening. Punctually at 6.45 the guests assembled in the dynamo-room, and after a few introductory words from Mr. Graham Harris (Messrs. Bramwell and Harris) the chairman switched on the current, and the energising of the pilot arc was greeted with cheers. We were unable in our last issue to illustrate the switchboard provided by Messrs. Siemens, but that lapse is now remedied, and the accompanying drawing will enable the reader to understand the arrangement. There are two main switchboards—one for public and the other for private lighting. The connections on the board for private lighting allow of either or all of the four alternators being connected either singly or in parallel to any one or all of the four feeder mains, or of either or both exciters being connected to either or all the alternators. The switchboard for public lighting is similar to the alternator board, and is so arranged that any one of the three direct-current machines can be connected to either one of the two circuits upon which the arc lamps are placed. After switching on the current the company left in brakes for the Public Buildings, in the hall of which, as our readers know, an electric exhibition has been arranged. Here Mr. Nelson dwelt briefly upon the history of the electric light movement in Ealing, and insisted that the work was good, and that the day was a most auspicious one in the annals of the district. While speaking, the lamps at the various stands had been switched on, and the declaration "that this exhibition is now open" was greeted with cheers and the martial sound of the trumpet. Subsequently the band discoursed sweet music, while the invited guests made still another move to the Lyric Hall, wherein they were entertained to dinner by the authorities. The dinner was well served, and the after-dinner speeches commendable for their brevity. After the toast of "The Queen," Mr. C. Jones gave "The Town and Industries of Ealing." He described his career at Ealing, coming

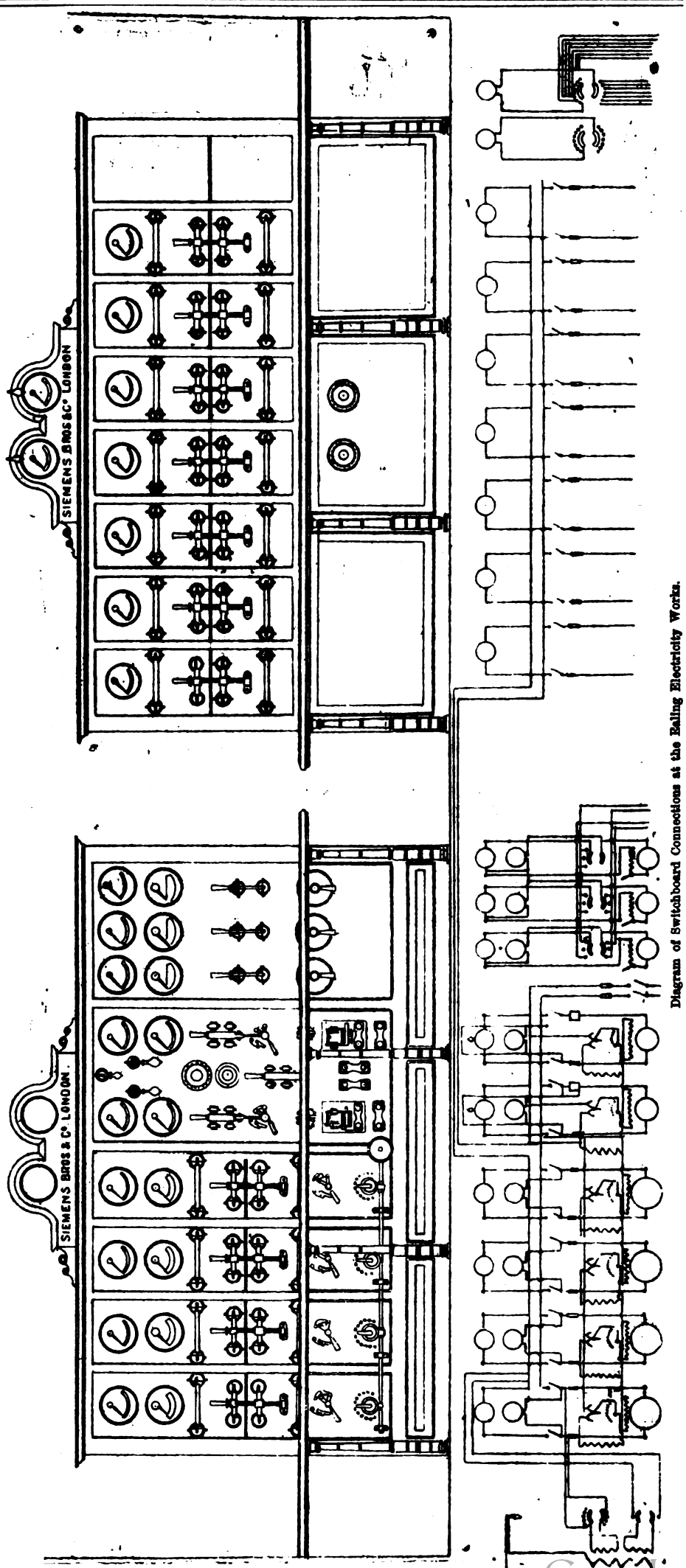

Diagram of Switchboard Connections at the Ealing Electricity Works.

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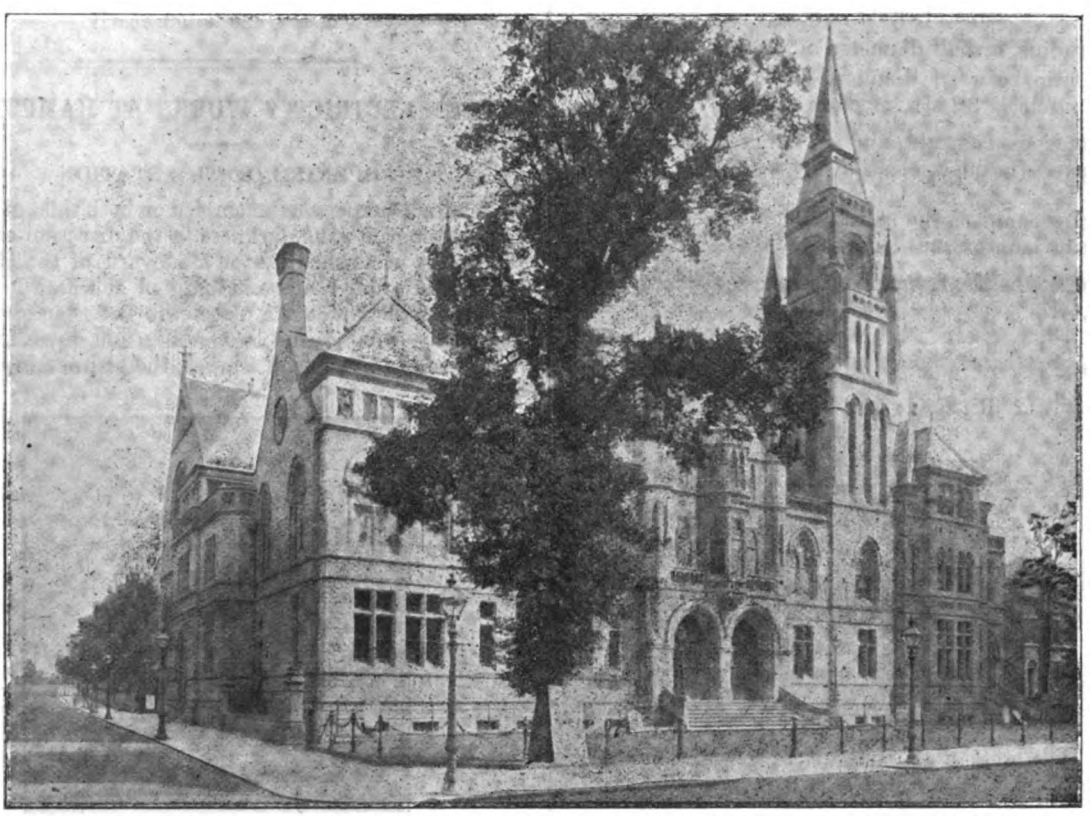
there when it was a mere village, making in those early years a rate upon £17,000 ratable value, watching and participating in its growth till its ratable value had arrived at something like £175,000. He looked upon Ealing as one of the most progressive and best-managed towns in suburban London. It was perfectly evident his hearers thought so likewise, as did the business men who responded to the toast. The chairman had the next toast, and gave "The Engineers" (Messrs. Bramwell and Harris), describing how under great difficulties they had kept their word in being ready to open that night. Sir Frederick Bramwell, in a few happy phrases, declined the credit of the work, throwing that upon the shoulders of Mr. Graham Harris. The latter, in his reply, gave Sir Frederick a Roland for his Oliver, acknowledging the difficulties and crediting the success of overcoming those difficulties to the contractors, whose healths he toasted, and to which toast Mr. A. Siemens and Mr. T. Callender replied. "The Visitors" and "The Chairman" concluded the



Ealing Public Buildings

business of a pleasant evening, and we will simply re-echo the words of various speakers and wish success to the Ealing installation.

CITY AND GUILDS OF LONDON INSTITUTE.

LECTURE IV.—FORMULÆ AND EXAMPLES CONNECTED WITH OHM'S LAW.

(Specially contributed.)

Having Ohm's law, it is easy to tell the voltage required to produce any required current in a wire of given resistance.

Example 1.—Given a wire of two ohms resistance, what voltage is required to obtain a current of 18 amperes?

$$C = \frac{E}{R};$$

putting the given values in the equation, we have

$$18 = \frac{E}{2},$$

or,
$$18 \times 2 = E,$$
$$36 = E:$$

that is, we require 36 volts.

Example 2.—Suppose we have a resistance of $\frac{1}{4}$ ohm, and require a current of 200 amperes. What voltage must we have?

Again putting the given values in the equation,

$$200 = \frac{E}{\frac{1}{4}};$$

or,
$$200 \times \tfrac{1}{4} = E;$$
$$50 = E;$$

that is, we require 50 volts.

Calculations, however, are not usually so simple as this in practice; and unless you can apply your knowledge to practical work, it is of little service to you. Let us first turn our attention to the resistances that go to make up a circuit, and for the moment trouble only about the external circuit. Usually, the conductor in the circuit consists of copper wire of circular section. The formulæ, however, which we obtain will serve for any conductor of circular section.

I have here a piece of wire. Call its length L. Taking another piece of wire of exactly the same section, and connecting it to the first, we have now a length of conductor = L + L, or, = 2 L.

L L

When conductors are added one after the other like that, they are said to be in *series*, or we may speak of them as resistances in series.

Let us symbolise resistance by R. Then if

R represent the resistance of a wire of given length, material, and sectional area,

2 R will represent the resistance of double that length, the materials and sectional area remaining the same.

Thus, the total resistance of any number of resistances in series is the sum of the separate resistances.

If, then, we have four separate resistances in series, having respectively 4, 5, 6, and 7 ohms resistance, the total resistance is 4 + 5 + 6 + 7 = 22 ohms.

Now, if we take any conductor like this copper wire we can at will alter its length or its sectional area, or both, or we can alter the material of the conductor. Whatever change we make, whether of length, sectional area, or material, has its independent effect upon the resistance of the circuit.

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We have seen that the resistance of any particular wire increases directly as its length; let us now consider the effect of sectional area.

Here are two wires of the same material, length, and section, and I find that by putting these two wires side by side

$$\frac{R}{R}$$

or, as we say, in parallel, the resistance R is not 2 R nor R, but $\frac{R}{2}$.

Doubling the sectional area, then, has halved the resistance, but if I have doubled the sectional area I have doubled the weight, W. Thus, resistance with length and material kept the same varies inversely as the sectional area or the weight.

When the sectional area is circular in form—as it usually is when wire is used—its area is represented thus:

$$\text{area of circle} = r^2 \pi;$$

where r = radius, or half diameter of circle;

π = ratio between diameter and circumference of circle = 3·1416, or more roughly $\frac{22}{7}$.

The value of π is constant, and so the area of any circle must vary as r^2 (radius^2), or as d^2, where d represents the diameter.

We can now compare the resistances of two wires, when we know their lengths and diameters.

Let R and R_1 be the respective resistances;
L „ L_1 „ „ lengths;
d „ d_1 „ „ diameters;
S „ S_1 „ „ sectional areas;

then $$R : R_1 :: \frac{L}{d^2} : \frac{L_1}{d_1^2};$$

$$\frac{R}{R_1} = \frac{\frac{L}{d^2}}{\frac{L_1}{d_1^2}} = \frac{L\,d_1^2}{L_1\,d^2}$$

If sectional area is known this formula is written,

$$\frac{R}{R_1} = \frac{L\,S_1}{L_1\,S}.$$

Fortunately, in practice most of the common calculations are tabulated so that it is only necessary to consult the tables, but it is better that you should thoroughly familiarise yourselves with methods of calculation, rather than rely only on tables which when wanted may not be at hand.

Example 3.—Two wires of the same length and material are found to have resistances of 4 ohms and 11 ohms respectively. If the area of the first is ·0064 square inch, what is the area of the second?

Here length is the same, so we need not trouble about it in the formula, but use

$$\frac{R}{R_1} = \frac{S_1}{S}.$$

Putting in the formula the known values, we get

$$\frac{4}{11} = \frac{S_1}{\cdot 0064},$$

or,
$$\frac{4 \times \cdot 0064}{11} = S_1$$

$$= \frac{\cdot 0256}{11} = S_1$$

$$= \cdot 0023 = S_1,$$

that is, the sectional area of the second wire is ·0023 square inch.

Taking Glover's tables, we find the resistance of 1,000 yards of $^7/_{20\cdot5}$ S.W.G. wire at 60deg. F. given as 4·0864 ohms, and same length, etc., of $^7/_{25}$ as 11·124 ohms, while area of former is given as ·0064 square inch, and of latter as ·0022. In the above question the resistances are not taken exactly the same as in the tables, but sufficiently near to see that the result is correct. If required, we can get the diameter of the wires from the area, for area = $r^2 \pi$, as before stated.

Example 4.—What must be the diameter of a wire 500ft. long that has three times the resistance of a wire 150ft. long, and having a diameter of ·5in.

We know $$\frac{R}{R_1} = \frac{L\,d_1^2}{L_1\,d^2}.$$

In this case $R_1 = 3\,R$. So that we may write

$$\frac{1}{3} = \frac{L\,d_1^2}{L_1\,d^2};$$

$$= \frac{150 \cdot d_1^2}{500 \times \cdot 25} = \frac{150 \cdot d_1^2}{125} = \frac{6 \cdot d_1^2}{5};$$

$$\frac{1}{3} \times \frac{5}{6} = d_1^2;$$

$$\frac{5}{18} = d_1^2;$$

$$d_1^2 = \cdot 28 \text{ nearly};$$

$$d_1 = \sqrt{\cdot 28} = \cdot 53 \text{ nearly}.$$

THE ELECTRICITY WORKS AT HAMPSTEAD.

OPENING OF THE STATION.

A few knots of persons assembled on both sides of Finchley-road, peering into the darkness in the direction of that end of Lithos-road formed by the stoneyard of the Hampstead Vestry, indicated that something of the weird and mysterious was about to take place. It was then about 7 p.m. on Monday evening, the 1st October, and down Lithos-road were passing in twos and threes the visitors invited to be

MR. R. A. CHATTOCK.

present at the inauguration of the electricity works of the Hampstead Vestry. Dim oil lamps placed at intervals on the ground guided the footsteps of the guests through the stoneyard, which, it may be mentioned, was established in 1879. This yard, which covers an area of two acres, is the depôt for the carts and implements and materials used by the Vestry, whilst in the winter the unemployed are there provided with a certain amount of work. Reaching the end of the yard, where the electricity works have been built, the visitors entered the station through the outer office. But where was the electric light?

At first sight the engine and dynamo room appeared to be in absolute darkness, but after a little time a few oil lamps arranged round the room became visible. These lamps served their purpose; they were barely sufficient to allow one to grope about the room, but just ample to let the visitors collide with one another, and that, too, with an inward, if not verbally expressed, exchange of compliments. The weird scene was rendered more impressive by the hum of one of the combinations—one of the arc lighters, in fact,

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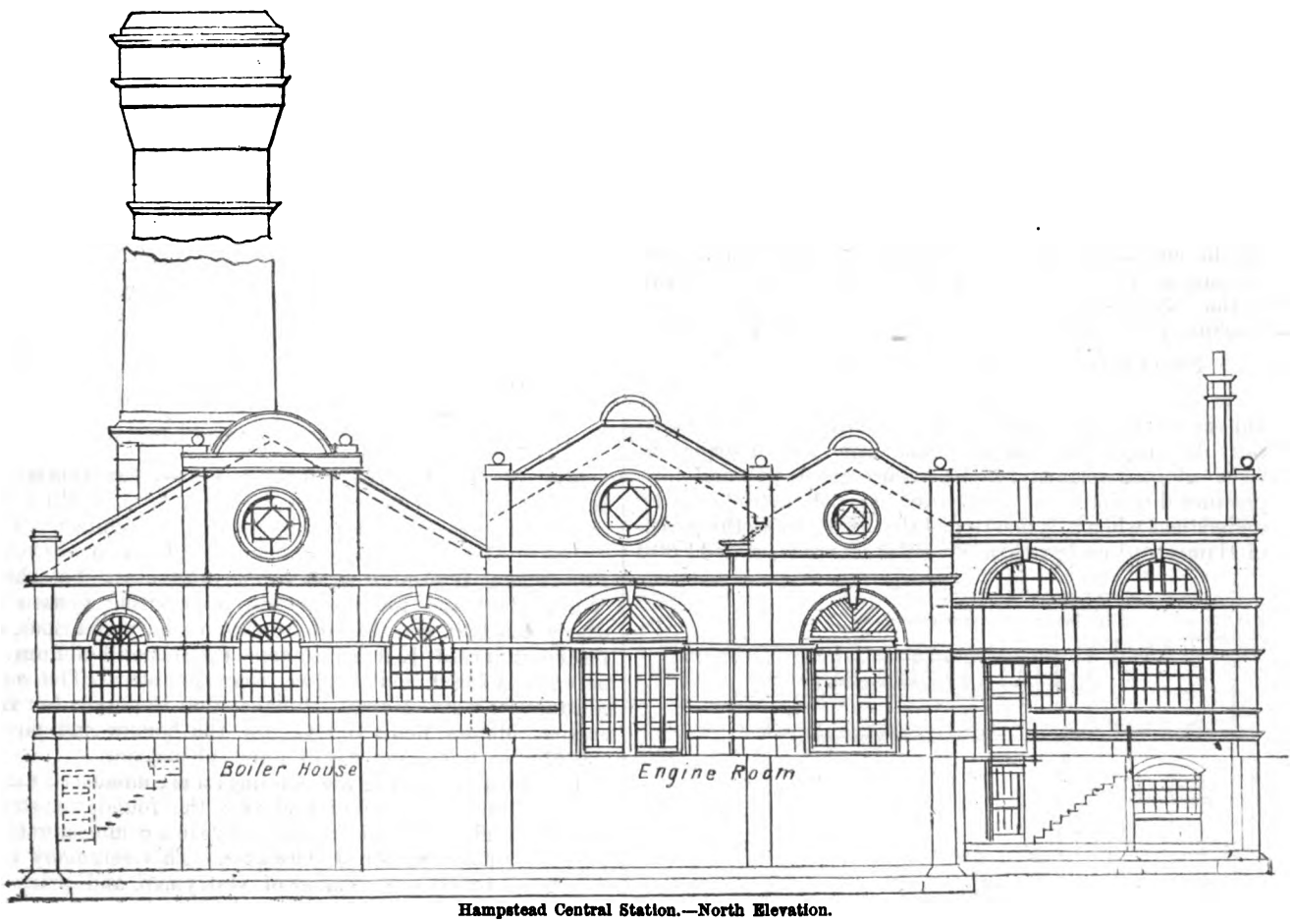
A little surprise at this state of affairs was manifested by some of the visitors, but the reason was eventually fully explained. Searches after friends led to little result beyond perhaps a few collisions, but until that evening we were not aware that the science of football was so well understood by the Hampsteadonians. Then, again, one or



Hampstead Central Station.—North Elevation.

two gentlemen endeavoured to make the acquaintance of a Siemens high-pressure arc light machine, but the dynamo refused to be coaxed, shrinking in its shell behind the roping. Now, who would think of making friends with a stranger in the dark, and in this manner, too, especially when the stranger carries on his nose, painted

Hampstead Central Station.—Longitudinal Section.

in large letters, the word "danger." No one, of course; but danger is a thing which is laughed at, and quite right—when the danger is far away. We do not know whether it is true that two new watchmakers' shops have been opened at Hampstead since Monday. If so, that explains why so many gentlemen played in the same field as the alternators on that occasion. After a little trouble, thanks to his photograph which we reproduce, we managed to discover Mr. R. A. Chattock, the electrical engineer to the Vestry.

A nice little joke at the expense of oil was perpetrated. As already stated, the reason for the oil lamp illumination of the station was forthcoming. Mr. J. Thwaites, A.I.E.E., the chairman of the Electric Lighting Committee of the Vestry, committed it. The oil lamps were dim; possibly the rats infesting the district had removed most of the oil, or perhaps the wicks had not been trimmed. Anyhow, it is many years since we saw such ill effects from lighting by means of oil lamps, bad as they are. It was to show, as Mr. Thwaites put it, the great contrast between the old light and the new, the latter being, of course, the electric light, which was subsequently switched on. This striking comparison, it is scarcely necessary to say, hugely tickled the humouristic propensities of those present.

Mr. W. H. PREECE, in the course of some well-chosen remarks, stated that 1,400 incandescent lamps were con

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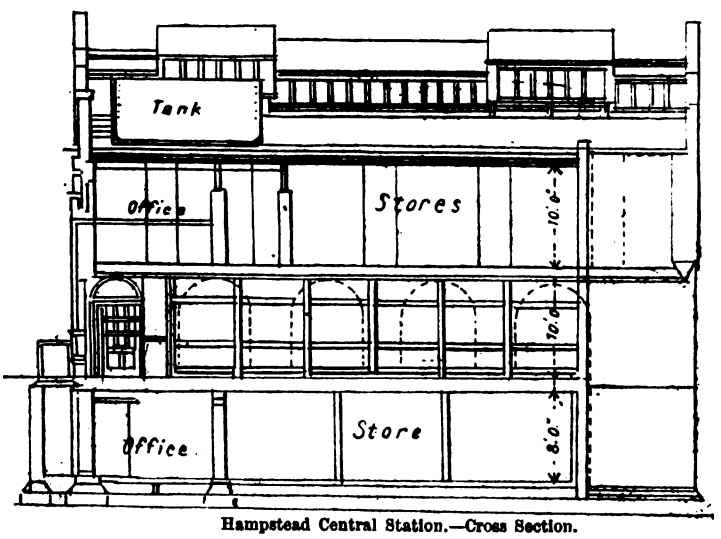
nected to the mains, and that in a week or two this number would be increased to 3,000 lamps, apart, of course, from public lighting. With a view to emphasise his frequently expressed opinion that the electric light is the poor man's light, the speaker said that from an analysis of 24 electric light stations he had found that the average cost of each incandescent electric lamp was 9s. a year, and that it consumed between 17 and 18 units. The figure of 9s. was, he observed, also the average price per annum for a gas light in the case of 24 gas undertakings.

Mr. FLETCHER, having made a few observations, proposed a vote of thanks to Messrs. Siemens Bros. and Co., Limited, the contractors. To this Mr. ALEX. SIEMENS suitably responded.

Amid cheers, Mr. R. Hackworth then switched on the incandescent lamps in the station, and Mr. Thwaites turned on the current to the arc lamps in Finchley-road. The visitors, at the invitation of Mr. A. Siemens, next drank to the "Success of the Electric Light," after which the machinery was inspected and explained by the engineers.

PRELIMINARY STEPS IN ELECTRIC LIGHTING.

As in the case of Ealing, so in regard to Hampstead did the district comprised in the provisional order practically determine the system of production and distribution to be adopted—namely, high-pressure generation and low-pressure distribution. The extent of the district will be understood when it is mentioned that there are in the parish of Hampstead no less than 53 miles of roads, with 11,000



Hampstead Central Station.—Cross Section.

occupied houses, and that there is every prospect of a rapid appropriation by builders of the 400 acres of land which alone remain to fall into their hands. The ratepayers by a free use of the light will help to reduce the public expense, and residents have the satisfaction of knowing that in paying for the electric lighting of their houses they are not helping to fill the pockets of shareholders, but are directing their money into a channel which will assist either in reducing the rates or enable the Vestry to bestow further benefits upon the parish.

The parish of Hampstead has had its vicissitudes in connection with electric lighting. When the matter was first considered several years ago, a committee was appointed to deal with it, but their recommendation that the Vestry should provide a municipal supply was shelved. Mr. F. E. Baines, C.B., who was the first chairman of this committee, was succeeded in 1891 by Mr. James Thwaites, who has taken an active part in bringing the project to a successful issue. Some time after the rejection of the proposal to establish a municipal supply, the Vestry very wisely reconsidered the subject, and as a result the services of Mr. W. H. Preece were called in to advise the Vestry. The report prepared by Mr. Preece having been fully discussed, the Vestry decided to apply for a provisional order, which was granted. In December, 1892, the Vestry resolved, rather than to transfer their powers to a company, to undertake the work of supplying the parish with the electric light, and in due course they applied to the London County Council for permission to borrow the sum of £30,000 upon the security of the lighting rates of the parish. Mr. Preece was instructed to prepare the plans and specifications, and the works have been carried out in accordance with his scheme, and under the supervision of the Electric Lighting Committee.

It will be seen from the list given below that the members of the Electric Lighting Committee are numerous:

J. THWAITES, A.I.E.E.,	HACKWORTH, R.
AITCHISON, T. [chairman.	HALL, C.
BARTLETT, C. T.	HARBEN, H.
BECKETT, H.	HANHART, N.
BENCE, H. R.	HARDCASTLE, J.
BODEN, J. W.	JONES, W. J.
BUCKINGHAM, J. S.	KING, C. B.
BUSTON, S. W.	LEFFMANN, P.
COLLEY, J.	PADBURY, R. H.
CUFF, W. S.	PAYNE, E. S.
DALNTON, S. J.	RANDALL, T. G.
DIMOND, W.	REED, C. H.
DOBBS, S.	RUSSELL, C. A.
EDWARDS, F. YEATS.	RYALLS, C. W.
ELLIOTT, E.	SHAW, P. G. C.
EVANS, M. H.	SMITH, T. EUSTACE.
FARMER, L.	SWAN, E.
FAULKNER, A.	UNDERWOOD, R.
FRAMPTON, W.	WELLS, T. N.
GRAHAM, H. HOWGRAVE.	WILLS, C. A.
GREENHILL, G.	YOUNG, R., Major-General.

Mr. W. H. Preece, F.R.S., has acted as consulting engineer to the Vestry, and Mr. A. Ardron, F.R.I.B.A., of 39, Victoria-street, Westminster, is the architect. The tender of Messrs. Siemens Bros. and Co., Limited, of Queen Anne's-gate, Westminster, to supply and erect the whole of the plant and the feeder and distributing system at nearly £20,000, and that of Messrs. Yerbury and Sons, of Birchington-road, Kilburn, to erect the station buildings at between £7,000 and £8,000, were accepted. The sub-contractors were Messrs. Willans and Robinson for the engines, Messrs. Bellis and Co. for the boilers and pipes, and Messrs. Lucas and Aird for the sub-stations.

The work of erecting the buildings was commenced early in 1893; in the autumn of that year the foundation-stone was laid, and in May of the present year a commemoration tablet was fixed by Mr. J. Thwaites. This ceremony was witnessed by a large number of vestrymen, and prior to the ceremony the company were photographed. The tablet is a large one, and bears the names of the principal gentlemen concerned. The ceremony was followed by a dinner at the Midland Hotel, St. Pancras. The toast of "The Vestry of Hampstead" was proposed by Mr. J. S. Fletcher, J.P., L.C.C., who congratulated that body upon its present work in giving the advantages of the electric light, and hoped it would be a financial success. Mr. Preece on the same occasion observed that the electric light would be the poor man's light, and that it was going to be successful financially.

The compulsory area of supply specified in the provisional order includes Arkwright-road, College-crescent, College-terrace, Finchley-road (from Arkwright-road to Swiss Cottage), Fitzjohn's-avenue, Frognal (from Finchley-road to Arkwright-road), Lithos-road, Maresfield-gardens, Netherhall-gardens, and Nutley-terrace. It appears, however, that the Vestry have a competitor in the Hampstead Electric Battery Company, who have for some time been furnishing a supply of the electric light to private consumers. The works of the company are situated close to those of the Vestry, the former being in Finchley-road, close to Lithos-road. The company, we are informed, have entered into agreements with their customers for periods ranging from 12 to 18 months, so that they intend to retain their clients. The sphere of operations by the company being restricted, the competition between them and the Vestry, who have a wide area of supply, should only be of a mild and friendly nature.

THE STATION BUILDINGS.

The details of the electricity works are shown in the accompanying illustrations, including plan, elevation, and section of the buildings, and views of the boilers and engines and dynamos. The buildings comprise a substantial structure erected in stock bricks, with red-brick dressing, having in the rear a chimney shaft 130ft. high. Ample room for future extensions of the buildings and of the plant is pro-

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vided from the boiler-house end. As will be seen from the illustrations, the buildings consist of an engine-room built in two spans, one of 26ft. and the other of 16ft. The dimensions of the engine-room are 58ft. long, 42ft. wide, and 23ft. high. It is large enough to accommodate an increase in the incandescent and arc lighting machinery to the extent of 50 per cent. The boiler-house, which is at a lower level than the engine-room, is covered by one roof having a span of 43ft. It is 58ft. long and 24ft. 6in. high; its floor is 9ft. below that of the engine-room, which is on the ground level. It will be noticed that this arrangement allows of coal bunkers being provided under the roadway, these bunkers having a capacity of 100 tons of coal. The chimney is 8ft. in internal diameter, and up to a height of 50ft. it is divided into two compartments only, one of which is used with the present boiler plant, the other half being provided for future extensions. Offices, consisting of engineer's office, clerks' office, stores and testing room, are also provided. The water-tank for the supply of the boilers is fixed on the roof; it has a capacity of 10,000 gallons. Both the boiler-house and the engine and dynamo room are lighted by incandescent lamps, the latter having, in addition, two arc lamps for use as occasion may arise.

The Boiler-house.

The boiler-house, of which a photograph showing the line of boilers and mechanical stokers is annexed, contains four boilers of the Lancashire type, made by the Oldham Boiler Company, and supplied under a sub-contract, together with the steam-pipes, by Messrs. G. E. Belliss and Co., Limited, of Birmingham. Each boiler is 28ft. long and 8ft. in diameter, and will evaporate 5,000lb. of water an hour at a pressure of 150lb. The boilers are of Siemens-Martin steel, and each has been tested to a pressure of 250lb. They are provided with dead-weight safety-valves and Hopkinson's fittings throughout, including two safety-valves, and duplicate feed-water check-valves. The boilers are equipped with mechanical stokers, conveyor, and elevator of the type made by Messrs. Bennis and Co., of Bolton. The fuel is supplied to the stokers by a coal elevator, consisting of an endless chain and buckets working in a sheet-steel case, and a conveyor, consisting of a worm working in a trough from which the coal falls through shoots into the stoker hoppers. The coal, which is Welsh smokeless fuel, is shovelled into the buckets from the coal bunkers by the trimmers. The stoking machinery is driven by a small vertical engine, of which a duplicate is provided as reserve; and the whole is arranged with clutches, loose pulleys, and striking gear so as to be completely under control, and so that the breakdown of any portion of the machinery cannot interfere with the working of the station.

A complete duplicate service of feed water is arranged for each boiler—a supply being obtained from the mains of the water company and also from the before-mentioned storage tank. There are two Worthington feed pumps, each of which is capable of delivering 4,000 gallons of water per hour, and each can supply water to any or all of the boilers independently of the other. The feed water is heated by an exhaust steam-heater of the Babcock and Wilcox type, and also by a Green's economiser of 192 pipes placed in the main flue. Each heater is provided with a by-pass, and each can be used together with or independently of the other. The economiser, made by Messrs. E. Green and Son, Limited, of 2, Exchange-street, Manchester, has been constructed on their improved principle—namely, in two groups—thus allowing a space between to facilitate passage between the pipes in case of repairs or cleaning operations. These groups of pipes are coupled together at the top and bottom by expansion elbows, and the whole apparatus is fitted with patent access pipes at bottom, which provides an easy means of cleaning the deposit out of the bottom boxes without removing the branch pipes absolutely and breaking the whole of the joints. Being constructed to work at high pressure—150lb.—the apparatus is specially strengthened throughout, and fitted with patent internal lids to top boxes, which allows of greater water space therein.

The steam from the boilers is taken to the engines in a wrought-iron ring main, divided by valves placed between each engine and each boiler into sections, each section being drained. A small auxiliary steam ring connected to two sections of the main steam ring supplies steam to the feed-water pumps and stoker engines. The exhaust steam is carried through a cast-iron exhaust-pipe to the atmosphere 50ft. above the ground level.

The Engine and Dynamo Room.

The main steam-piping from the boilers forms a complete ring main in the engine and dynamo room, having connections to each boiler and engine, each connection being fitted with a stop valve. The steam-main is of wrought iron, with solid copper ring joints. Valves are provided in the main steam-pipe, so that the breakdown of any portion will not interfere with the working of more than one engine and one boiler at the same time.

The plant, which is divided into two parts—one for public and the other for private lighting—consists for the latter of one 200-kilowatt steam alternator, capable of supplying 5,700 8-c.p. lamps; two 100-kilowatt steam alternators, each of a capacity of 2,850 8-c.p. lamps; and one 20-kilowatt steam alternator for the supply of 570 8-c.p. lamps. For public arc lighting there are two 13-kilowatt steam dynamos, supplying 22 2,000-c.p. arcs. Two 18-kilowatt steam dynamos are provided for exciting the alternators, and for station lighting. The engines are of the Willans compound and the dynamos of the Siemens type, and are in all cases direct coupled.

The alternators have revolving disc armatures, the periodicity being 90. The large alternator of 200 kilowatts, which is coupled direct to a Willans compound engine, single acting, of 290 b.h.p., gives at 340 revolutions a current of 96 amperes at 2,100 volts. The two 100-kilowatt machines, at 385 revolutions, yield 48 amperes at 2,100 volts, and the 20-kilowatt alternator gives 9·5 amperes at the same pressure.

The two exciters, at 450 revolutions, each give 150 amperes at 100 volts, these being coupled direct to Willans E E type of engines. The exciters have bar armatures.

The two arc light machines, driven at 360 revolutions, are continuous-current generators, each giving 10 amperes at 1,300 volts, and capable of supplying 25 arc lamps in series. Each machine is direct coupled to a Willans D D engine.

The current from these dynamos is led to the station switchboard, which is arranged in a recess on one side of the room. This board, which is somewhat similar to that illustrated on another page in connection with the Ealing electricity works, is built up of polished slate panels, one panel being provided for each dynamo and one for each circuit. The alternators are connected through these panels by omnibus bars to the circuits, and they are arranged to work in parallel, a synchronising panel being provided for this purpose. Each panel is provided with an ammeter and voltmeter, fuses, etc., and the whole of the switchboard is mounted in a polished teak frame, and is railed off from the engine-room.

The engine-room is equipped with an overhead travelling crane of 10 tons capacity. It has a span of 25ft., and was constructed by Messrs. Appleby Bros., 22, Walbrook, E.C. The traveller differs in some respects from the cranes they have made for other dynamo-houses. The hauling ropes or chains respectively for lifting, traversing, and travelling are usually carried on the crab; but some inconvenience having been caused by these ropes fouling machinery, etc., they are worked from the gangway, which in this case runs along one side of the house. The crab has single and double purchase lifting gear and all appliances for travelling longitudinally, and for traversing from end to end of the main beams. These, and the end cradles which carry the travelling wheels, are of steel, and a steel rail for the cross traverse is riveted to the upper table of each main girder. The chain is of Best Best tested quality, and the proportions throughout give a factor of safety of not less than 5. The maximum load is quite easily lifted by two men, but one man works all motions with the ordinary loads. The details are neatly worked out, and attention has been given to several points which are sometimes overlooked, such as provision for lifting close to the wall, etc.

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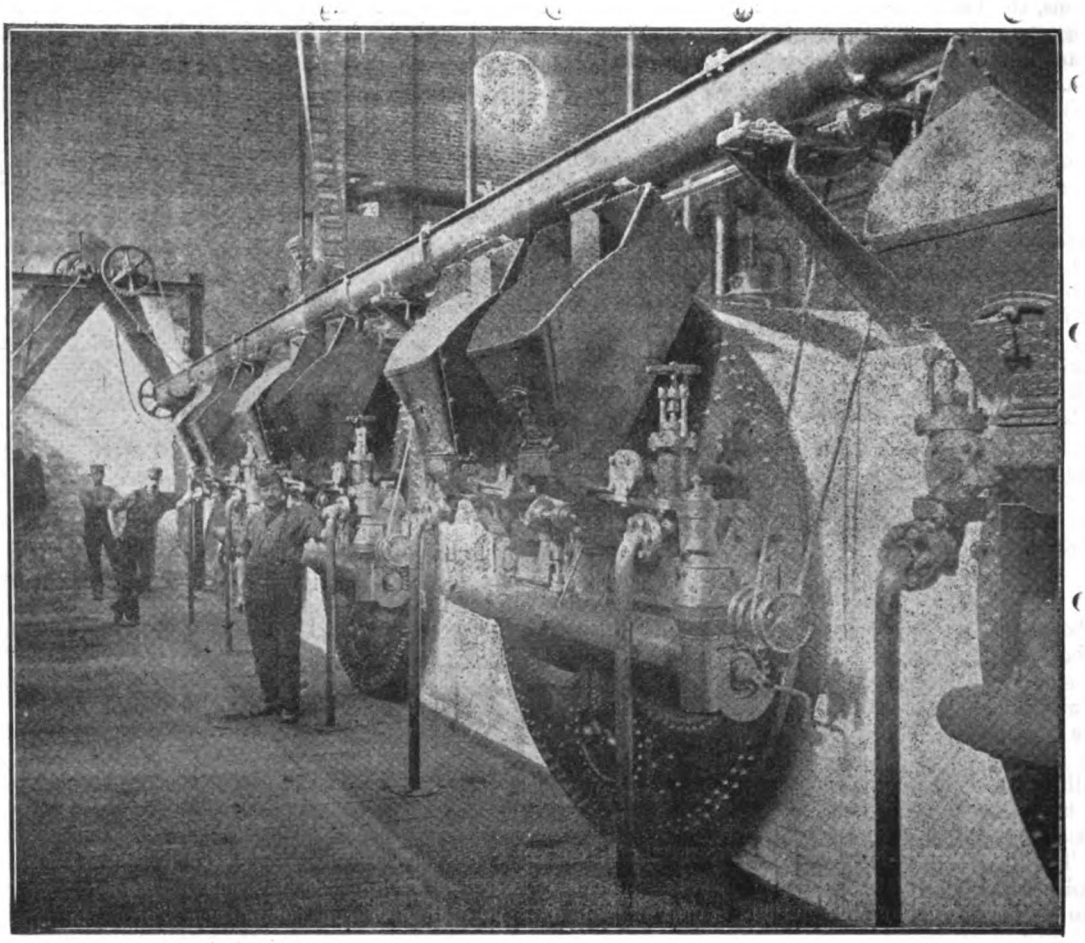
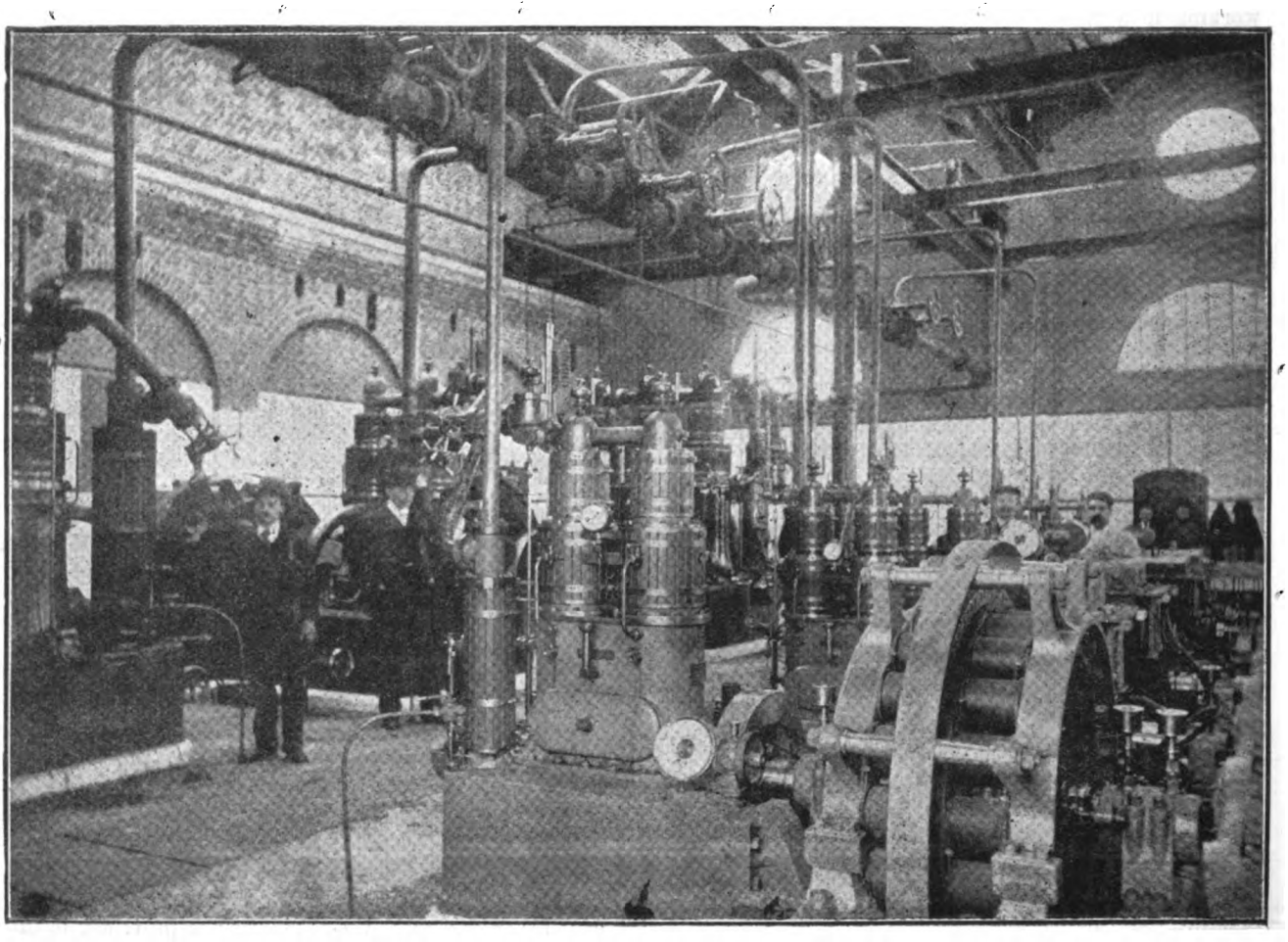


Hampstead Central Station.—Internal View of Boiler House, showing Boilers equipped with Mechanical Stokers, Conveyor, and Elevator.



Hampstead Central Station.- Internal View of Engine and Dynamo Room.

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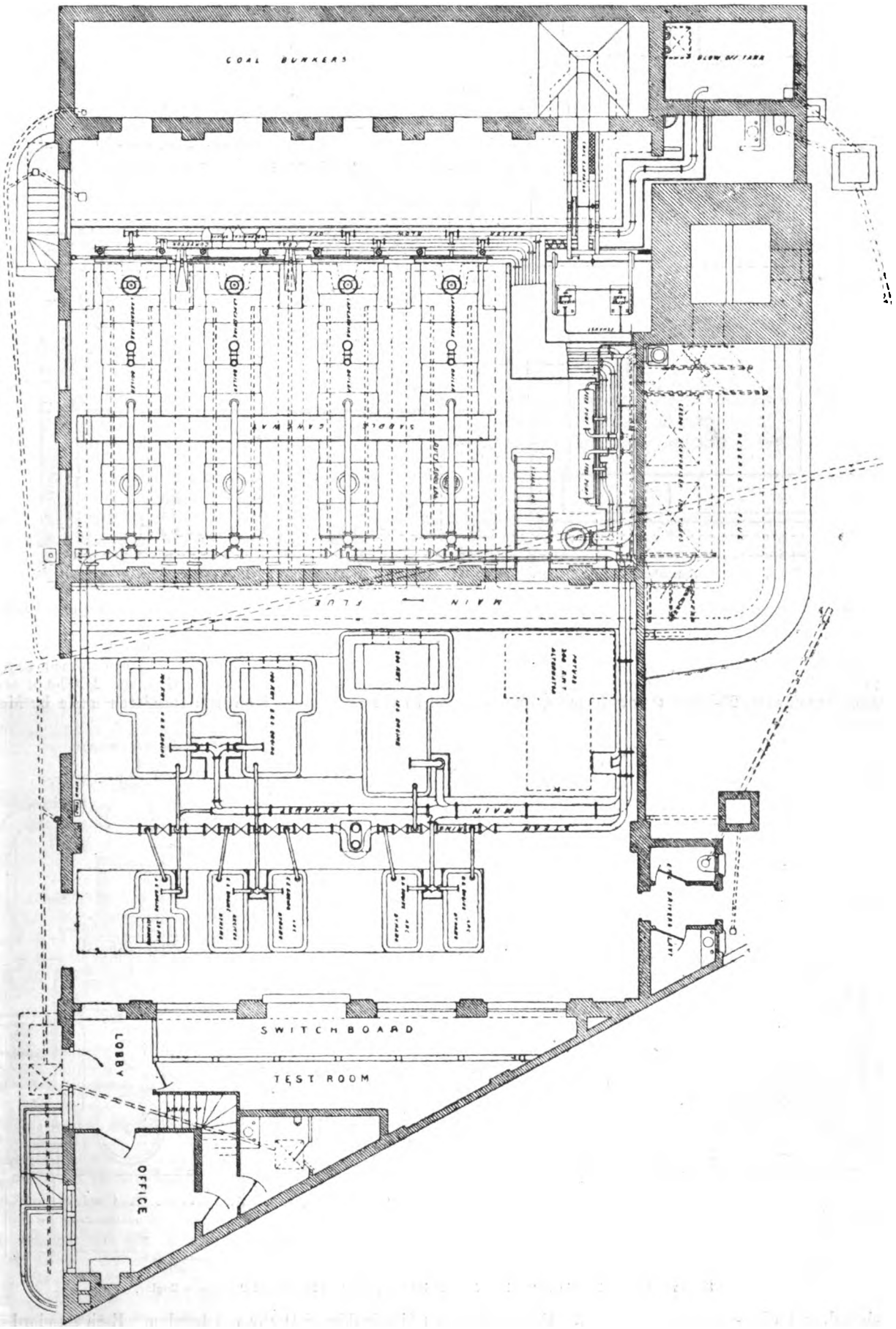
Private Lighting.

The current for the supply to private consumers is taken from the main switchboard by high-tension feeder cables to seven sub-stations, each of which supplies a small area, all the sub-stations to Siemens transformers, which convert the current from 2,000 to 105 volts, at which pressure customers are supplied from low-tension mains similar to the high-tension mains, but not so highly insulated. These



Hampstead Central Station.—General Plan, showing Arrangement of Plant.

seven sub-stations being connected by low-pressure distributing mains. The feeders are of Siemens H.C.N. concentric type, protected with iron armour, insulated with special fibrous material cased in lead, and are connected in feeders are laid direct in the ground, as are also the distributing mains. A pair of pilot wires is arranged in each feeder for measuring the E.M.F. at the sub-stations.

The seven sub-stations are situated (1) at the corner of

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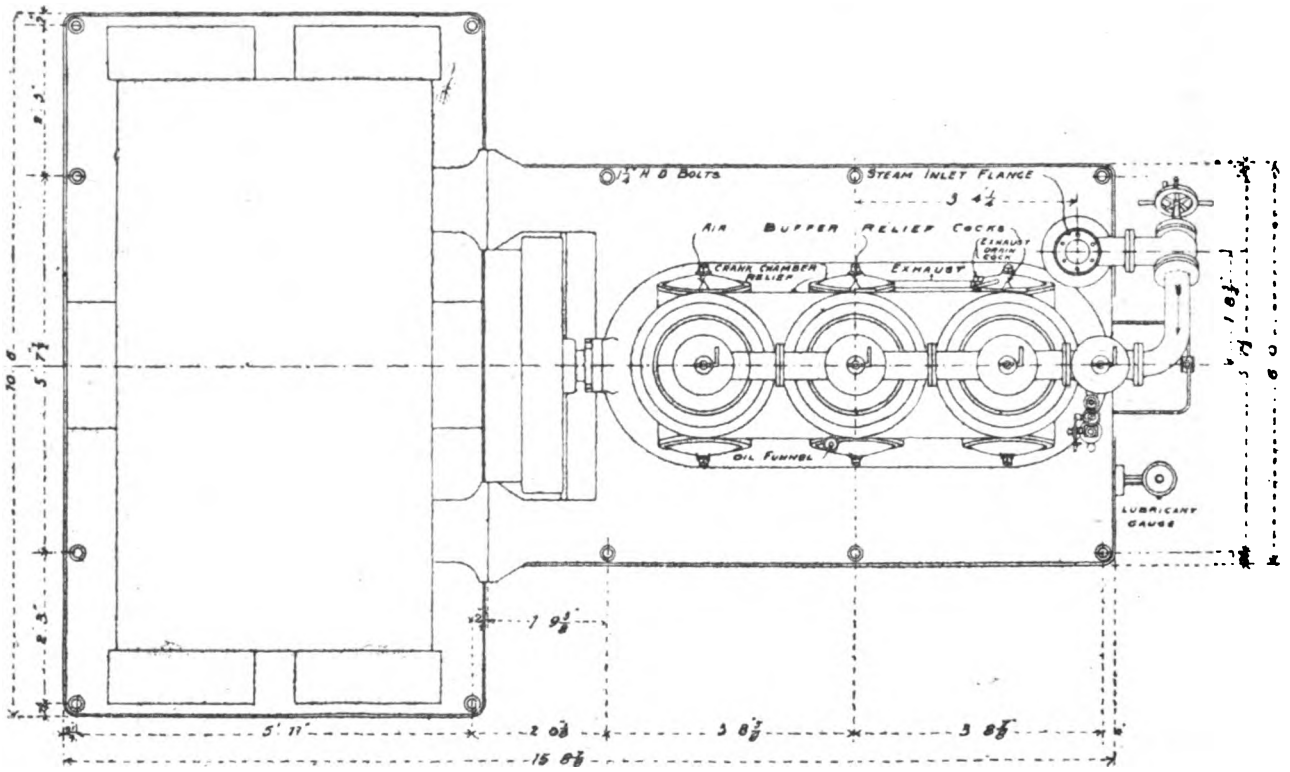
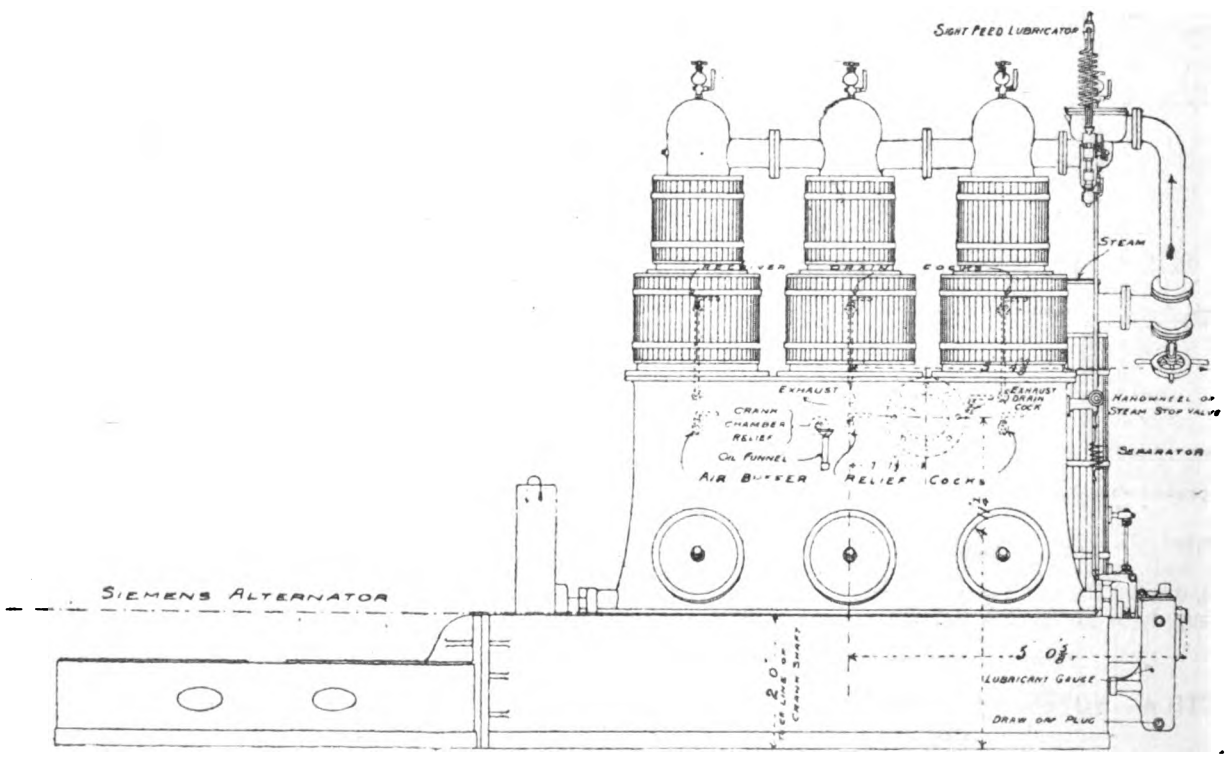
Arkwright-road and Fitzjohn's-avenue; (2) in Arkwright-road, about 100 yards from Finchley-road; (3) at the corner of Netherhall-gardens and Maresfield-gardens; (4) at the corner of Fitzjohn's-avenue and Nutley-terrace; (5) in Finchley-road; (6) at the corner of Fitzjohn's-avenue and Maresfield-gardens; and (7) in Finchley-road, near College-villas. These sub-stations comprise small brick chambers, 6ft. by 5ft., built under the pavement, access being obtained through a small manhole in the top. Each sub-station contains two 25-kilowatt transformers, a high-tension fuseboard, and a low-tension switchboard. From the latter the distributing mains are taken, and are so arranged that the supply to any length of distributing main between two sub-stations can be cut off for the purpose of connecting customers without interfering with any other part of the system. Each sub-station will supply 1,430 8 c.p. lamps. The total length of feeder main is a little more than 3½ miles, and will carry current for the supply of 17,000 8-c.p. lamps. The total length of low-tension main, which is of the triple concentric type for three-wire distribution, is 3½ miles, and this is sufficient to supply 10,000 8-c.p. lamps.



Hampstead Central Station.—Outline Plan of General Arrangement of IIIS Willans Engine.

Public Lighting.

At present the public lighting is confined to a portion of Finchley-road, where 22 Siemens 2,000-c.p. arc lamps have been erected on iron standards made by Messrs. A. Handyside, of Derby and London. Each standard consists of a cast-iron base surmounted by a wrought-iron stem and and an arched bracket, similar to those adopted at Ealing. The arc lamps are connected in series, and are supplied with current through a Siemens cable protected with iron armour and insulated with vulcanised rubber.



Hampstead Central Station.—Outline of General Arrangement of IIIS 360 H.P. Willans Engine.

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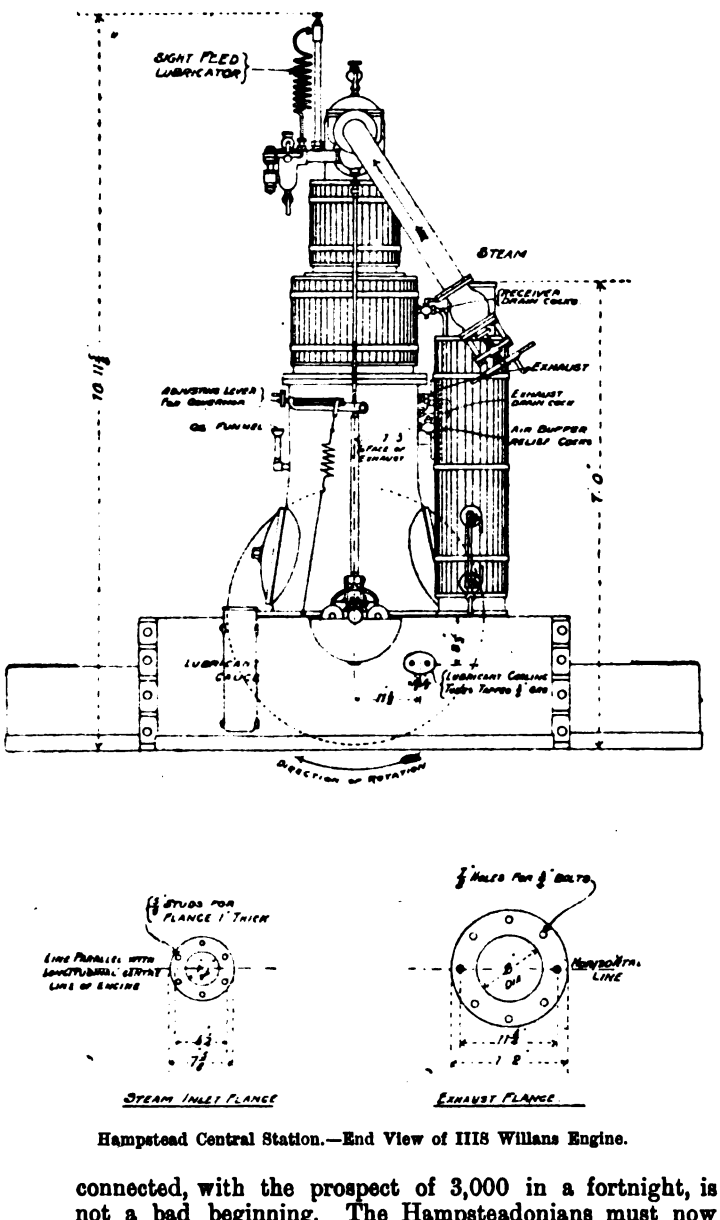
The contractors, Messrs. Siemens Bros. and Co., Limited, are to be congratulated for the very able manner in which they have carried out the whole of the work; the station is thoroughly equipped, and the plant is of the excellent workmanship characteristic of the company. Mr. W. H. Preece, who designed the station, has supervised the work and acted as consulting engineer to the Vestry. To the members of the Vestry congratulations must also be extended for having practically followed the increasing belief in the municipalisation of those undertakings which are of public benefit: and in doing this in the case of electric lighting, they have provided for the public not only the illuminant which is gradually making its way throughout the country, but they have also rendered available a supply of light which is the best and is as reliable as any other. Let the public now step in and take up a supply. To commence with 1,400 lamps



Hampstead Central Station.—End View of IIIS Willans Engine.

connected, with the prospect of 3,000 in a fortnight, is not a bad beginning. The Hampsteadonians must now awake, discard the vile gas now used, and ask the Vestry for a supply of the electric light.

PRACTICAL NOTES ON DYNAMO CALCULATION.*

XIV.

BY ALFRED E. WIENER.

30. *Mechanical Calculations about Armature.* (*a*) *Shaft.*—The length of the armature shaft varies considerably for the different arrangements of the field-magnet frame, and, owing to the length of the commutator, in equal output dynamos of the same design depends upon the voltage: and, therefore, a general rule for the length of the shaft cannot be given.

Its diameter, however, directly depends only upon the output and the speed of the dynamo, and can be expressed as a function of these quantities, different functions, however, being employed for various portions of its length. For while in the bearing portions, d_b (Fig. 43), torsional strength only has to be taken into account, the centre portion, d_c (Fig. 43), between the bearings, which carries the armature core, is to be calculated to withstand the torsional force as well as the bending due to the weight.

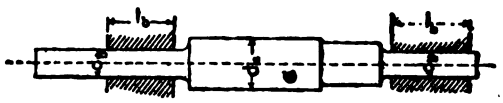


Fig. 43.

For steel shafts the author has found the following empirical formulæ to give good results in practice:

$$\text{For bearing portions: } d_b = k_8 \times \sqrt{W} \times \sqrt[4]{N} \quad . \quad (76)$$

where d_b = diameter of armature shaft at bearings, in inches;
W = output of dynamo, in watts;
N = speed, in revolutions per minute;
k_8 = constant, depending upon the kind of armature (see Table XXXVI.).

The value of k_8 varies between ·0025 and ·005, as follows:

Table XXXVI.—Value of Constant in Formula for Journal Diameter of Armature Shaft.

Kind of armature	Value of k_8.
High-speed drum	·0025
High-speed ring	·003
Slow-speed drum	·004
Slow-speed ring	·005

$$\text{For core portion: } d_c = k_9 \times \sqrt[4]{\frac{W}{N}} \quad . \quad . \quad . \quad . \quad (77)$$

where d_c = diameter of core portion of armature shaft, in inches;
W = output of machine, in watts;
N = speed, in revolutions per minute;
k_9 = constant depending upon output of machine (see Table XXXVII.).

This constant indicates the dependence of the diameter of the shaft upon the length between its supports, and since the weight supported and also the length supporting it increase with the output, it is evident that k_9 has a greater value the larger the output of the machine. For capacities up to 2,000 kilowatts k_9 numerically ranges between 1 and 1·8, thus:

Table XXXVII.—Value of Constant in Formula for Diameter of Core Portion of Armature Shaft.

Capacity in Watts, W.	Value of k_9.
Up to 1,000 watts	1
,, 5,000 ,,	1·1
,, 10,000 ,,	1·2
,, 50,000 ,,	1·3
,, 100,000 ,,	1·4
,, 200,000 ,,	1·5
,, 500,000 ,,	1·6
,, 1,000,000 ,,	1·7
,, 2,000,000 ,,	1·8

Considering the speeds given in Tables VIII., IX., and X., chapter 7, for various outputs, we obtain the following Tables XXXVIII., XXXIX., and XL., giving respectively the diameter of shafts for drum armatures, for high-speed ring armatures, and for slow-speed ring armatures.

For wrought-iron shafts the diameters obtained by formulæ (76) and (77), or those taken from Tables XXXVIII., XXXIX., and XL. respectively, are to be multiplied by 1·25; that is, increased by 25 per cent.

(*b*) *Driving Spokes.*—Ring armature cores usually are attached to the shaft either by means of spider frames or of skeleton pulleys. In both cases the driving of the conductors is effected by a number of spokes, which respectively form part of the spider itself, Fig, 44, or of a separate driving frame keyed to the skeleton pulley, Fig. 45.

In dimensioning these driving spokes, on the one hand

* From the *Electrical World* (New York).

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TABLE XXXVIII.—Diameter of Shafts for Drum Armatures.

Capacity in watts. W.	Speed in revs. per min. (from Tab. VIII.) N.	Diameter of armature shaft, in inches. Bearing portion. $d_b = \cdot0025\sqrt{W} \times \sqrt[4]{N}$.	Core portion. k_s.	Core portion. $d_c = k_s \times \sqrt[4]{W}\sqrt[4]{N}$
100	3,000	$\frac{3}{16}$	·9	$\frac{3}{8}$
250	2,700	$\frac{6}{16}$	·95	$\frac{1}{2}$
500	2,400	$\frac{7}{16}$	1	$\frac{5}{8}$
1,000	2,200	$\frac{9}{16}$	1	$\frac{13}{16}$
2,000	2,000	$\frac{3}{4}$	1·05	1
3,000	1,900	$\frac{13}{16}$	1 1	$1\frac{1}{4}$
5,000	1,800	$1\frac{1}{16}$	1·15	$1\frac{1}{2}$
10,000	1,700	$1\frac{5}{16}$	1·2	2
15,000	1,600	$1\frac{7}{8}$	1·25	$2\frac{1}{4}$
20,000	1,500	$2\frac{1}{16}$	1·25	$2\frac{1}{2}$
25,000	1,350	$2\frac{3}{16}$	1·25	$2\frac{3}{4}$
30,000	1,200	$2\frac{1}{2}$	1·3	3
50,000	1,050	3	1·3	$3\frac{1}{2}$
75,000	900	$3\frac{5}{16}$	1 35	$4\frac{1}{2}$
100,000	750	$4\frac{1}{16}$	1·4	$4\frac{3}{4}$
150,000	600	$4\frac{3}{4}$	1·45	$5\frac{3}{4}$
200,000	500	$5\frac{1}{4}$	1·5	$6\frac{3}{4}$
300,000	400	6	1·55	8

TABLE XXXIX.—Diameters of Shafts for High-Speed Ring Armatures.

Capacity in watts. W	Speed in revs. per min. (from Table IX.) N.	Diameter of armature shaft, in inches. Bearing portion. $d_b = \cdot003\sqrt{W} \times \sqrt[4]{N}$.	Core portion. k_s.	Core portion. $d_c = k_s \times \sqrt[4]{W}\sqrt[4]{N}$
100	2,600	$\frac{1}{4}$	·9	$\frac{3}{8}$
250	2,400	$\frac{3}{8}$	·95	$\frac{1}{2}$
500	2,200	$\frac{1}{2}$	1	$\frac{11}{16}$
1,000	2,000	$\frac{3}{4}$	1	$\frac{7}{8}$
2,500	1,700	1	1·05	$1\frac{1}{4}$
5,000	1,500	$1\frac{3}{16}$	1·1	$1\frac{5}{8}$
10,000	1,250	$1\frac{3}{4}$	1·2	2
25,000	1,000	$2\frac{5}{8}$	1·25	$2\frac{7}{8}$
50,000	800	$3\frac{1}{2}$	1·3	$3\frac{3}{4}$
100,000	600	$4\frac{3}{4}$	1·4	5
200,000	500	$6\frac{3}{16}$	1·5	$6\frac{3}{4}$
300,000	450	$7\frac{1}{2}$	1·55	$7\frac{7}{8}$
400,000	400	$8\frac{1}{2}$	1·55	9
600,000	350	10	1·6	$10\frac{1}{2}$
800,000	300	11	1·65	12
1,000,000	250	12	1·7	$13\frac{1}{8}$
1,500,000	225	14	1·75	$15\frac{3}{4}$
2,000,000	200	16	1·8	18

TABLE XL.—Diameters of Shafts for Slow-Speed Ring Armatures.

Capacity in watts. W.	Speed in revs. per min. (from Table X). N.	Diameter of armature shaft, in inches. Bearing portion. $d_b = \cdot005\sqrt{W} \times \sqrt[4]{N}$.	Core portion. k_s.	Core portion. $d_c = k_s \times \sqrt[4]{W}\sqrt[4]{N}$
2,500	400	$1\frac{1}{8}$	1·05	$1\frac{5}{8}$
5,000	350	$1\frac{1}{2}$	1·1	$2\frac{1}{16}$
10,000	300	2	1·2	$2\frac{5}{8}$
25,000	250	$3\frac{1}{8}$	1·25	4
50,000	200	$4\frac{1}{4}$	1·3	$5\frac{1}{4}$
100,000	175	$5\frac{3}{4}$	1·4	$6\frac{7}{8}$
200,000	150	$7\frac{3}{4}$	1·5	9
300,000	125	$9\frac{1}{8}$	1·55	$10\frac{3}{4}$
400,000	100	10	1·55	$12\frac{1}{4}$
600,000	90	12	1·6	$14\frac{1}{2}$
800,000	80	$13\frac{1}{2}$	1·65	$16\frac{1}{2}$
1,000,000	75	15	1·7	$18\frac{1}{2}$
1,500,000	70	18	1·75	22
2,000,000	65	20	1·8	$24\frac{1}{2}$

sufficient mechanical strength for driving should be provided, while on the other hand, if spiral winding is to be used, not more than necessary of the inner winding circumference should be made unavailable.

For the latter reason, the axial breadth of the spokes, b_s (Fig. 44 and Fig. 45 respectively), is to be made as large as the construction of the armature allows, and their thickness, h_s, calculated to give the requisite strength.

Multiplying equation (57) for the circumferential force per armature conductor (Chapter 23) by the number of effective conductors we obtain the total peripheral force of the armature:

$$F_p = f_p \times K \times \beta' = \cdot7375 \times \frac{E \times C}{S} \quad . \quad (78)$$

and allowing a factor of safety of about 4, we get:

$$F_p' = 3 \times \frac{W}{S}.$$

Dividing F_p' by the total number of spokes, we have the pull for each spoke, and this multiplied by the leverage gives the external momentum acting on each. The latter

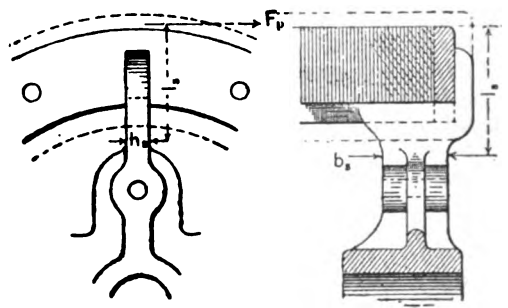

FIG. 44.

must be equal to the internal momentum—*i.e.*, the product of the modules of the cross-section and the safe working stress of the material. In consequence we have the equation

$$\frac{3 \times \frac{W}{S}}{n_s} \times l_s = \frac{b_s \times {h_s}^2}{6} \times Q;$$

or,

$$b_s \times {h_s}^2 = 18 \times \frac{W}{S} \times \frac{l_s}{n_s \times Q} \quad . \quad . \quad . \quad (79)$$

in which b_s = smallest width of spoke (parallel to shaft), in inches;

h_s = smallest thickness of spoke (perpendicular to shaft), in inches;

l_s = leverage at smallest spoke section—*i.e.*, distance of smallest section from active armature conductors—in inches;

n_s = total number of spokes per armature;

W = total output of dynamo, in watts;

S = conductor velocity of armature, in feet, per second;

Q = safe working load of material, in pounds per square inch.

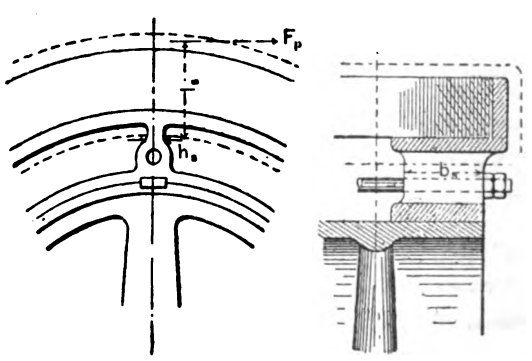

FIG. 45.

Cast iron.....	Q = 5,000lb. per square inch.
Brass	= 6,000lb. ,,
Phosphor bronze	= 7,000lb. ,,
Wrought iron.....	= 10,000lb. ,,
Aluminium bronze.....	= 12,000lb. ,,
Cast steel	= 15,000lb. ,,

For spiral windings, now, b_s, as stated above, is given by making it as large as possible, and from (79) we therefore obtain:

$$h_s = 4{\cdot}25 \times \sqrt{\frac{W}{S} \times \frac{l_s}{n_s \times b_s \times Q}} \quad . \quad (80)$$

For windings external to the core, h_s may be fixed, and then b_s calculated from

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$$b_s = 18 \times \frac{W}{S} \times \frac{l_s}{n_s \times h_s^{\,2} \times Q} \quad . \quad (81)$$

For very heavy duty dynamos a larger factor of safety should be taken, say from 6 to 8; this will change the numerical coefficient of formulæ (79) and (81) into 27 to 36, and that of equation (80) into 5·3 to 6 respectively.

(*c*) *Bearings.*—To determine the size of the armature bearings, ordinary engineering practice ought to be followed. In machine design, on account of the increased heat generation at higher velocities, it is the rule to provide a larger bearing surface the higher the speed of the revolving shaft. This rule may, for dynamo shafts, be expressed by the formula:

$$l_b = k_{10} \times d_b \times \sqrt{N} \quad . \quad . \quad . \quad . \quad (82)$$

where l_b = length of bearing, in inches;
d_b = diameter of bearing, in inches, from formula (76);
N = speed of shaft in revolutions per minute;
k_{10} = constant depending upon kind of armature and on output of dynamo (see Table XLI.).

The numerical values of k_{10} range between ·1 and ·225 for high-speed armatures, and from ·15 to ·3 for slow-speed armatures, as follows:

TABLE XLI.—Value of Constant in Formula for Length of Armature Bearings.

Capacity in kilowatts.	Value of constant k_{10}.	
	High-speed armatures.	Slow-speed armatures.
Up to 5	·1	·15
,, 10	·1	·175
,, 50	·125	·2
,, 100	·15	·225
,, 500	·175	·25
,, 1,000	·2	·275
,, 2,000	·225	·3

Applying these values to formula (82) and using the journal diameters previously determined, the following Tables XLII., XLIII., and XLIV. are obtained, giving the sizes of bearings for drum armatures, high-speed ring armatures, and slow-speed ring armatures, respectively:

(*d*) *Pulley and Belt.*—The pulley diameter is determined by the speed of the dynamo and the linear belt velocity:

$$d_p = \frac{12 \times S_b}{\pi \times N} = 3{\cdot}7 \times \frac{S_b}{N} \; ; \quad . \quad . \quad (83)$$

d_p = diameter of pulley, in inches;
S_b = belt speed, in speed per minute (see Table XLV.);
N = speed of dynamo, in revolutions per minute.

TABLE XLII.—Bearings for Drum Armatures.

Capacity in kilowatts.	Value of constant k_{10}.	Speed in revs. per minute (from Table VIII.) N	Size of bearing.		
			Diameter (from Table XXXVIII.) d_b	Length. $l_b = k_{10} \times d_b \times \sqrt{N}$.	Ratio. $l_b : d_b$
·1	·1	3,000	$\frac{3}{16}$	1	5·3
·25	·1	2,700	$\frac{5}{16}$	$1\frac{5}{8}$	5·2
·5	·1	2,400	$\frac{7}{16}$	$2\frac{1}{8}$	4·9
1	·1	2,200	$\frac{9}{16}$	$2\frac{5}{8}$	4·7
2	·1	2,000	$\frac{3}{4}$	$3\frac{3}{8}$	4·5
3	·1	1,900	$\frac{15}{16}$	4	4·3
5	·1	1,800	$1\frac{1}{8}$	$4\frac{3}{4}$	4·2
10	·1	1,700	$1\frac{5}{8}$	$6\frac{3}{4}$	4·2
15	·105	1,600	$1\frac{7}{8}$	$7\frac{7}{8}$	4·2
20	·11	1,500	$2\frac{1}{8}$	9	4·2
25	·115	1,350	$2\frac{3}{8}$	10	4·2
30	·12	1,200	$2\frac{1}{2}$	$10\frac{1}{2}$	4·2
50	·125	1,050	3	12	4·0
75	·13	900	$3\frac{5}{8}$	14	3·9
100	·14	750	$4\frac{1}{8}$	$15\frac{3}{4}$	3·8
150	·15	600	$4\frac{3}{4}$	$17\frac{1}{2}$	3·7
200	·16	500	$5\frac{1}{4}$	$18\frac{3}{4}$	3·6
300	·175	400	6	21	3·5

TABLE XLIII.—Bearings for High-Speed Ring Armatures.

Capacity in kilowatts.	Value of constant k_{10}.	Speed in revs. per minute (from Table IX.) N.	Size of bearing.		
			Diameter (from Table XXXIX.) d_b	Length $l_b = k_{10} \times d_b \times \sqrt{N}$.	Ratio $l_b : d_b$
·1	·1	2,600	$\frac{1}{4}$	$1\frac{1}{4}$	5
·25	·1	2,400	$\frac{3}{8}$	$1\frac{7}{8}$	5
·5	·1	2,200	$\frac{1}{2}$	$2\frac{3}{8}$	4·75
1	·1	2,000	$\frac{5}{8}$	$2\frac{3}{4}$	4·4
2·5	·1	1,700	1	$4\frac{1}{8}$	4·1
5	·1	1,500	$1\frac{3}{8}$	$5\frac{3}{8}$	3·9
10	·11	1,250	$1\frac{3}{4}$	$6\frac{3}{4}$	3·85
25	·12	1,000	$2\frac{5}{8}$	10	3·8
50	·13	800	$3\frac{1}{2}$	13	3·7
100	·15	600	$4\frac{3}{4}$	$17\frac{1}{2}$	3·7
200	·16	500	$6\frac{1}{4}$	23	3·6
300	·17	450	$7\frac{1}{2}$	27	3·6
400	·175	400	$8\frac{1}{2}$	30	3·5
600	·18	350	10	$33\frac{1}{2}$	3·35
800	·19	300	11	36	3·3
1,000	·2	250	12	38	3·2
1,500	·21	225	14	45	3·2
2,000	·225	200	16	51	3·2

TABLE XLIV.—Bearings for Slow-Speed Ring Armatures.

Capacity in kilowatts.	Value of constant k_{10}.	Speed in revs. per minute (from Table X.) N.	Size of bearing.		
			Diameter (from Table XL.) d_b	Length. $l_b = k_{10} \times d_b \times \sqrt{N}$.	Ratio $l_b : d_b$
2·5	·15	400	$1\frac{1}{8}$	$3\frac{3}{8}$	3
5	·16	350	$1\frac{1}{2}$	$4\frac{1}{2}$	3
10	·17	300	2	$5\frac{7}{8}$	2·9
25	·18	250	$3\frac{1}{4}$	$8\frac{3}{4}$	2·8
50	·19	200	$4\frac{1}{4}$	$11\frac{1}{2}$	2·7
100	·20	175	$5\frac{3}{4}$	$15\frac{1}{4}$	2·65
200	·21	150	$7\frac{3}{4}$	20	2·6
300	·23	125	$9\frac{1}{8}$	$23\frac{3}{4}$	2·6
400	·25	100	10	25	2·5
600	·265	90	12	30	2·5
800	·27	80	$13\frac{1}{2}$	$32\frac{1}{2}$	2·4
1,000	·28	75	15	36	2·4
1,500	·29	70	18	$43\frac{1}{2}$	2·4
2,000	·30	65	20	48	2·4

TABLE XLV.—Belt Velocities for High-Speed Dynamos of Various Capacities.

Capacity in kilowatts.	Belt speed in feet per minute. S_b
Up to 5	2,000 to 3,000
2·5 ,, 25	3,000 ,, 4,000
10 ,, 100	4,000 ,, 5,000
50 ,, 500	5,000 ,, 6,000

The belt speed in modern dynamos ranges between 2,000ft. and 6,000ft. per minute, as above:
The pull at the pulley circumference, in pounds, is:

$$F_p = \frac{33{,}000 \times H.P.}{\frac{d_p \times \pi}{12} \times N} = \frac{33{,}000 \times H.P.}{S_b} = 44{\cdot}2 \times \frac{W}{S_b}$$

For an arc of belt contact of 180deg., which can safely be assumed for dynamo pulleys, the pull, F_p, is to be multiplied by 1·4 in order to obtain the tension on the tight side of the belt; hence the greatest strain upon the belt:

$$F_b = 1{\cdot}4 \times F_p = 62 \times \frac{W}{S_b}.$$

Allowing 300lb. per square inch as the safe working strain of leather, the necessary sectional area of the belt can be found from

$$b_b \times h_b = \frac{F_b}{300} = {\cdot}2 \times \frac{W}{S_b} \; ; \quad . \quad . \quad (84)$$

b_b = width of belt, in inches;
h_b = thickness of belt, in inches;
W = capacity of dynamo, in watts;
S_b = belt speed, in feet per minute (Table XLV.).

(To be continued.)

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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SPECIFICATIONS.

To judge from the outcry—lately raised with ample justification in quarters well qualified to complain—against the too frequent absurdities of *soi-disant* consulting electrical engineers, there must be at least two distinctly vicious attributes that may be discovered in the characters of these gentlemen. In the first place, their absolute ignorance of *essentials* as compared with the mere frills or trimmings, which only entail useless expense without any material advantage to be gained thereby, is usually on a par with their entire confidence in the self-assertive ability so abundantly bestowed upon them by a nature that seems fond of freaks. Conceit in every line and a gratuitous assumption of superiority are commonplaces in the specifications drawn up by these individuals for the guidance (?) of contractors or engineers whom fate brings within their range.

Such trifles as elaborately printing a folio document, tied with red tape, and bearing outside a red seal (with green ribbons) somewhat smaller than a saucepan lid, with verbal gems inside—such as "Consulting Engineer, John Jorkins, Esq.; "Portable fittings to be based on Mr. John Jorkins's method," etc.—only serve to make the true engineer or hard-headed practical man smile on both sides of his mouth. When, however, ridiculous restrictions are enforced—as, for instance, a minimum coal consumption to be guaranteed—although no help be given in the matter of compounding or condensing, or even the cost of raw fuel *in situ*, the situation becomes more serious; and if hard-and-fast conditions of payment are insisted upon, the unfortunate contractor may consider himself well off at escaping with a *slight* money loss. Yet what is he to do? He cannot retire from business on a competency gained by hard work and fair dealing: efforts in these directions appear too often to result in a competency for someone else more unscrupulous.

This brings us to the second "grievous fault" to be found, we fear, in more than one case; and a far more serious piece of wrong-doing it is than that above named. Much as the trade owes to some half-dozen consulting engineers, whose record is blameless in every way, there are, it may be asserted, some who do not scruple to set up their own personal pecuniary advantage above the interests of their clients; not of course by "accepting insults" in the manner of the Lord High Everything Else in the "Mikado"—the very name of "commission" would cause them to throw up both hands and eyes in holy horror! There are easier and more polite methods than that. Smith's patent engines or boilers, Robinson's improved dynamos (lately patented), Jones's lamps (see specification No. 50,000,004, 1892), are all to be employed on the particular contracts which our "consulting" engineer may have on hand, and no one would dream of accusing the dear man of partiality unless they knew that Smith, Robinson, and Jones are nominees or friends of the consultant, whose name, of course, must not be associated with patent rights, although he may draw the royalties.

This is, however, only a single instance of "how

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to do it," or from a slightly more moral standpoint of "how *not* to do it." If, speaking more broadly, we did not firmly believe in the capacity of natural law to assert itself sooner or later, and as an essential part of continued existence bring wrong-doing to its ultimate (sometimes *very* ultimate) punishment, life would really not seem worth living. Usually, however, it is the case that sooner or later the Adelphi drama is truly representative of life—virtue becomes victorious and villainy is vanquished. All we ask now is to let it be sooner rather than later.

STEEL v. IRON.

Even to-day we think it more than probable that nine-tenths of the electrical industry, or, to specialise more closely, of the dynamo makers and designers, are prepared to stake their word that there is no material so good, from an electrical standpoint, as soft wrought iron for the cores, poles, and polar extensions of dynamos: and the makers back up their word by using this type of iron, except for very cheap machines, or in cases where power costs little, and magnetic loss may therefore be disregarded.

We have lately, however, received some tabulated reports, accompanied by complete diagrams, concerning a series of tests undertaken by Mr. Kapp and Prof. Ewing upon a particular form of cast steel intended for use in this direction; and to judge from the results therein detailed, there would seem to be no reason for doubting the actual magnetic superiority of certain steels as compared with good wrought iron. The importance and value of such results will hardly require emphasising for those who know the difference in cost between somewhat complicated forgings (with the accompanying disadvantage of magnetic joints) and simple castings which avoid all joints of this kind.

In what manner such excellent results are obtained does not appear evident: we have no information as to whether the effect is reached by such methods as annealing, or whether it is due simply to an alloy such as aluminium. So long as the cost of the metal is not materially greater than usual, its exact constituents may remain the makers' secret: Sheffield will always be sure of orders when its works are able to turn out castings of this kind.

The chief advantage which they offer is a high permeability at such comparatively strong magnetisations as are used in dynamo magnets: this is considerably higher than that of good wrought iron. "Its permeability," says Prof. Ewing, "with respect to low magnetic forces, is somewhat less than that of wrought iron; with high forces the reverse is the case. From B=14,000 upwards, the permeability of this cast metal is superior to that of iron forgings, and it will consequently take up more magnetism for a given exciting current." The results show, for instance, that a force of 40 units produces a magnetic induction of 17,000, as against 15,000 to 16,000 in wrought iron, whilst an induction of 18,000 may be reached with a force of 68 units, whereas ordinary wrought iron would require at least 125 units for the same induction. The diagrams showing complete cycles of double magnetic reversal evince further good qualities of this metal so far as concerns the energy lost in hysteresis, but of course this is not a serious matter in the design or working of dynamo magnets. In five separate tests, the figures representing the area enclosed between the completed curves of magnetisation—*i.e.*, the energy expended in carrying the iron through the magnetic reversals—give a very regular curve; thus taking the positive and negative limits of magnetising force as 3·57, 5·93, 7·83, 15·6, and 37·0 for each cycle, and the similar limits of magnetic induction as 6,080, 9,400, 11,070, 14,500, and 16,800, the corresponding values for the energy lost are 2,780, 5,720, 7,470, 11,740, and 15,420.

A final advantage offered by these steel castings, to judge from the reports, appears to be of a mechanical nature: they can be made remarkably free from blowholes, whilst, in addition, a little care in moulding and casting ensures excellent surfaces, thereby effecting considerable economy of labour and time in the machine-shop. Provided, therefore, the actual cost of such castings can be kept down to the same as, or less than, that of forgings, there would seem to be great inducement for makers to employ them, not only in their own interest, but those also of their customers who have to pay for exciting current.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE PRICE OF GAS AND ELECTRIC LIGHT.

SIR,—Mr. Preece is reported to have stated that electricity at 6d. per B.T. unit is equal to gas at 3s. per thousand; but you will see from the enclosed cutting that the cost of electricity is *ten times* the cost of gas. Can you assist

A PUZZLED RATEPAYER.

[The cutting is an advertisement, which runs as follows: "Gas *v.* Electric Light.—A statement of fact.—A 16-c.p. electric incandescent lamp lasts on an average 1,000 hours, and absorbs 60 units of electricity in that time. A 60-c.p. incandescent gas lamp (the mantle of which lasts on an average 1,000 hours) consumes 3½ cubic feet of gas an hour, or 3,500 cubic feet in 1,000 hours. It may, therefore, be taken that three incandescent electric lamps are required to give the light of one incandescent gaslight. This means that, taking 3s. per 1,000 cubic feet as the average price of gas, and 6d. a unit as the average price for electric current, the cost of electric light is 10 times the cost of incandescent gaslight."]

WORCESTER.

The number of central stations being completed and set in operation at the present time is being rapidly added to. Last week we fully described and illustrated the Ealing electricity works, which were opened on Wednesday, and this week we deal similarly with the Hampstead central station, which was inaugurated on Monday. Before our next issue, the electricity works at Worcester, which pressure on our space prevents our dealing fully with in this issue, will have been opened. Next week we hope to be able to publish a detailed description of the novel features of the Worcester central station.

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JAMES PRESCOTT JOULE.*

BY LORD KELVIN.

The unveiling last December of a statute of Dr. James Prescott Joule at Manchester, England, has given that city the possession of a work of art which will ever remain an ornament and an honour to it.

Joule's work began in Manchester, was carried on in Manchester, and finished in Manchester. It began very early, when he was only 19 years of age. He was not altogether a self-taught man in science. After a good ordinary school education, he had the inestimable benefit of the personal teaching of Dalton in chemistry. He and his elder brother, Benjamin, were favourite pupils of Dalton. They went to his house in the rooms of the Literary and Philosophical Society of Manchester for regular daily lessons, and were a little disappointed at first when they found that Dalton, instead of introducing them straight away to the grandeur of the atomic theory of chemistry, kept them to the grindstone, forced them to do their additions correctly, and held up to them, as something essentially necessary for them to learn, the practice of trigonometry and the logarithmic tables. James Joule and his brother got great good from that early severe, almost hard, training by Dalton. They were both full of original brightness and acuteness in their observations. They went through the country, even before they came to be pupils of Dalton, making memoranda of what they saw and heard—an aurora borealis or a wonderful thunderstorm, or sounds of artillery or lightning, they could not tell which.

The two brothers continued pupils of Dalton until the failure of his health; but for a year after that, and no doubt to the very end, they continued to receive ideas from that great man. It must not be thought that Dalton only taught them arithmetic and trigonometry. I rather emphasise that point with an eye perhaps to the young men who aspire to follow in Joule's footsteps, and upon whom I wish to impress the conviction that it was hard work, early begun and persevered in and conscientiously carried out. That is the foundation of all great works, whether in literature, philosophy, or science, or in doing good to the world in any possible way. In electricity and electromagnetism Joule, I think I may say, was wholly self-taught. All he knew he learned from his own reading—from reading in text-books and in Sturgeon's "Annals of Electricity," and also from conferences with Sturgeon himself. The Literary and Philosophical Society of Manchester has the distinguished honour of having been the cradle of Joule's scientific childhood when it was Dalton's home, and of being afterwards Joule's life-long scientific harbour. From those early days he kept constantly in touch with that society. Many of his most important papers were first given to the world there, and during the last years of his life he was an exceedingly regular, it might almost be said a constant, attendant at the meetings of the society. An interesting and sympathetic memoir of Joule, with much important scientific information and judgment regarding his work, by Prof. Osborne Reynolds, constitutes the sixth volume of the fourth series of its *Memoirs and Proceedings*.

A great surprise that came out very early in Joule's work was burning without heat—an absolutely novel idea which Joule developed most wonderfully and most magnificently by his experiments on the generation of heat in the voltaic battery. Joule was the first to develop the idea, and it came to him not as a bright flash of genius, but as the demonstrated result of years of hard, measuring, calculating work. This burning without heat was a fundamental idea that pervaded all Joule's work. A few years later he expanded it in an admirable way. About 1884, in a joint paper by himself and Scoresby, "On the Mechanical Powers of Electromagnetism, Steam, and Horses," he brought out the startling but truly philosophical idea that when a man or any other animal walked uphill, only a part of the heat of combustion of his food was developed, and that it was only when the body was quiescent, or walking about on a level, or going down hill that the chemical attraction between the food and the oxygen dissolved in the blood developed its whole energy in animal heat. He showed, further, that a horse or a man employed in doing mechanical work against resistance was more economical of fuel than was any steam-engine hitherto realised. This was a very far-reaching idea, and seemed to hold out prospects of greatly advancing the efficiency of the steam-engine. That promise has not been lost.

It is due to Joule more than to any other individual that the great improvement of surface condensation is now universal, although it was very rarely practised before 1860 or 1862. Between 1855 and 1862, Joule and I had a small steam-engine fitted up in the stable of his father's house, Oakfield, for use in our joint investigations on the thermic effects on fluids in motion. To that little steam-engine Joule applied a surface condenser on an entirely new principle and plan, which gave us such good results that, starting from it, he undertook a special investigation on the surface condensation of steam with the assistance of a grant from the Royal Society for the purpose. The results of this very elaborate investigation, communicated to the Royal Society on December 13, 1860, and published in the *Philosophical Transactions*, have proved to be of enormous practical importance. They led directly and speedily to the present practical method of surface condensation.

But I have not yet touched upon Joule's great fundamental discovery, the discovery which is first in every one's mouth when asked what was Joule's work—the mechanical equivalent of heat. It was not merely by a chance piece of experiment or of guessing that he stumbled on a result which was afterwards found to be of great value. It was measurement, rigorous experiment and observation, and philosophic thought all round the field of physical science that made the discovery possible to him. Very early, however, in his working time Joule brought out the mechanical equivalent of heat, and in a paper at the British Association of Cork, in 1843, published afterwards in the *Philosophical Magazine*, he gave the number "770." Six years later a second determination gave him a result about one-third per cent. larger, and 29 years later he completed a third determination. The result of this final investigation of Joule's is 772·43 Manchester foot-pounds for the quantity of heat required to warm from 60deg. to 61deg. F. 1lb. of water weighed in vacuum, which is about $\frac{1}{200}$ per cent. greater than the result of 1849 expressed in the same term.

In the year 1894 a great theory was originated by a very young man, who died only a few years later—Sadi Carnot, son of the Republican War Minister and uncle of the late President of the French Republic. It was he who made "Carnot's theory" a household word throughout the world of science. Carnot's theory gave an important fundamental principle regarding the development of motive power from heat. Joule's work, on the other hand, so far as the mechanical equivalent was concerned, was the generation of heat by mechanical work. It was quite the middle of the century before Carnot's theory began to attract attention; but Joule was early made acquainted with it, and after fighting a little against it, as differing from his own theory, he, of all others, took it up in the most hearty manner. I can never forget the British Association at Oxford in the year 1847, when in one of the sections I heard a paper read by a very unassuming young man who betrayed no consciousness in his manner that he had a great idea to unfold. I was tremendously struck with the paper. I at first thought that it could not be true, because it was different from Carnot's theory, and immediately after the reading of the paper I had a few words of conversation with the author, James Joule, which was the beginning of our 40 years' acquaintance and friendship. On the evening of the same day that very valuable institution of the British Association, its conversazione, gave us opportunity for a good hour's talk and discussion over all that either of us knew of thermodynamics. I gained ideas which had never entered my mind before, and I thought I, too, suggested something worthy of Joule's consideration when I told him of Carnot's theory.

Then and there in the Radcliffe Library, Oxford, we parted, both of us, I am sure, feeling that we had much more to say to one another and much matter for reflection in what we had talked over that evening. But what was my surprise a fortnight later when, walking down the

* From *Cassier's Magazine* for September.

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valley of Chamounix, I saw in the distance a young man walking up the road towards me and carrying in his hand something which looked like a stick, but which he was using neither as an alpenstock nor as a walking-stick. It was Joule with a long thermometer in his hand, which he would not trust by itself in the *char-à-banc* coming slowly up the hill behind him, lest it should get broken. But there, comfortably and safely seated on the *char-à-banc*, was his bride—the sympathetic companion and sharer in his work of after years. He had not told me in Section A or in the Radcliffe Library that he was going to be married in three days, but now in the valley of Chamounix he introduced me to his young wife. We appointed to meet again a fortnight later at Martigny to make experiments on the heat of a waterfall (Sallanches) with that thermometer; and afterwards we met again and again and again, and from that time, indeed, remained close friends till the end of Joule's life. I had the great pleasure and satisfaction for many years, beginning just 40 years ago, of making experiments along with Joule which led to some important results in respect to the theory of thermodynamics. This is one of the most valuable recollections of my life, and is, indeed, as valuable a recollection as I can conceive in the possession of any man interested in science. Joule's initial work was the very foundation of our knowledge of the steam-engine and steam power. Taken along with Carnot's theory it has given the scientific foundation on which all the great improvements since the year 1850 have been worked out, not in a haphazard way, but on a careful philosophical basis. James Watt had anticipated to some degree, in his compound engine and his expansive system, the benefits now realised; but he was before his time in that respect, and he had not the complete foundation which Joule's mechanical equivalent and Carnot's theory have since given for the improvement of the steam-engine.

THE BOARD OF TRADE STANDARDS AND STANDARDISING LABORATORY.

(Continued from page 371.)

Turning now to the "standards" room, a description must be given of the two main standards—the ampere standard and the volt standard; these, with the standard ohm as verified during the present year, giving the permanent units of current, E.M.F., and resistance.

Construction and Use of the Instrument for Determining the Standard of Electrical Current.

The standard ampere-meter is a truly magnificent piece of apparatus. We illustrate it in perspective with some of the chief details. Its construction is practically as follows:

A sensitive balance suitable for the accurate determination of weights up to five kilogrammes, with a beam 16in. in length between the knife-edges, from which the scale pans, S S (Fig. 1), are hung, is fixed on an upper horizontal platform of marble, supported on four marble columns at a height of 2ft. 3in. above a similar platform fixed on a suitable stone pier, bedded solidly in a mass of concrete, and kept clear from contact with the wooden floor of the laboratory.

On the lower platform (see Fig. 2) is placed on three supports—details of which are given below—a cylinder of white statuary marble, partly hollow. The cylinder is thoroughly impregnated with paraffin wax. A block of ebonite, *e* (Figs. 1 and 2), is fixed on one side of the cylinder, and serves as a terminal board.

Two circular grooves are cut completely round the cylinder, in which are wound coils of No. 18 standard wire gauge, 0·012 centimetre diameter, insulated with two coverings of white silk. The wire was passed through a bath of shellac and alcohol as it was wound on the marble, and each layer was well coated with the same material when in its place.

Each coil has 16 turns per layer, and 16 layers of wire. The coils are both wound in the same direction, and the outer ends are strained tight and secured to the terminals, *t t* (Fig. 3). The inner ends are passed through the marble and secured to bolts in connection with terminals, *i i* (Fig. 2).

Between the grooves on the marble cylinder, at points equidistant from each other, are bored through the marble three sighting holes, one of which is shown at *h*, Figs. 1 and 2. These holes are closed on the inside by glass, the exact centres being indicated by the intersection of two straight lines engraved in the glass, and also by the angle of a quadrant of tinfoil affixed to the glass.

A circular coil, shown in sectional elevation at C, Fig. 2, and of the dimensions given, is suspended from one end of the beam of the balance by means of three gilded phosphor-bronze wires, 0·086 centimetre diameter, *w*, *w*, *w* (Fig. 2). These wires pass through an aperture in the upper marble platform.

The wire in this coil is the same as in the fixed coils, and is similarly insulated and varnished. There are 18 turns of wire in each layer, and 18 layers. Each complete layer was allowed 24 hours to dry after being coated with shellac varnish before the next layer was put on. The coil is covered with a taping of silk ribbon, closely laid on to overlap, and varnished with shellac in alcohol four coats, each being allowed to thoroughly dry before applying the next one. The ends of the coil are brought out next each other on the upper surface at *l*, Fig. 2. A considerable length of wire is left for each end, and is formed into a spiral and then projected horizontally to the centre of the coil, where the stiff wires terminate, and flexible connections are made by three silk-covered silver wires No. 40 S.W.G. from each to the posts, *p* (Fig. 2), which are connected to terminals, *n n*.

Three ebonite blocks (*b*, Fig. 2) are fitted over the coils as shown, and secured by a lashing of silk thread, the suspended wires being attached to brass eyelets screwed into the ebonite. At *d*, *d*, *d*, Fig. 2, are shown ivory cranks for effecting the vertical adjustment of the suspended coil.

The details of the attachment of the suspending wires to the balance are shown on Fig. 4; *r*, *r*, *r*, are ivory rings which are hooked on to the three-legged fitting, *f*, this being hooked to the stirrup, *j*, hung on the knife-edge of the beam. The scale pan, S, is also hung from *f*. On the upper part of each ebonite piece, *b*, facing the sighting hole, *h*, is fixed a mirror, *m*, the centre being marked by the intersection of cross-lines and by the angle of a quadrant of tinfoil.

The proper adjustment of position of the suspended coil is indicated by the coincidence of the angles of the tinfoil quadrants on the mirrors, M, and the glass back of holes, *h*, when the eye is so held that no reflected image can be observed.

A means of fine horizontal adjustment is provided in the supports of the marble cylinder, which are three short slate cylinders, *k*, *k*, *k* (Fig. 2), having projections from their upper and lower surfaces, the upper projection being excentric and fitting in a hole in the bottom of the marble cylinder, and the lower projection being concentric and fitting in a radial groove in the marble slab. An iridio-platinum weight is suspended on each side of the scale beam from a system of levers, by means of which it can be lowered into its respective scale pan, and released from the outside of the case.

The marble cylinder is enclosed by means of three sheets of plate glass which slide in grooves cut in the marble platforms, and when in position are in contact with the sides of the three pillars adjacent to the cylinder, the plan of this enclosure being an equilateral triangle with the axis of the marble cylinder at its centre. The planes of the three glass sheets are respectively parallel with those of the glass at the back of the sighting hole viewed through them.

The balance is enclosed within a case of mahogany and glass (see Fig. 1) and arrangements are made, as indicated, for manipulating the rider weights of the balance and the ampere weight from the outside of this case. The whole enclosure is fairly dust-tight, and sufficiently air-tight to prevent any disturbance of the weighing operations by currents of air. The connections to the reversing switch, Z, are brought outside the enclosure by means of rods passing through the pillar adjacent to the ebonite block, *e*. Fig. 3 shows these connections and the direction of the current through the various parts of the apparatus, the lower arrows

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over the fixed coils showing the alteration of direction caused by operating the switch.

Auxiliary Current Balance.

In the construction of the standard ampere-balance the chief object aimed at has been the securing of the greatest possible constancy and precision of determination. On account of the slow period of vibration of the beam, however, the use of an auxiliary instrument has been found advantageous.

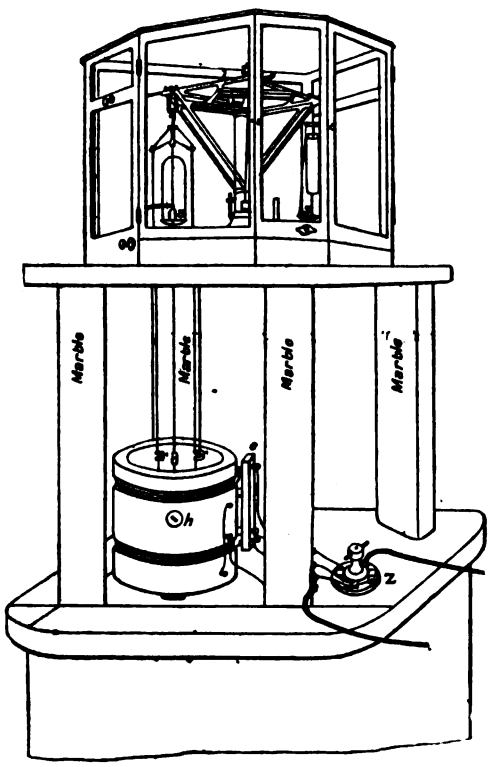

Fig. 1.

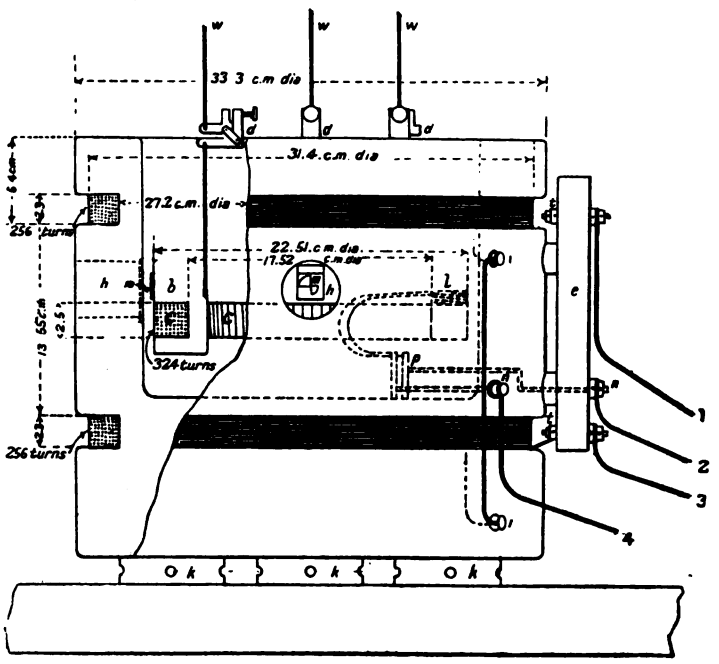

Fig. 2.

This is a special form of Lord Kelvin's current balance instrument arranged to balance with a current of one ampere passing through the coils when a certain weight is applied to one end of the beam, equilibrium being also maintained when, with no current passing, this same weight is applied to the other end of the beam.

Use of the Ampere Standard.

In using the apparatus thus described the standard balance, auxiliary balance, and the instruments to be standardised are connected in circuit with a sufficient number of accumulators and an adjustable resistance, part of which is capable of continuous variation. The whole circuit is arranged so that a current of approximately one ampere will pass on completion of the circuit. This current is allowed to pass continuously for at least one hour, being directed through the coils of the standard, so as to increase the force of gravity on the suspended coil, and the counterweight in the right-hand pan being adjusted from time to time.

At the end of this preliminary period the current is stopped for a short time to take a reading of the zero of the auxiliary balance, and apply a correction by means of the rider weight, if necessary. The current is then again put on, and as rapidly as possible regulated by means of the adjustable resistance to exactly the value of one ampere, as indicated by the auxiliary balance.

The counterweight in the right-hand pan, standard balance, is also exactly adjusted. The switch, Z, is then operated to reverse the current in the fixed coils, and at the same time the weight, A, is lowered into the left-hand scale pan. The balance should then still be maintained when the current, after adjustment, if requisite, is exactly one ampere by the auxiliary balance.

Construction and Use of the 100-Volt Standard.

We may next enter upon a description of the 100-volt electrical standard: the instrument itself is shown in plan and sectional elevation in Figs. 10, 11, and 12. It consists of:

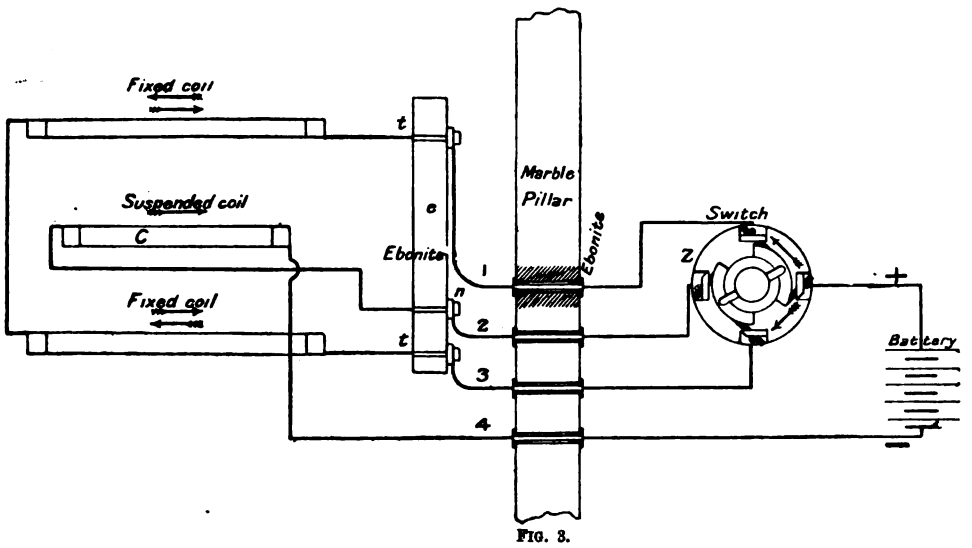

Fig. 3.

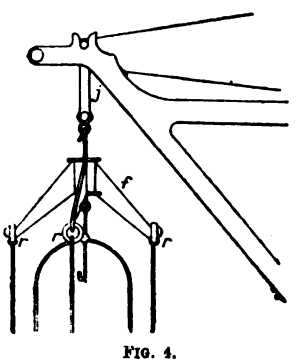

Fig. 4.

(*a*) An arrangement of 10 parallel vanes shaped like the moving portion of Sir W. Thomson's quadrant electrometer fitted on an axis passing through the centre of gravity of each vane, and separated by distance-pieces to a distance of nine millimetres apart.

(*b*) On the same axis is fixed the aluminium frame of a

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concave mirror 19 millimetres in diameter and about 61 millimetres focal length, which is held in the frame by means of three light phosphor bronze springs.

(*c*) This arrangement is suspended by means of a wire ·05 millimetre in diameter and 18 centimetres in length, formed by an alloy of 10 parts of iridium to 90 parts of platinum, attached to the end of the axis above the mirror, so that the axis hangs in a vertical line.

(*d*) The upper extremity of the suspending wire is fixed to the centre of a circular brass plate having teeth cut in the circumference into which a tangent screw is geared so as to enable the end of the wire to be rotated in the horizontal plane for the horizontal adjustment of the vanes.

(*e*) The vertical adjustment of the position of the vanes is accomplished by the raising or lowering of the platform on which the circular brass plate mentioned above is pivoted by means of three screws for raising and three for lowering. These screws regulate the distance of the platform above a similar platform fixed by means of three supports to the framework of the instrument.

(*f*) The vanes are suspended so as to slightly enter at the zero position of the instrument into the spaces between two sets of 11 thin polished brass plates shaped as quadrants of a circle, which are fixed horizontally one above another to a vertical support. These two sets of plates are in metallic connection, and are carefully insulated from the framework of the instrument.

(*g*) In order to reduce the vibration of the suspended system and the time which must elapse before an accurate observation can be taken, a thin horizontal brass disc is suspended in refined mineral oil, contained within a glass vessel by means of a wire attached to the lower portion of the axis of suspension of the vanes.

(*h*) The suspended system and quadrants with their supports are enclosed in a brass case, having in front of the mirror a rectangular window of parallel worked glass. A hole is cut in this case for the insertion of a key fitting the squared arbor of the tangent screw.

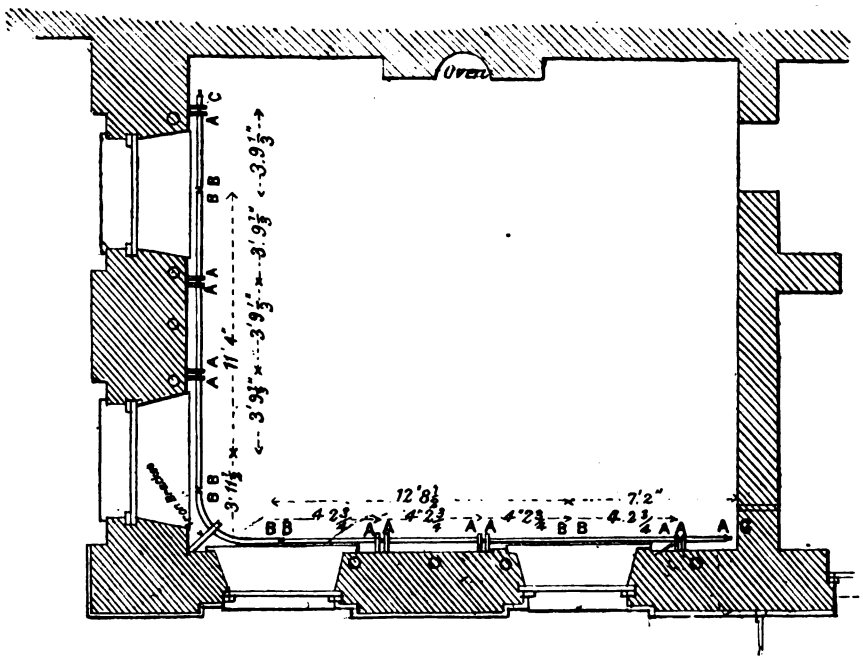
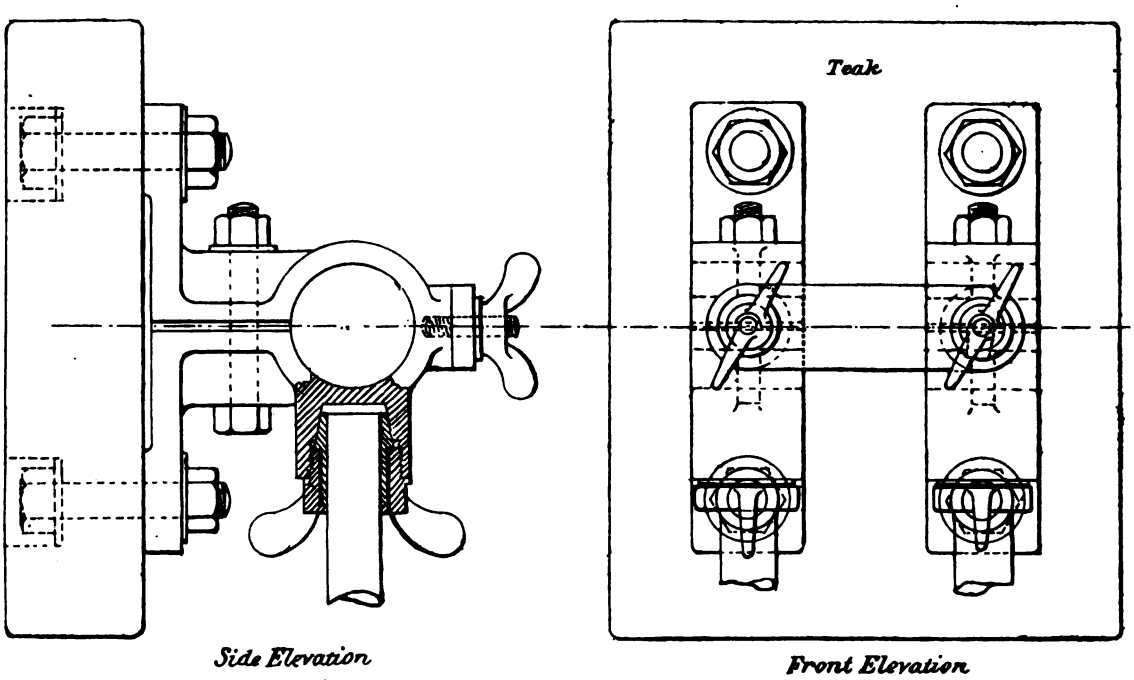


FIG. 5.



FIGS. 6 AND 7.

(*i*) The terminals by means of which connection is obtained with the vanes and quadrants are fixed on a thick piece of polished ebonite projecting beyond the brass cover. One terminal is in connection with the metal framework, the other is entirely insulated, and a tongue of brass, or switch, connected by means of a brass rod with the two sets of quadrants can be turned so as to make contact either with the insulated or with the uninsulated terminal.

(*k*) The arrangement described above, forming the electrical portion of the instrument, is mounted near the

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apex of a framework of brass in the form of a circular arc, which rests by means of three feet on a horizontal slab of polished marble supported on a large block of Portland stone on a concrete foundation. A screw thread is cut on the feet for accurate levelling of the framework, to which two spirit-levels are attached.

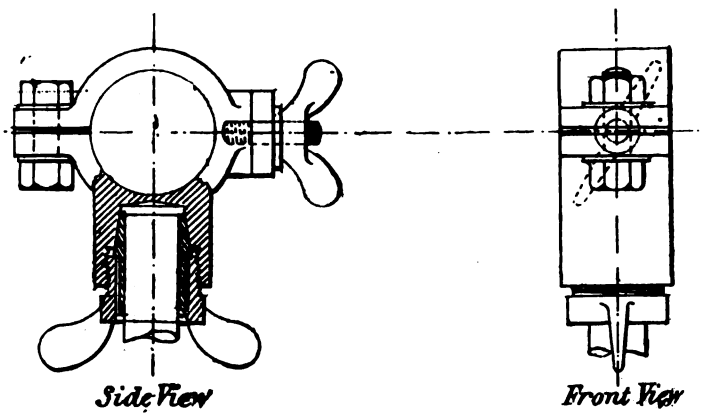
(*l*) On a support attached to the centre of the curved portion of the framework is fixed the observing portion, consisting of a magnifying eye-piece in front, in the focus of which is stretched a vertical copper wire ·06mm. in diameter.

(*m*) At each end of the arc is erected a vertical support, to which is fixed a tablet of brass with the surface facing towards the mirror platinised. On each of these faces is engraved a vertical line. These lines form the fiducial marks—that on the left of the observer giving the zero position, and that on the right the correct position for 100 volts pressure. The distances from the mirror of these tablets and of the sighting wire is adjusted so that the image of the line on the tablet when the mirror is at the proper angle coincides with the sighting wire.

Use of the Instrument.

The instrument is brought into accurate adjustment as regards level and position of the suspended system. The vertical adjustment of the latter is obtained by trial. The vanes are kept at equal distances from the quadrants above and below, this position giving minimum sensibility. The horizontal adjustment of the suspended system is obtained when the image of the zero fiducial mark produced by the mirror exactly coincides with the sighting wire, the switch being turned so as to connect the quadrants with the metal framework of the instrument. The levelling of the framework and vertical adjustment of the suspended portion of the instrument were carefully attended to when the instrument was first set up, and these adjustments have since that time remained constant, but the horizontal adjustment of the suspended system requires occasional attention from time to time.

In taking readings, arrangements are made for obtaining a pressure which can be continuously varied from about



FIGS 8 AND 9.

98 to 102 volts. This pressure is applied to the 100-volt standard and to the instruments to be compared with it, and is adjusted until the image of the fiducial mark indicating 100 volts pressure exactly coincides with the sighting wire by observation through the eye-piece. This coincidence is maintained by adjustment of the pressure, if necessary, until the expiration of five minutes from the time of first applying the pressure, when, if there is no visible vibration of the mirror, the pressure is exactly 100 volts.

In arriving at the value of the 100-volt standard, this instrument was checked and compared a number of times with Cardew voltmeters, the main readings being first taken with standard Clark cells as against the mercury ohm resistance. A sub-standard voltmeter, reading from 20 to 70 volts, is in use for ordinary work; and for high potentials there is a Thomson electrostatic voltmeter of vertical type capable of registering up to 10,000 volts.

Other Instruments, Etc.

In the standards room, as already mentioned, a series of instruments is ranged round the wall on benching, and supplied with current from an overhead Ferranti concentric main. Fig. 5 shows a plan of the room with this main in position; and Figs. 6, 7, 8, and 9 give details of the ingenious coupling adopted in order to secure a good contact between the main and branches leading downwards to each instrument. The main itself is designed to carry currents up to 500 amperes. From it a supply is taken to five instruments used as working sub-standards, and ranging in capacity as follows:

1. ·001 to 1 amperes
2. 1 to 5 „
3. 5 to 30 „
4. 25 to 100 „
5. 100 to 600 „

whilst the largest, measuring from 500 to 2,500 amperes, has special leads of copper strip brought up to it from

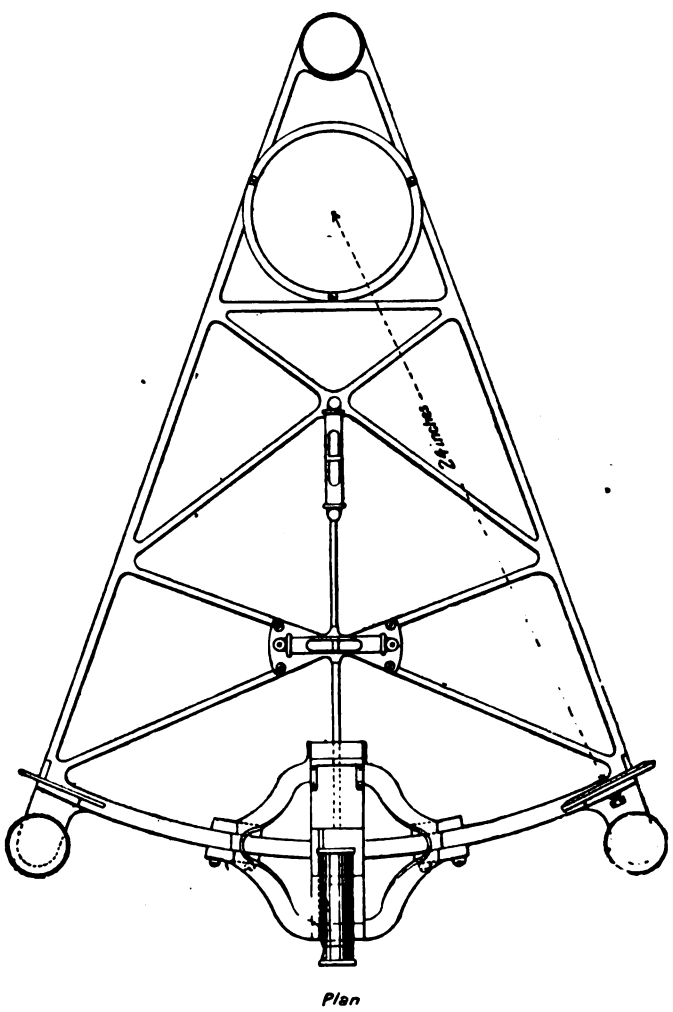


FIG. 10.

the battery mains. These instruments are all of the Thomson balance type.

One corner of the standards room is occupied by an arrangement for registering potentials up to 2,100 volts by means of Cardew voltmeter tubes set in series one with another, the indicating device being left on the end ones only. There are 12 tubes and two indicators, which may be coupled in series or parallel.

The other corner is fitted up with a series of switch and resistance gear to be used with the motor and dynamos already described. The first arrangement consists of adjustable carbon and platinoid resistances for insertion in the main or armature circuit of the motor; the second, of two variable iron wire resistances for insertion in the motor field circuit. The third comprises an adjustable iron wire and water resistances in the alternator field circuit; whilst the fourth consists of a variable iron wire and platinoid resistance in the field circuit of the high-pressure (2,000 volt) continuous-current machine. By the employment of these regulating devices the currents used

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in the testing work may be altered as desired in almost any manner.

Turning now to the other departments of the laboratory, space will only allow somewhat brief mention of the leading features to be noted.

One small room is devoted to the measurement of resistances, and the illustration which we give in Fig. 14 is taken from a photograph of the arrangement used in obtaining the standard ohm. The latter, indeed, is shown in the foreground on the right. The apparatus includes a Carey-Foster bridge—seen in the centre—the galvanometer, lamp and screen, with resistances to be tested in the foreground. One improvement to be noticed is the bringing forward of the screen right in front, whilst the galvanometer itself is in the background. The spot of light may thus, being nearer to the operator, be more easily watched, whilst the galvanometer is protected by greater distance from small fluctuations due to "personal," if not "bodily," magnetism.

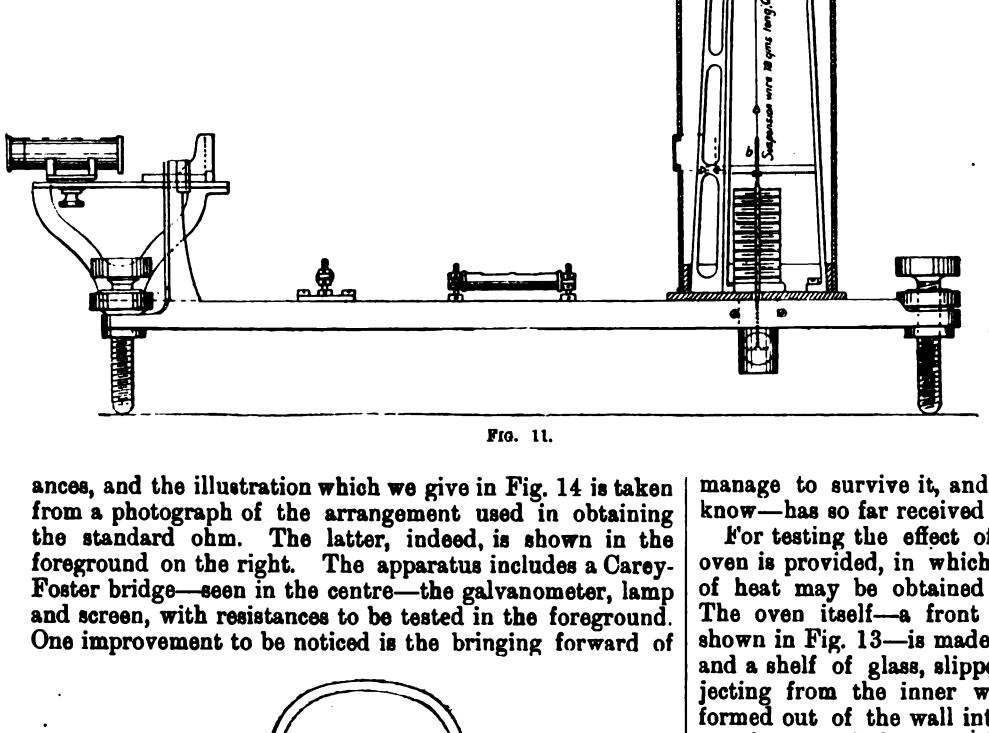

FIG. 11.

FIG. 12.—Showing Angle between Mirror and Vanes at Zero Position of Instrument.

FIG. 13.—Plans on Lines A B and C D.

Not the least important department of the whole laboratory—at any rate, to the electrical trade in general and instrument-makers more particularly—is the verification room, known to some as the "Chamber of Inquisition." Here the commercial electricity meters for which official sanction is sought, undergo crucial tests, both electrical and mechanical. Many there are that come to trial, but few manage to survive it, and one only—as our readers well know—has so far received official sanction.

For testing the effect of heat upon their indications an oven is provided, in which practically any desired degree of heat may be obtained by means of Bunsen burners. The oven itself—a front view and plans of which are shown in Fig. 13—is made of fireclay, with a glass front and a shelf of glass, slipped on to a couple of ribs projecting from the inner walls. At each side, in recesses formed out of the wall into which the oven is built, there are four vertical rows of burners directed against the exterior walls of the oven, and corresponding burners are fixed underneath also.

It would, of course, be against all law and order to give details of what may be seen going on in the verification room: various meters are still under test, but their design and makers must remain undetailed. We need only say, in conclusion, that a visit to this laboratory gives rise to a feeling of absolute security as to the careful and accurate work involved in properly carrying out the duties which have been laid upon the Board of Trade in this direction.

FIG. 14.

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NEW CLOSED-CONDUIT SYSTEM.

There has been in operation for some months, in connection with the Lyons Exhibition, a new closed-conduit electric tramway system devised by Messrs. Claret and Wuillemier. According to this method, the electric motors on the cars are connected with the generating plant at the station by means of contacts or sectional rails laid between the track rails on the street-level, and which are brought into circuit successively and automatically during the short time of the passage of the car over the sectional rails. The line is double, and about two miles in length. The generating station is within the exhibition grounds, motive power being obtained from a Delamarre-Deboutville and Malandin 100-h.p. gas-engine using low-grade gas. This engine drives a Thury six-pole dynamo of 175 kilowatts.

The gauge of the line is one metre, and the rails are laid in lengths of 10 metres. In the centre of the track are placed the before-mentioned contact-pieces, consisting of sections of inverted rails 2·8 metres in length, and laid at intervals of three metres apart. These are insulated from each other and from the rails of the track by wooden pavement arranged in bitumen. Feeding-wires run from these contact-pieces in a wooden channel to the conductor,

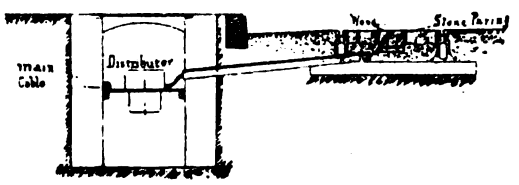

FIG. 1.—Section of Line

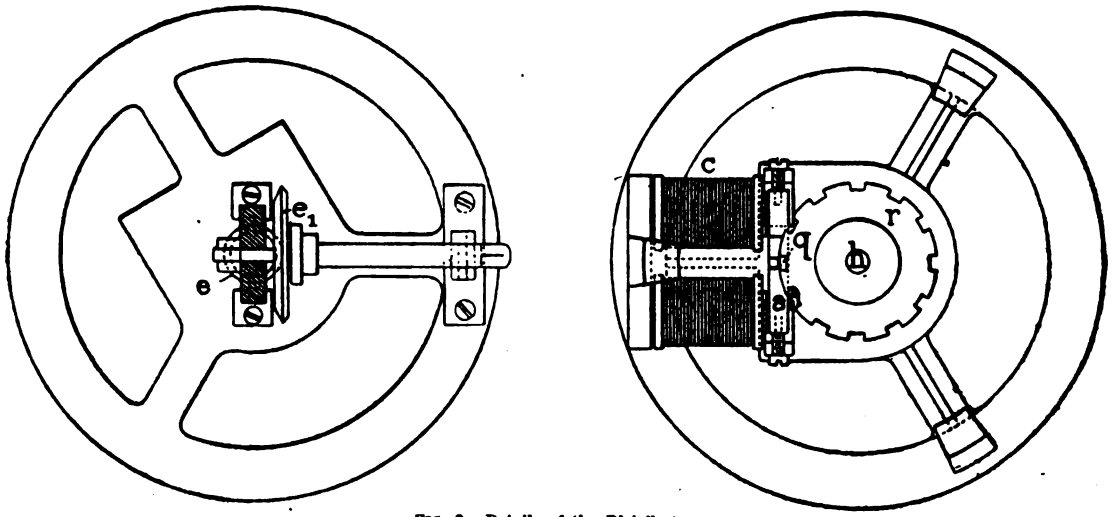

FIG. 2.—Details of the Distributor.

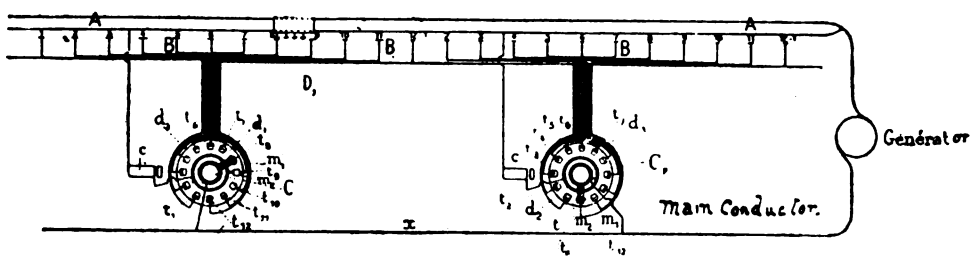

FIG. 3.—Connections of the Distributor.

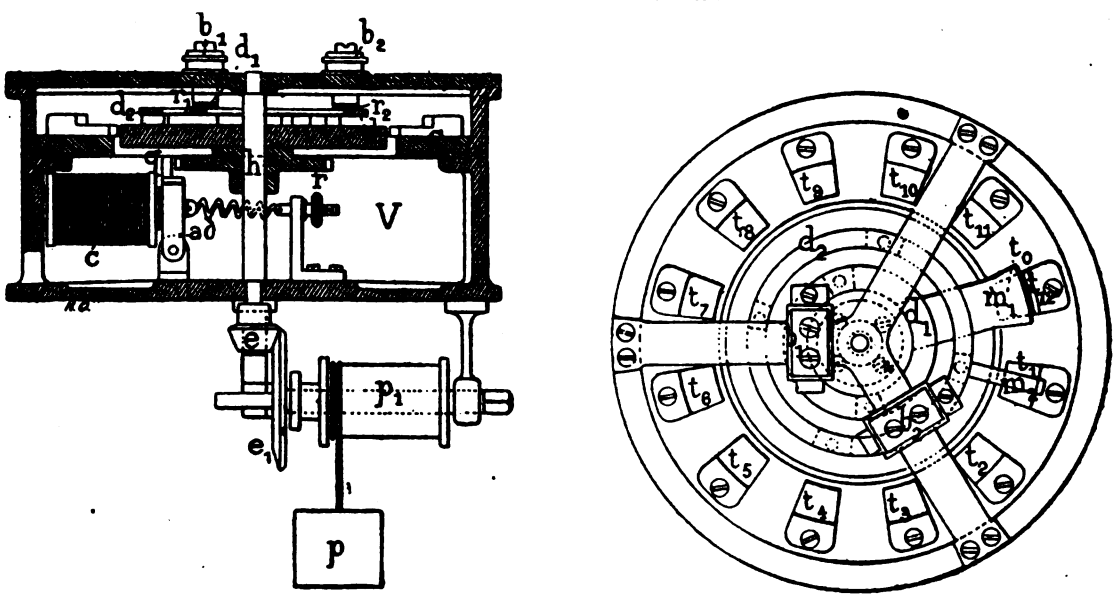

FIG. 4.—Elevation and Plan of Automatic Distributor.

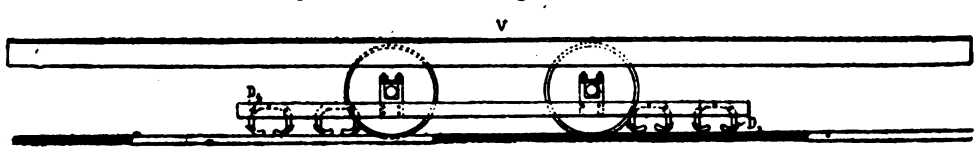

FIG. 5.—Method of Collection by Magnetic Collectors.

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receiving current at a pressure of 500 volts. The return current passes along the rails of the track. We give, in Fig. 1, a section of the roadway showing the distributor and cables.

By means of these automatic distributors, which are placed at stated intervals along the line, the sectional contact rails are brought into the circuit successively, only one section being alive at any one time. The details of the distributor, which is placed at distances of 100 metres, are shown in Fig. 2; Fig. 3 represents its connections, Fig. 4 is an elevation and plan of the distributor, and in Fig. 5 is illustrated the method of collecting the current. There are 12 cars in operation on this system.

THE UTILISATION OF TOWN REFUSE FOR GENERATING STEAM.*

BY T. W. BAKER, B.A.

The practice of the larger southern towns in England is that all fluid waste from dwellings is called sewage, and its disposal is provided for in these towns by different systems of treatment; but there are even now some towns in the North where the pail system is still in use. The class of refuse treated under the latter system is not included in this paper, but what will be considered consists of the usual ashbin contents, street sweepings, and sludge. The disposal of the ashbin refuse and street sweepings in large towns has been a source of considerable trouble and expense to the local authorities, and several vestries in London are now paying 3s. per ton for its disposal, exclusive of the expense of collecting it. Consequently, if 70 per cent. can be utilised and barging saved, considerable economy must ensue. There appears at the present time no doubt whatever that ordinary ashbin and street refuse should be dealt with by fire at the earliest moment and at the nearest possible point, as it soon becomes a prolific source of zymotic diseases. Consequently, prompt and localised destruction is particularly desirable, as railway conveyance or barging causes delay and contamination to the surrounding atmosphere.

Component parts.	Average per 1,000 loads. tons.	cwt.	qrs.	lbs.	Weight per cent.
Breeze, cinder, and ashes	611	3	0	4	63·69
Fine dust	187	1	0	8	19·51
Vegetable, animal, and various mineral matters	44	3	3	20	4·61
Waste paper	41	1	1	20	4·28
Straw and fibrous material	30	18	1	6	3·22
Bottles 5,000	—	—	—	—	0·96
Coal and coke	8	0	2	14	0·84
Tins	7	11	2	22	0·79
Crockery	5	5	0	0	0·55
Bones	4	12	1	1	0·48
Broken glass	4	11	2	2	0·47
Rags	3	15	3	16	0·39
Iron	2	0	0	20	0·21
					100·00

In order to better understand what ashbin contents consists of the author appends the analysis of Mr. Joseph Russell, given in a paper read before the Sanitary Institute on February 10, 1892, and which may be of interest, the same having been practically corroborated by several other authorities.

From the report of the London County Council on dust destructors, the average from several districts gives 260 tons per annum for 1,000 of the population, although the actual quantities vary widely. Taking this into consideration, and the fact of the preponderant amount of combustible material which it will be noticed is present in this refuse, it is apparent that it should be disposed of by fire, not merely with a view to its destruction for hygienic reasons, nor yet to reduce its bulk (which is done by the destructors in present use, leaving only from 25 per cent. to 30 per cent. of ash and clinkers), but that the heat set free in the process of destruction should be utilised.

Prof. Forbes and others have estimated the value of ashbin refuse at a much higher figure than results from practice, the various estimates ranging from 3lb. to 5lb. of water evaporated for 1lb. of refuse. Hitherto, in practice, this result has not been obtained, and according to statistics collected by Mr. C. Jones, M.I.C.E., from the larger towns using destructors with steam generators by the waste heat, 6 h.p. per cell burning from six to eight tons every 24 hours appears to be the average result. This result, doubtless, can be increased by the use of forced draught, at the same time enabling the furnaces to do a far greater amount of work as destructors.

These statistics no doubt include the disposal of the street sweepings, which must be taken carefully into account, they being the vehicle for moisture impregnated with effluvia, which during destruction absorbs some of the active heat from the more combustible ashbin refuse. As the various local authorities, particularly around London, are now anxious to use their powers under the electric lighting provisional orders granted to them for laying down plant for lighting their districts by electricity, this appears to be the better and most direct method of using this source of gratuitous heat. At the same time there are waterworks and sewage pumping stations requiring steam, as well as baths and wash-houses, which frequently belong to the local authorities, where the heat could be advantageously utilised.

There can be no doubt that the calorific value of the refuse is low, particularly when street sludge is used, and from results obtained by the author only 1lb. of water evaporated per pound of unsifted refuse is actually obtained. With screened refuse, however—that is, with the paper and loose rubbish, commonly called breeze, taken out—a fair average of 2½lb. of water evaporated per pound of breeze is the result. For some months past the author has been using this fuel in an ordinary double-flued Galloway boiler 22ft. long, 7ft. diameter, with 22 cross-tubes and steam-jet forced draught, the boiler being used for boiling purposes. These results could only be obtained by burning the breeze in direct contact with the boiler, and could not be so obtained if used in a destructor and then passed through brick flues to the boilers. Mr. Jones's statistics, before referred to, are based upon the working of plants of the latter description.

The trouble in stoking owing to the amount of ashes and clinkers prohibits the general use of town refuse in boiler furnaces to any great extent. A very large boiler capacity and grate area, proportionate to the quantity of steam required, are necessary, far beyond that usually required for ordinary coal burning, and, further, unless the refuse is mixed with coal, 60lb. appears to be the maximum boiler pressure obtainable. Even with a strong forced draught in the ashpit 80lb. only has been obtained. Consequently, to make the use of the town refuse economical in connection with the best modern steam-engine practice, a greater heat must be available and a higher pressure attained. Moreover, in thickly-populated districts all escaping vapours must be rendered innocuous, so that there are three conditions for consideration—namely: (1) facilities for stoking and cleaning the fires; (2) burning up the obnoxious fumes; (3) temperature of combustion to be raised to produce higher pressures.

First, as regards facilities for stoking and cleaning the fires. The principle of the ordinary dust destructor in its general design is doubtless the best—viz., having the feeding hopper at the upper end and the firebars at a lower level continuing towards the cleaning doors, and having mechanically-moved firebars bringing the refuse forward, allowing the green fuel to be gradually brought towards the fire, thus evaporating and burning up the moisture in it. Of the several designs of different makers, that known as Healey's appears to be a good type, and most advantageous when used with a forced air draught, although there are several other designs which are equally applicable—viz., Fryer's, Horsfall's, Whiley's, and Warner's.

In Healey's furnace the hearth-plate is at an upper level on which the refuse is fed, and which in its descent travels on to a movable gridiron and from thence to the firebars proper. In order to keep the furnace at its full work this continual feed is necessary; but Healey's movement of the furnace bars has the triple effect of feeding the furnace and clearing the clinkers off the bars and pushing them into a receptacle for removal. This is accomplished by resting the front of the firebars on the dead plate, the back bearer being a rotating camshaft with eccentrics, on which is fitted each alternate bar which has a slot fitting these eccentric cams on their undersides. The other alternate bars are fixed to a bearer and in a recess on the front dead plate. On their upper edge another bar is fitted with a parallel ball and socket joint. The upper ends of these bars oscillate in a recess in the upper hearth-plate. The fronts of the firebars also oscillate on the front dead plate, so that on the bearer shaft being rotated towards the front the movable bars lift the clinkers and fuel forward off the fixed bars and a constantly clean fire is kept. At the same time new fuel is fed from the upper hearth-plate. The shaft is rotated by a ratchet wheel worked by an eccentric from a rotating shaft at the furnace front driven by the forced draught blast-engine. The air blast is brought from a conduit under the ashpits by pipes on either side and opposite each other in the fore part of the ashpits. Special facilities are provided for clearing away the dust from the flues at all possible points, and a dust-settling flue or chamber is also provided between the furnaces and the chimney, which is preferably on the back of the furnaces.

Hitherto the practice as regards the generation of steam has been to place a tubulous steam-boiler between the destructors and the chimney, leaving the walls of the flues to absorb a large quantity of the heat before reaching the boiler. Between the destructor and the boiler a Jones's fume cremator is frequently used, which consists of coke furnaces so constructed and arranged that the flues from the destructors conduct the gases over these fires by deflecting masonry, thus cremating them and rendering them innocuous by destroying the excess of moisture and effluvia which would otherwise escape as noxious vapours and condense in the atmosphere and cause what has been recently described as an unmitigated nuisance.

At Cambridge, Messrs. Wood and Brodie's system of furnace is being adopted. It consists of a water-tube, Babcock type steam generator placed in series between every two refuse furnaces. The waste gases are conducted through brick flues into a chamber under a V-shaped ash tray or pit, and then over its upper edges through the fire grate to the water-tubes and ordinary setting of the generators.

At Warrington, a special refuse furnace has been erected in front of the furnace of a Babcock steam generator, the place of which it takes. It is fitted with forced draught, the refuse fuel being conducted by hoppers from the floor above to the furnace. The following are the results of working which Messrs. Babcock and Wilcox have kindly supplied:

TEST OF PATENT DESTRUCTOR FURNACE WITH UNSCREENED REFUSE.—WARRINGTON INSTALLATION.

Date, noon to noon	November 23-24, 1893.
Duration of trial	24 hours.
Nature of fuel	unscreened refuse.

* Paper read before the Society of Engineers.

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Total quantity of fuel burned	53,536lb.
Quantity of fuel per hour	2,231lb.
Total quantity of water evaporated	61,344lb.
Quantity of water per hour	2,556lb.
Weight of clinker produced	14,460lb.
Per cent. of clinker	27
Pressure of steam maintained	66lb.
Temperature of air in boiler-house	45deg. F.
Temperature of feed water	104deg. F.
Temperature of gases leaving damper	550deg. F.
Quantity of water evaporated per pound of house refuse	1·14lb.
Average temperature of copper-wire test	2,000deg. F.
Average air pressure (water) maintained	3½.
Draught velocity in feet per minute	820ft.

From the author's experience the system which recommends itself is that of placing a steam generator directly over the destructor furnace, so that the heat shall pass around or impinge directly on the heating surface of the generator. The ordinary generator furnaces are placed above the refuse furnace, and are used as supplementary furnaces to increase the temperature necessary for the higher pressure demanded, and also to cremate any obnoxious gases from the refuse furnace below. Where destructors are in use, and it is desired to utilise the heat from them to generate steam at high pressures, the generators may be arranged in a series adjoining the main flue to the chimney, and by connections the gases may be directed into their combustion-chambers, and so utilised and cremated. Where it is practicable, however, to place the generators over the existing lower furnaces or destructors, it is greatly to be preferred, as being more effective.

There is no doubt that the gases from refuse are impregnated with a large percentage of moisture, and are of low temperature. This is shown by an analysis of the gases, where a preponderating amount of nitrogen is found, amounting to 22 per cent., and any contact with the side walls of brick flues has the effect of impairing the efficiency, the walls being always ready to absorb some of the moist heat, the surfaces necessarily having to be large. With these considerations it will be seen that to obtain the best effect the radiated heat must be absorbed directly by and transmitted to the generator. This is accomplished by placing a reverberatory perforated firebrick arch over the refuse furnace, with the generator above it, so that when an excess of green fuel comes down from the hearth-plate, the regenerative heat from the arch assists to cremate the fumes before passing to the upper furnace.

There is no doubt that hand sorting of dustbin refuse will be largely discontinued on account of its degrading nature, and also from the decreasing prices of bones, rags, waste paper, etc., making it less profitable than formerly. There will, therefore, be a proportionately greater quantity of animal matter to be disposed of, and the consequent effluvia must be constantly dealt with, so that the need of an effectual fume cremator is absolutely necessary. These fumes it is proposed to cremate and destroy, with the assistance of the reverberatory arch, by the higher temperature of the combustion-chambers of the ordinary and supplemental furnaces of the generators, this being their hottest part, the temperature of which will be never less than 1,500deg. F. It has been found that to effectually destroy refuse fumes, 1,250deg. F. is absolutely necessary, and it would appear almost impossible for any effluvia to escape after passing through these two heats. Means must also be provided for the admission of fresh oxygen into the combustion-chambers if necessary to complete combustion; the gases or fumes from the destructors might also be burnt through the furnace bars of the supplementary furnaces, if desired, when oil or producer gas is used as fuel.

The author has recently had some experience of the effect of escaping effluvia when saturated with moisture. It was proved in a recent law case that persons in close proximity to the 60ft. chimney shaft from whence it was alleged the foul gases were escaping scarcely complained, but numerous complaints arose from those from 300 to 1,000 yards distant, showing that it took that distance to bring the saturated effluvia to earth.

In some existing plants in which no utilisation is attempted, the cost of fuel for the crematory fires has been so great that they have been discontinued, but serious complaints from the neighbourhoods are now arising, thus showing the advantages of cremation.

The calorific value of refuse being low, it is necessary to provide ordinary generator furnaces to assist in raising the steam to the required pressure for economical use as well as for cremating, as in several of the existing plants with the boilers in the flues 40lb. pressure per square inch is all that can be obtained, and at Warrington, as previously stated, 66lb. only is obtained even with forced draught. In the ordinary furnaces of the generator good fuel should be used, and if a supply of Russian oil can be obtained, that, or producer gas, appears to be especially applicable.

Having now described the general principles of the generation and absorption of the heat by the generator, and having specially in view the use of the steam generated by it for electric light stations—viz., to assimilate the supply to the demand—the author will deal with the question from the latter point of view. It is well known that the demand of electricity during the day is so light, even where a fairly high load-factor is obtained, that the use of the steam generating plant at even half its capacity would be an excess, so that a system of heat storage is necessary for the economical use of the refuse, as the destructors must always be at work. Any ordinary form of steam generator may be adopted, but the cylindrical dry-back marine boiler with two flues or the inclined water-tube boiler of the Babcock and Wilcox type are best suited. Lancashire boilers, on account of their length, are not well suited to the present purpose, as the temperature of the gases in the combustion-chambers frequently falls below 1,250 F., and allows the moisture to pass away undecomposed.

In all cases the refuse gases are conducted into the combustion-chambers or their hottest part, while in the marine form they are led to the space above the flues and opposite the tubes, the gases from the ordinary and crematory furnaces of higher temperature mixing with them. In the water-tube generators they enter the ordinary furnace from behind the furnace back, in both cases meeting with the partly incandescent firebrick masonry, which assists in evaporating any moisture and destroying the effluvia. It is also necessary to keep the generators short, otherwise the feeding floors must be placed over the boilers with descending hoppers. This design also takes up more ground area for the inclined roadway, the other forms being conspicuous for the small space occupied by them.

Referring to the refuse destructor and steam generator combined for dealing with 420 tons of refuse per week (which is an average quantity from several London vestries), some six or eight sets would be required for electric lighting purposes. These would be in one battery, adjoining each other, the flues between the arches over the refuse furnaces, and under the generators, would communicate with each other, so that any number of refuse furnaces might be coupled to one generator and its crematory furnace. For the day load, however, they should be worked in sets of three, so that the middle generator alone would have its ordinary furnace in use, the refuse furnaces below all communicating with the one generator by dampers being opened between them, and other dampers closing the two outer generators from the chimney flue. It will thus be seen that the two outer generators would be kept at the same working pressure as the middle one, and would always be available by their own furnaces being brought into use, so that the stand-by losses would be wholly taken up by the refuse. There would also be an excess of steam, during the extreme light loads, which should be stored in the following manner:

A tank or reservoir properly clothed to prevent radiation is to be placed as a roof to the boiler-house, and in this tank near the bottom is fitted a coil of pipes. The waste steam would be taken into this coil, which is immersed in water, thus condensing the steam, and ejecting the condensed water into the tank itself, eventually filling it with practically distilled hot water every day, and this would be the case either with condensing or non-condensing engines; but when condensing engines are used it will be preferable to filter the condensed water from the air-pumps, and use this as feed water through the boilers, and thence into the storage tanks, as before described, but where non-condensing engines are used it would be better to allow the exhaust steam in the coil to heat up and boil the water in the storage tanks, in which would be deposited most of the impurities, the coil being connected by a system of steam flow and water return to the generators. Under these circumstances a live steam feed-water heater and separator would be necessary to feed the generators during the light load, bringing into use the boiled storage water during the heavy demand for steam. When multitubular generators are used, care must be taken that increased internal tube area is afforded for the passing of the gases from the three refuse and crematory furnaces. This system can be applied to existing destructors, as water-tube generators may be made of a width to suit such circumstances where probably cylindrical boilers could not be so placed.

The net result of this system would probably be that ¾lb. of water would be evaporated by 1lb. of refuse, allowing for the lesser value of street sweepings or sludge and the absorption of a certain quantity of heat in the furnace masonry, as compared with the 1lb. of water per 1lb. of refuse, which has actually been accomplished, as before explained—a result which is corroborated by Mr. A. Collins, A.M.I.C.E., of Reading, and the Warrington tests in directly fired generators. Reducing this to financial terms, the saving in barging, which has been mentioned as the only credit, must be first considered. This, according to the average cost per ton to several of the London vestries, amounts to 3s. per ton after collection, and 70 per cent. can be utilised, leaving only 30 per cent. of ash and clinkers as a residue to be disposed of, which in the spring is readily marketable for roadmaking, and where crushing machinery is in use it can be prepared for mortar, and with cement manufactured into street paving. This source of profit will, however, be absorbed by the cartage on the unsold residue, also by the fuel account for the generator furnaces, for working the forced draught, and moving the furnace bars, the net saving being therefore the cost of barging or disposal of 70 per cent. at 3s. per ton; and taking six furnaces burning 10 tons each every 24 hours, equal to the consumption of 420 tons per week of seven days, 294 tons at 3s. will represent the saving in barging, amounting to £44 per week, or £2,288 per annum.

The gross credit will be the value of the steam generated from the refuse. As each furnace will be of a capacity to burn 10 tons every 24 hours, and taking 20lb. of steam per indicated horse-power per hour and non-condensing engines without the cremating fires, the effective evaporation will be equal to 35 i.h.p. per hour per generator set and available for electric lighting.

From the returns of the various London electric lighting plants published in *Lightning*, 1d. per unit appears to be a fair average for the cost of coal. Six destructors and generators would give an hourly output of 210 i.h.p. from refuse only, or, allowing 15 per cent. for frictional loss = 177 e.h.p., which at 1·34 h.p. per unit = 128 units at 1d., or 11s. 1d. per hour, say £93. 1s. 6d. per week, against which the extra cost of maintenance, wear, and tear have to be debited. If ashbin refuse alone were burnt the results would be 15 to 20 per cent. in excess of this, but this result could only be attained if the steam were used by the engine as generated, but against this, and as a general debit, the inherent losses of storing the heat and the reheating will have to be considered. As this process will be going on for two-thirds of each 24 hours, the author estimates this loss at 30 per cent., but being 16 hours only out of the 24 = 20 per cent. on the total 35 i.h.p., leaving a net effective result (after deducting 15 per cent. for frictional losses) of 23·6 e.h.p. per hour per set, which may be absolutely depended upon. The total value at 1·34 h.p.

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per unit equals 1s. 5½d. per hour per set, or 8s. 9d. per hour for the six sets—that is

£73. 10s. per week, or, per annum ...	£3,822
Less £350 for steam for auxiliary blast and grate,engines and pumps	350
	£3,472

Mr. G. Watson, C.E., of Leeds, in his paper read before the British Association in 1892, gives the theoretical value of ashbin refuse as 11lb. evaporating 2·13lb. of water, and the practical result at 1d. per indicated horse-power per hour with a steam generating plant of improved type, or 1s. 3d. per cell per hour, burning 5cwt. of refuse at a total cost of 1s. 10d. per ton. At Oldham some authorities give the cost at 1s. 6d. per ton, including all expenses and depreciation. Taking these figures and the evaporative tests of the author, of Mr. Collins, and those from Warrington, the foregoing figures may be considered fairly substantiated, together with the results deducible therefrom. The ordinary or supplementary furnace heat is not considered in these estimates, as that would be directly available for extra evaporation at proportionately increased returns.

The author considers, as previously stated, that plant capable of dealing with 420 tons of refuse per week would be of suitable working capacity for a London vestry. The plant would consist of eight refuse furnaces (two in reserve), with six steam generators for 140lb. working pressure, with feeding, coal, and cleaning floors, forced draught, machinery, movable firebars, storage tanks, and chimney, and capable of a total output of 900 brake or electrical horse-power when fully loaded. The author estimates the cost, including £3,000 for the site, at £18,000. The maximum indicated horse-power from the refuse only is computed at 48 h.p. per cell, the extra evaporation by the supplementary furnaces at high load utilising the remainder of the heated feed water out of a total of 25,000 gallons. The following is a statement of the returns, which are inclusive of engineers' charges and royalties.

Wages, renewals, repairs, oil, lighting, depreciation, water, etc., at the Oldham estimates of 1s. 10d. per ton	£2,002
Yearly payment for redemption in 25 years of interest at 3½ per cent. and principal on a loan of £18,000	1,092
Credit balance.....	378
	£3,472
Value of heat	£3,472
From heat account	378
From saving in barging.....	2,288
Net saving	£2,666

The quality of ashbin refuse varies greatly. During the summer it is generally very poor, but from the better districts of London it may be advisable to sift it over a shoot during early spring, reserving the better fuel which it will be found to contain for use in the ordinary furnaces during the summer, and thus increasing the economy. From enquiries the author finds that the refuse from some localities would not repay this necessary outlay. The author's experience is that the Paddington siftings have been fully 25 per cent. less in value in July than in March, which has caused a lower evaporative average value to be given than the individual tests before referred to by others, as on individual weeks in January to March the breeze was particularly good, which is shown by the water and quantity tests.

The author has endeavoured to place the complex question of the disposal of town refuse in a practical light before the society. The obtaining of the facts has been the outcome of the necessity of obtaining a cheap fuel for slow steaming, and of utilising refuse for producing electricity. The author's experience in connection with electric lighting since 1878, particularly when required for factories, is that would-be users first ask themselves, "Have I engine or boiler power to spare?" The idea of a separate plant using a waste product has been, until the past few years, quite foreign to the question. It now, however, may be said to solve an important problem. It will probably be admitted from what has been stated that, in addition to meeting sanitary and hygienic requirements, this system of refuse utilisation constitutes a valuable source of profit, to which public authorities are at length becoming alive.

THE ELECTRICAL STANDARDS COMMITTEE.

FINAL REPORT.

In our issue of August 31 we reproduced an order by the Queen in Council describing the new standards of electrical measurements for use in trade. There has now been published, as a parliamentary paper, a supplementary report and final report of the Electrical Standards Committee. The supplementary report deals with the work of the committee down to the close of 1892. From the final report we extract the following:

To the Right Honourable James Bryce, M.P., President of the Board of Trade.

Since the date of our last report the Board of Trade have laid before us a *résumé* of the action of the International Electrical Congress held in Chicago in August, 1893, to determine the units of electrical measurement. We were also informed by the Board of Trade that her Majesty's Government had been invited by the United States Ambassador in London to take steps to adopt the recommendations of the congress.

These recommendations, so far as they refer to the units of electrical resistance, electrical current, and electrical pressure, are substantially the same as those suggested for adoption in our previous reports.

We see no reason for further delay in the legalisation of standards of the above-mentioned units, and we have prepared and attach a revised draft order in Council which we advise may be submitted for her Majesty's gracious approval.

The accompanying notes to the specification for the Clark's cell have been communicated by Mr. Glazebrook, and will be found of great assistance in the preparation of this form of cell.—(Signed) COURTENAY BOYLE, KELVIN, FRANCIS J. S. HOPWOOD, P. CARDEW, W. H. PREECE, RAYLEIGH, G. CAREY FOSTER, R. T. GLAZEBROOK, J. HOPKINSON, W. E. AYRTON, T. W. P. BLOMEFIELD (secretary), August 2, 1894.

NOTES TO THE SPECIFICATION ON THE PREPARATION OF THE CLARK CELL.*

The Mercurous Sulphate.—The treatment of the mercurous sulphate has for its object the removal of any mercuric sulphate which is often present as an impurity. Mercuric sulphate decomposes in the presence of water into an acid and a basic sulphate. The latter is a yellow substance—turpeth mineral—practically insoluble in water; its presence at any rate in moderate quantities has no effect on the cell. If, however, it is formed, the acid sulphate is formed also. This is soluble in water, and the acid produced affects the E.M.F. The object of the washings is to dissolve and removed this acid sulphate, and for this purpose the three washings described in the specification will in nearly all cases suffice. If, however, a great deal of the turpeth mineral is formed it shows that there is a great deal of the acid sulphate present, and it will then be wiser to obtain a fresh sample of mercurous sulphate rather than to try by repeated washings to get rid of all the acid. The free mercury helps in the process of removing the acid, for the acid mercuric sulphate attacks it, forming mercurous sulphate and acid, which is washed away. Pure mercurous sulphate when quite free from acid shows on repeated washing a faint primrose tinge which is due to the formation of a basic mercurous salt, and is distinct from the turpeth mineral or basic mercuric sulphate. The appearance of this primrose tint may be taken as an indication of the fact that all the acid has been removed, and the washing may with advantage be continued until this primrose tint appears. Should large quantities of this basic mercurous salt be formed, the sulphate should be treated as described in the instructions for setting up Clark cells issued from the Physical Technical Institute of Berlin (*Zeitschrift für Instrumentenkunde*, 1893, Heft 5).

The Zinc Sulphate Solution.—The object to be attained is the preparation of a neutral solution of pure zinc sulphate saturated with $ZnSO_4 7H_2O$. At temperatures above 30deg. C. the zinc sulphate may crystallise out in another form; to avoid this, 30deg. C. should be the upper limit of temperature. At this temperature water will dissolve about 1·9 times its weight of the crystals. If any of the crystals put in remain undissolved, they will be removed by the filtration. The zinc sulphate should be free from iron, and should be tested before use with sulphocyanide of potassium to ascertain that this condition is satisfied. If an appreciable amount of iron is present it should be removed by the method given in the directions already quoted (*Zeitschrift für Instrumentenkunde*, 1893, Heft 5). The amount of zinc oxide required depends on the acidity of the solution, but 2 per cent. will in all cases which will arise in practice with reasonably good zinc sulphate be ample. Another rule would be to add the zinc oxide gradually until the solution became slightly milky. The solution when put into the cell should not contain any free oxide. If it does, then, when mixed with the mercurous sulphate, zinc sulphate and mercurous oxide are formed. The latter may be deposited on the zinc and affect the E.M.F. of the cell. The difficulty is avoided by adding, as described, about 12 per cent. of mercurous sulphate before filtration. This is more than sufficient to combine with the whole of the zinc oxide originally put in if it all remains free. The mercurous oxide formed, together with any undissolved mercurous sulphate, is removed by the filtration.

The Mercurous Sulphate and Zinc Sulphate Paste.—Although, after the last washing of the mercurous sulphate, as much water as possible may have been drained off, sufficient water generally remains to necessitate the addition of a very considerable quantity of crystals of zinc sulphate from the stock bottle, in order to ensure saturation, when the washed mercurous sulphate is added to the zinc sulphate solution as described in No. 4 of Specification B appended to the order in Council. If the sides of the test-tube above the cork be soiled by the introduction of the paste, the marine glue does not adhere to the glass; the liquid in the cell rises by capillary action between the glue and the glass, and may damage the cell. The form of the vessel containing the cell may be varied. In the H form devised by Lord Rayleigh and modified by Dr. Kahle the zinc is replaced by an amalgam of zinc and mercury. The other materials should be prepared as already described. Contact is made with the amalgam in one leg of the cell and with the mercury in the other by means of platinum wires sealed through the glass. The amalgam consists of about 90 parts of pure mercury mixed with 10 parts of pure redistilled zinc. These are heated in a porcelain crucible to about 100deg. C., and gently

*The specification will be found in the *Electrical Engineer* of August 31, 1894.

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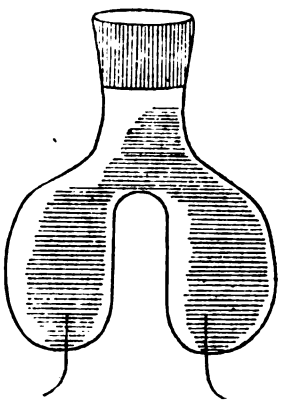
stirred until the zinc is completely dissolved in the mercury. The amalgam is liquid while warm, and must be poured into the cell before it becomes solid on cooling. The vessel containing the element consists of two vertical tubes. These, as shown in the figure, are closed below and open above into a common neck, which can be closed by a ground stopper of glass. The two tubes should be 2cm. in diameter and 3cm. in length. The neck should be at least 1·5cm. in diameter and 2cm. long. A short length of platinum wire is sealed through the bottom of each tube. The end of the wire in one tube is covered by a small quantity of pure mercury, that in the other tube by the zinc mercury amalgam. Above the mercury a layer about 1cm. thick of the mercurous sulphate paste is placed; above this, and also above the amalgam, a layer also about 1cm. in thickness of zinc sulphate crystals, and the vessel is filled up with the saturated zinc sulphate solution. The zinc sulphate crystals are obtained by evaporating at a temperature of less than 30deg. C. some of the zinc sulphate solution prepared as in 4 of the specification. The stopper is then inserted, leaving a small air bubble above the liquid, and sealed on the outside with shellac dissolved in alcohol. The ends



of the platinum wires outside the cell form the two poles, and should be connected to suitable terminals.

The final report concludes with the order in Council published, as already stated, in the *Electrical Engineer* of August 31, 1894.

NEW AYRTON-MATHER GALVANOMETER.

About two years ago we described* an improved form of moving-coil or D'Arsonval galvanometer, which has since been widely used under the name of the Ayrton-Mather galvanometer. The principal feature is the adoption of a narrow coil of peculiar cross-section, enclosed in a tube and suspended freely between the poles of the permanent magnet by a phosphor-bronze torsion strip. In these instruments the working parts are enclosed in an outer tube, Fig. 1, so as to protect them and render them interchangeable. No cover is required in this form.

It has been thought, however, that for laboratory and test-room work, where compactness and portability are not the chief essentials, an instrument whose working parts were more accessible and open to view would be useful. It was considered desirable to retain the interchangeability of the working parts, so that aperiodic or ballistic coils of different resistances could be used in any instrument.

The manner in which this requirement has been met will be seen from Fig. 2. A brass base, with levelling screws and a circular level, carries a tripod on which a powerful permanent magnet is firmly clamped. An insulated socket, connected to one terminal, is fixed beneath the poles of the magnet, and carries a vertical brass tube, cut away in front for the greater part of its length. The suspension strip is fixed to a torsion-head in the upper part of the tube, but is not screwed to it directly; it first passes through a fine hole in a thin bronze spring, which yields when the instrument is set down roughly, and prevents breakage of the suspension. The lower end of the tube is fitted with an ebonite plug, through which a brass stud is screwed, whose lower end makes contact on an insulated spring attached to the remaining terminal. This stud is slotted at its upper end, and fitted with a collar and set-screw to close the slot; similar clamps, seen in Fig. 3, are provided at the extremities of the tube containing the moving coil. The suspension strip is clamped in the upper of these, and the lower grips one end of the light spiral of phosphor bronze, which connects it with the fixed stud. Thus the coil is put in circuit with the insulated terminals, and hangs with its centre of gravity accurately below the point of suspension; it can be suspended by those who would find a difficulty in soldering the connections, but soldered contacts on the coil tube may be provided for those who prefer the original arrangement.

To clamp the coil securely, a slot is cut in the brass tube, opposite the middle of the coil, in which two phosphor-bronze springs work; when drawn back they embrace the coil and hold it firmly to the brass tube, and when pushed forward they clear it so that it swings freely. The flexibility of the connections allows this motion of the coil and clamping does not alter the adjustments; any number of the brass suspension tubes may be fitted to one instrument, and slipping them in place makes the connections.

The cover is made in two parts, so that only the cap need be lifted off to get at the torsion-head and set the spot on the scale. Aperiodic coils are enclosed in tubes of fine silver, but ballistic coils are fixed in ivory tubes. The mirror is attached to a metal clip soldered to the prolongation of the tube.

FIG. 1.

FIG. 3.

The general adoption of the moving-coil galvanometer by electrical engineers is due to its quickness of action, aperiodicity or "dead-beatness," and the fact that it is unaffected by the magnetic disturbances which make the use of sensitive Thomson galvanometers in the works such a misery.

Owing to the comparative unsensitiveness of the early D'Arsonval galvanometers, there is an impression that they cannot be as sensitive as those with suspended magnets, but Prof. Ayrton and Mr. Mather in 1892 showed that their pattern was more sensitive than the best Thomson galvanometers, having regard to resistance and time of swing.

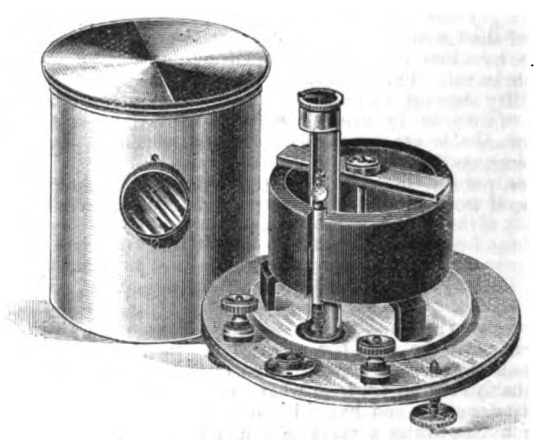


FIG. 2.

Great difficulties were, however, found to arise when the extreme sensitiveness sometimes required in the laboratory were attempted, though a good working instrument could be made to give 100mm. deflection with a millionth of an ampere. The difficulties were chiefly due to the traces of magnetism found to exist in the silk and other parts of the coil usually considered non-magnetic, and to the fatigue of elasticity or sub-permanent set of the fine suspension required in this case. A great number of trials was made at the Central Technical College, which showed that magnetism could be detected in almost all bodies by suspending them and noting the times of vibration within and without a magnetic field. The purest wire of electrolytic copper or of fine silver, specially drawn and covered, showed traces, and a method of treating the coils was at length devised which has practically solved this difficulty. The effect of "fatigue" of the suspension which causes the spot to come to rest slightly above zero may be reduced to a great extent by "ageing" the strip—*i.e.*, deflecting the coil, say, half-a-million times. By care in these details, and by proportioning the parts properly, the sensitiveness can now be pushed further than ever before without destroying the good working of the instrument, while the non-magnetic property of the coil allows a magnet to be used whose field is four times as strong as those originally used in this pattern. The instruments are made by Mr. Paul, of 44, Hatton-garden, E.C.

* *Electrical Engineer*, June 24, 1892, p. 618.

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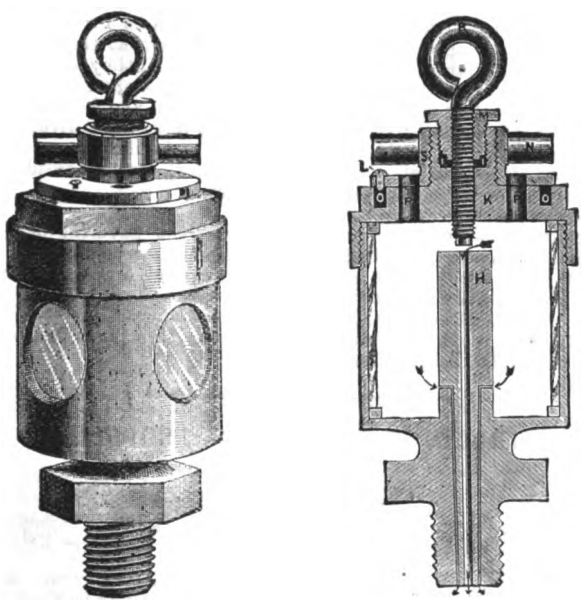
"SAFETY" AUTOMATIC DOUBLE-FEED CRANK-PIN LUBRICATOR.

In the accompanying illustrations is shown a lubricator now being introduced by Messrs. W. H. Willcox and Co., of 34 and 36, Southwark-street, S.E. This lubricator, the makers inform us, is the only lubricator specially made for the crank-pins of engines, pumps, etc.; all others up to the present time in use being make-shifts—such as syphon lubricators, needle lubricators, etc. It will be seen from the illustration that the feed of this lubricator can be regulated to suit the exact speed at which the crank is running, and by such regulation will only feed the absolutely necessary quantity of oil required; this is done by giving the piston, marked H, more or less play as necessary. There is no waste of oil through running away, when the crank is standing, as the piston comes down on to its seating, and thus closes the outlet.



There is no trouble in adjustment when once the screw is set, the refilling being done by turning the handle, N, to the left, and pouring the oil into the holes then opened on the top of the cover. To close this again it is simply necessary to turn this hard to the right, and the lubricator is then ready for use again. The body of the lubricator is of glass, enclosed in a strong gunmetal casing, by which means the quantity of oil can always be seen in the lubricator. The makers claim that for simplicity, safety, and reliability this lubricator stands out before all others, and as a result of its great efficiency and merits many of the largest engine-makers are now adopting it on traction engines, portable engines, fixed engines for electric light and other purposes, gas and oil engines, pumps, and all rods and cranks where there is any motion to keep it working.

ELECTRICITY IN CHELSEA.

We have received from Mr. T. W. E. Higgens, the surveyor to the Chelsea Vestry, his annual report, which, among other matter, contains the following information about the electric lighting of the district: The number of houses in Chelsea lighted by electricity by the various companies for the last three years was as follows:

	1891-2	1892-3	1893-4
Chelsea Electricity Supply Company ...	312	390	500
Cadogan Electric Light Company	18	—	—
London Electric Supply Corporation ...	2 (?)	—	6

It will thus be seen that the Chelsea Electricity Supply Company have maintained a steady progress, and appear to be giving satisfaction to their customers.

Meter Testing.—Under the Chelsea Electricity Company's order the Vestry, who are the electrical authority, are authorised to examine and test meters. Only one application was made during the past year to have a meter tested, which was from 59, Cadogan-square. Mr. Morgan Williams, A.M.I.C.E., tested it on behalf of the Vestry, and found that at the average load it registered 8·27 per cent. too low. The supply company on receiving this intimation fixed a new meter in place of the defective one. To avoid delay in the testing of meters the Vestry authorised the surveyor to make arrangements to have electric light meters tested immediately an application is received.

Extensions of Electric Mains.—The Chelsea Electricity Supply Company made application in April to lay mains in Redesdale-street, Tedworth-square, Christchurch-street, Oakley-street, Chelsea-embankment, Manresa-road, Elm Park Estate, and other streets in these neighbourhoods, and in December to lay mains in Wellington-square. The London Electric Supply Corporation gave notice of their intention to lay mains in Sloane-square and King's-road as far as Smith-street in May, but in October they extended as far as Flood-street.

St. Luke's Electric Lighting Order, 1891.—On June 9, the Board of Trade officially notified that they had revoked this order. The circumstances connected with the cancelling were detailed in the last annual report of the surveyor.

London Electric Supply Corporation.—In the early part of October, a slight accident, causing more alarm than damage, occurred on this company's circuit—namely, the blowing off the cover of a pavement box in Sloane-square. Major Cardew, on behalf of the Board of Trade, reported upon the accident, and recommended certain alterations in the circuit and the insertion of a more sensitive fuse. At the end of the year, however, the requisite alterations had not been carried out to the satisfaction of the Board of Trade.

Proposed Electric Lighting Scheme of the Kensington Vestry.—In November, the Kensington Vestry gave notice in the *London Gazette* of their intention to apply to Parliament for power to lay mains for electric lighting from their wharf in Lots-road through certain streets in Chelsea, so as to light a portion of South Kensington, and from their depôt in Kensal-road to light a portion of North Kensington. These notices, in the opinion of the surveyor, did not comply with the Electric Lighting Acts, and they were subsequently withdrawn, without the Bills being deposited.

Pressure Records.—Chelsea Electricity Supply Company.—From time to time the surveyor has examined the records of pressure kept by the Chelsea Electricity Supply Company. They still maintain a very good average where the records are taken at a pressure point in the mains. The automatic system of regulation adopted appears to be very satisfactory. Self-registering records of pressure are maintained at all the stations and sub-stations belonging to this company.

London Electric Supply Corporation.—After the explosion in the street box in Sloane-square, the Vestry authorised the surveyor to examine the records of the London Electric Supply Corporation. He finds that they have one record of pressure kept at Adelphi-terrace, which appears to be the only continuous record kept. The records are not so regular as those of the Chelsea Electricity Supply Company, but as the system of the London Company is, of course, a high-pressure system, it is, perhaps, not to be expected that there should be the same regularity as in a smaller low-pressure station. In the early part of December, owing to an accident to the machinery at the generating station at Deptford, the supply was cut off for a short time, which was also the case at the end of October, when the fault appeared in the mains at Sloane-square, but otherwise the supply appears to have been constant.

Town Hall Lighting.—During the year the Vestry had under consideration the adoption of electric light at the Town Hall and Council-chamber. Estimates were submitted by 13 firms, and varied from £225 to £500. The surveyor reported upon the four lowest estimates, and finally the Vestry undertook to adopt electricity in the Town Hall, Council-chamber, large room and corridors. At the end of the year the actual contract had not been entered into.

COMPANIES' MEETINGS.

BRUSH ELECTRICAL ENGINEERING COMPANY, LIMITED.

The fifth annual general meeting of this Company was held on Monday to receive the report of the directors and the accounts, which we published in our last issue. Mr. J. B. Braithwaite, jun., the chairman of the Company, occupied the chair.

The **Chairman** said that the past year with the Brush Company had been one of continuous employment in their factory, and one of great commercial prosperity, considering the very keen competition. The balance-sheet showed that there had been no change in the capital issued during the past year. There was a loan from bankers on security of £25,000. It might be asked how it was that they had arranged for this overdraft instead of issuing further capital, in view of the fact that the debenture stock and preference shares were at a premium. The answer to this was that they did not require any additional working capital; that the reasons which made it desirable to arrange for a temporary advance from their bankers were only of a temporary character—one, the increased overturn of business; another, the large amount of money they had locked up at the present moment in the retention fund on the municipal contracts that they were executing. In addition, they would see from the credit side of the balance-sheet that they held £43,000 in shares and debentures of other companies. It was probable that during the present year at least half would be realised and turned into money, which, they would see again, would enable them, by itself, to repay the loan to the bankers and have plenty of cash in hand. With regard to the closing of the Manchester and Cardiff stations, that was the fortune of war. In both those cases the Brush Company was the pioneer of electric lighting in those two cities. In Cardiff they had had an electric station for a considerable number of years, and the only trouble was that they did the work so well that the Corporation said: "This is too good a business; we will do it ourselves." So when they applied for the provisional order, thinking that having supplied the town for some years would give them a reasonable claim to it, they found that their supply had been so excellent, and had given such universal satisfaction, that they could not induce them to give the provisional order. The same thing occurred in Manchester. In the present state of the

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electric industry there would be no occasion to go further in the way of pioneering and setting an example, for municipalities were convinced that it was to their interest to do the work themselves. In many cases they had come to the Brush Company as the people who were the most competent to supply them with first-class central-station plant. None of that plant, which was represented by £114,681 as in course of manufacture, was being manufactured for stock simply to keep the men employed and works going on. All of it was in execution of orders received. The net result, after paying interim dividend and charging interest on debenture stock, for the whole year was £15,938. 9s., out of which it was proposed that the sum of £12,150 be appropriated to paying the second half of the preference dividend, and a dividend on their ordinary shares at the rate of 5 per cent for the past half-year, carrying forward the balance, £3,788. Probably someone would ask why they did not pay the same dividend that was paid last year. It was quite true that they had earned it, but paying 7 per cent. instead of 5 per cent. would absorb £2,700. They could do that and still carry forward £1,088, and it was not unreasonable to ask if there was any special reason for not doing so. They had no special reason, except that the balance-sheets published by two competitors—the Electric Construction Company and Messrs. Cromptons—were of such a character that neither of them had earned their preference dividend out of trading profits, and it occurred to the directors that in an industrial company a carry forward of £800 or £1,000 was not sufficient. Turning to the profit and loss account, they would find that the gross profit this year had been £57,157, compared with a gross profit of £49,405, so that the gross profit had improved by £8 000. The standing charges had increased about 11 per cent., whilst the turnover had increased about 50 per cent. The business in Australia had been during the past year very much reduced and hampered owing to the crisis through which the Australian colonies had passed; but notwithstanding the financial depression the amount of debts that had been made was inside £50. With regard to the Vienna business, that had made exceedingly satisfactory progress during the past year. Turning to the accounts, there was a new item in their balance-sheet called "Trustees' Account," in connection with the employés' bonus scheme. With regard to the general prospects of the Company, it might interest the shareholders to know that during the year the stations which they had erected for the Municipalities of Lancaster, Huddersfield, and Hanley had been opened for work. They had also completed an installation for the Duke of Norfolk at Arundel Castle. They had now in hand the fitting up of a central station at Worcester, which was to be opened on the 11th of this month, and also works in hand for the Municipality of Leicester, which would be opened before the end of this year, and also for the Dover Company. With regard to the City of London contract, they were able to report satisfactory progress in regard to that from year to year. When they took that contract the largest size of dynamo machine made was one capable of giving 100 kilowatts, supplying 3,000 lights. The contract provided for their manufacturing machines of four times that size, and he was able to tell them at the meeting the year before last that they had successfully manufactured a machine of 200 kilowatts, which turned out to be capable of supplying, not 6,000 lights, but nearly 7,500. He was able to tell them last year that the two first of the larger machines had been built and erected in the City station These machines were specified to be capable of supplying 400 kilowatts, and they actually turned out machines capable of supplying 500 kilowatts—that was to say, each of those machines was capable of supplying current for 15,000 lights. Since last year they had erected four more machines of the same size, so that the City of London Electric Company had six of their 15,000-light machines over at its Bankside station, and its directors had ordered three additional ones. So far as the tests prescribed under specification had been carried out, in every instance the machinery supplied had exceeded the specification. The specification provided that the combined efficiency of the engine and dynamo should be not less than 80 per cent. The tests made by Profs. Kennedy and Thompson gave a result of 83 per cent. The specification also provided that the regulation test of the machinery should be 10 per cent., and the test came well within that figure. Credit was due to the technical officers by whom these results had been obtained. The engineer, Mr. Raworth, was responsible for the design of the engines, and the electrician, Mr. Mordey, was responsible for the design of the dynamos; and the fact that these gentlemen should have made designs of machines four times larger than they had ever built before, and that those machines should have been constructed from those designs practically without modification or alteration, was a very high testimony to the capability of those gentlemen. From the City Company they expected orders for another £100,000. As to the prospects of the County of London Company, he did not think it would be fair to say that they were one whit inferior to those of the City of London. The County of London Company held three very good London districts—St Luke's, Clerkenwell, and Wandsworth. In addition to that it held a very nice electric light station at Bournemouth, which already had nearly 18,000 lamps connected to its mains, and was earning a very satisfactory profit. Besides that it had a station at Dover which had a contract with the Corporation for the lighting of the town streets; also a contract with the pier company for the lighting of the pier, and also for lighting the harbour, besides the private lighting which it would get. In addition to that, the County of London Company had secured the outfall of Lake Windermere. Its directors would take the necessary steps for applying to Parliament for a provisional order, and if the scheme proposed should be carried out, they would be able to supply all the towns within a radius of 10 miles from their station at Newby Bridge. It would be one of the finest water-power stations that had ever been seen. In other directions the prospects of the Company were exceedingly good, and as they expected from them in the course of the next few years something like £1,000,000 worth of orders, they naturally felt a benevolent interest in their progress. Whilst it was impossible to prophesy what the financial result of the current year would be, so far as they had gone they had every reason to be satisfied. The works were at present employed to their utmost capacity, and orders were in hand which would keep them employed certainly up to the end of the present year, and additional orders continued to come in at a satisfactory rate. He moved that the report of the directors and statement of accounts to June 30, 1894, now presented to the shareholders be received, and that the same be adopted.

Mr. B. H. Van Tromp seconded the motion.

Mr. Boys said it should be borne in mind that for two years the ordinary shareholders received no dividend, and, while agreeing with the desire to have a reserve fund, he thought the ordinary shareholders might have been given 6 per cent.

The **Chairman** said there was no reason, in a sense, why they should not pay 7 per cent. on the ordinary shares for the past year, but he thought shareholders would agree that this was an opportunity for strengthening their position which they ought not to lose. His experience in industrial companies showed that a conservative policy was the best in the long run, and he thought that when people saw that this was a sound 5 per cent. dividend-paying company it would gain immensely in public favour, not only from an industrial standpoint, but from the lower consideration—the price of the shares on the market.

The motion was carried unanimously.

Resolutions were then passed confirming the payment of the interim dividends, and declaring the amounts recommended—namely, 6 per cent. on the preference shares and 5 per cent. on the ordinary for the six months ended June 30.

The retiring directors (Mr. A. H. Sanderson and Colonel F. G. Steuart) were re-elected, and Messrs. Cooper Bros. and Co. were reappointed the Company's auditors.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Manchester.—The Lancashire and Yorkshire Railway Company invite tenders by the 8th inst., for various stores, including copper and indiarubber.

Bradford.—Tenders are invited for the supply and erection of feed pumps and steam-pipes, for the Corporation. Copies of plans and specifications can be obtained at the Electrical Engineer's Office, Town Hall, on payment of £1. 1s., which sum will be returned on receipt of a bona fide tender. Sealed tenders, endorsed "Tender for Pumps," are to be forwarded to Mr. W. T. McGowen, town clerk, Town Hall, Bradford, by 15th inst.

RESULTS OF TENDERS.

Morley.—The Town Council have decided to buy an engine and dynamo from Messrs. Fowler and Co., of Leeds, for the purpose of lighting the Town Hall by electricity.

Cardiff.—For installing the electric light at the Town Hall and market buildings, for the Town Council, the tender of Messrs. Fergusson and Co., Cardiff, has been accepted at £523. 10s.

Kendal.—The Urban Sanitary Authority have accepted, for supplying and fixing telephonic communication between the gas company's offices, Parkside-road, and the borough treasurer's office, 69, Highgate, the tender of Mr. J. Tanner, 54, Stramongate, Kendal, at £21. 5s. Mr. W. Wilson, Entry-lane, Kendal, tendered at £21. 15s.

BUSINESS NOTES.

Southport.—An electricity class has been formed at the Science and Art Schools.

Hull.—Mr. Geo. B. Blanchard is to instal the electric light in the General Post Office.

Bedford.—Messrs. W. H. Allen and Co., of Lambeth, have erected new works here.

Killarney.—The lunatic asylum is to be lighted electrically by the Killarney Electric Light Company.

Basingstoke.—The Town Council have issued circulars to ascertain the probable demand for the electric light.

Southsea.—The residence of Captain Bradley, R.M., has been installed with the electric light by Messrs. Bowerman Bros.

Eastern Telegraph Company.—The receipts for the month of September were £57,368, as against £55,997 for the corresponding period.

Cuba Submarine Telegraph Company.—For the month of September the receipts were £186 less than for the corresponding period of last year.

Todmorden.—Messrs. Baxendale and Co. are carrying out electrical installations in Messrs. Bancroft and Co.'s Millsteads and Cinderhill Mills.

Direct Spanish Telegraph Company.—For the month of September the receipts were £1,898, as against £1,865 for the corresponding period.

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Castleford (Yorkshire).—The matter of lighting the town by electricity is being left by the Local Board to be dealt with by the new District Council.

Eastern Extension Telegraph Company.—For the month of September the receipts show an increase of £839 as compared with the corresponding period.

Cheltenham.—Mrs. Wetherhed, the mayoress, will lay the memorial stone at the central electric supply station. The charge for current is to be 6d. per unit.

Croydon.—The General Purposes Committee of the County Council are considering the question of having all telegraph and telephone wires laid underground.

West India and Panama Telegraph Company.—For the two weeks ended September 30 the receipts show a decrease of £122 as compared with the corresponding period of last year.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending 30th ult. amounted to £988, as compared with £649 in the correspondingweek of last year.

Direct United States Cable Company.—A quarterly interim dividend of 2s. per share has been declared, payable on the 24th inst., being at the rate of 2 per cent. per annum for the quarter ended September 30.

Henley's Telegraph Works Company, Limited.—Warrants have been posted for a dividend on the preference shares of this Company for the half-year ending June 30, 1894, at the rate of 7 per cent. per annum.

Coventry.—The technical institute is to be lighted electrically by the Coventry Gas Fittings, Electrical, and Engineering Company, Limited, until such time as the Corporation are able to supply from their central station.

Bangor (Wales).—It is proposed to erect a pier and landing-stage at Garth Point. A tramway of 3ft. gauge will be fixed on the pier for carrying passengers' luggage and light merchandise. This tramway will probably be worked by electricity.

Sunderland.—The Museum and Library Committee have discussed the question of lighting certain portions of the building by electricity. Mr. Brown, the engineer, was in attendance, and was instructed to prepare an estimate of the cost, and furnish other information.

Capsule Battery Company, Limited.—This Company has been registered, with a capital of £30,000 in £1 shares, to acquire certain patents, patent rights, etc., for galvanic batteries, call bells, etc., and to develop and turn to account the same, as electrical and general engineers, metal founders, etc.

City and South London Railway.—The receipts of the Company for the week ended September 30 were £881, against £798 for the corresponding week of 1893, or an increase of £83. The total receipts for the current period of the present half-year amount to £11,118, as against £10,479 in the corresponding period of 1893, an increase of £639.

Cardiff.—The installation of the electric light in Cardiff is delayed through the lack of a sufficient supply of gunmetal tubing. Otherwise the work has advanced almost to completion, but through the delay consequent on the want of this material it will be probably from four to six weeks ere the streets will be lighted by the new illuminant.

Wells.—The Town Council have received an application from Mr. Dixon Browne for the consent of the Council to his application for a license to provide the city with electricity for lighting, and after a brief discussion it was resolved, on the casting vote of the Mayor, to refer the question of electric lighting to the Lighting Committee to consider and report to the Council.

Keighley.—A proposal was brought forward at Tuesday's meeting of the Town Council in favour of making application to the Board of Trade for a provisional order to supply electric light. The Gas Committee, however, who had brought forward the proposal, considered it rather premature, as only a few people had signified their desire to have the light. The matter was referred back to the committee.

Chelmsford.—Mr. Shepherd, the clerk to the Essex Provident Society, has complained to the Town Council of the dark state of the entrance to the Market-road from Duke-street, and it was agreed to place an incandescent electric lamp there. The Deputy Mayor complained of the delay in the lighting of Maltese-road, and suggested that Messrs. Crompton and Co. should be pressed to carry out the work at once. It was resolved to write a letter.

Aberystwith.—On Tuesday evening the Mayor and Corporation of Aberystwith inaugurated the installation of the electric lighting of the marine front and main portion of the town by a banquet. The marine esplanade is lighted by arc lights of 2,000 c.p., placed 45 yards apart, and similar lamps are placed in the main thoroughfares. The lighting is carried out by Messrs. Bourne and Grant, electrical engineers, of London, under a contract with the Corporation of Aberystwith.

Dublin.—The *Evening Telegraph* says: "The shareholders of the Alliance and Dublin Gas Consumers' Company had the pleasant fact before them at their half-yearly meeting that the profit for the half-year showed an increase of £12,000. This, representing as it does a great increase in the use of gas, is a remarkable fact side by side with the more extensive use of electricity as an illuminant." The South City Markets, which have been rebuilt, are lighted by means of six arc lamps.

Hereford.—Having received notice of intention of the Great Western Electric Light and Power Company to apply in the next session for a provisional order to supply electricity within this district, the Gas Committee on Tuesday recommended that it was desirable the Corporation should obtain such order under the Electric Lighting Acts of 1882 and 1888. The recommendation was referred by the Town Council to a committee for consideration, with power to call a special meeting of the Council.

Ealing.—Messrs Paterson and Cooper have wired and fitted the following buildings for the electric light, for the Ealing Local Board, under the specifications of Messrs Bramwell and Harris, the consulting engineers: the public offices, Victoria Hall, Princes' Hall, etc., public library and newsrooms, public baths, fire station, stables, hospital, mortuary, and laundry, and Woodlands-terrace and lecture hall. The current was supplied to these buildings on Wednesday. The firm have also carried out numerous other installations in this district in connection with the public supply.

Liverpool.—Mr. J. Miles presided at the weekly meeting of the Finance Committee of the Town Council. A letter was received from Councillor Meade-King suggesting that the electric light should be substituted for gas at St. George's Hall and the Municipal Buildings. The Finance Sub-Committee had considered the matter, and recommended that in view of the great improvements constantly being made in the electric light, it was not desirable to incur any large expenditure on the electric light at present. It was resolved to send a letter to Councillor Meade-King to that effect.

Aluminium Company, Limited.—The Oldbury trading account shows a profit of £19,456. 5s. 2d. for the financial year. After providing for debenture interest, amounting to £7 043, and other fixed charges, and allowing for depreciation on plant and buildings, there is a balance of £4,775. 6s. 2d. Out of this the directors recommend the payment of a dividend of 5 per cent. for the year on the A shares, which will absorb £3,000, leaving a balance of £1,775. 6s. 2d. to be carried forward, less the sum of £300 due to Mr. Castner, under his agreement with the Company. The electrolytic process adopted by the Company is turning out well.

Ealing Electrical Exhibition.—Messrs. Paterson and Cooper have wired the whole of the buildings for the temporary lighting of the electrical exhibition. A pretty effect has been obtained by the grouping of about 400 united incandescent lamps and artificial foliage in the entrance hall and staircases. Their exhibit is worthy of note, containing as it does some excellent examples of hammered iron, brass, and other artistic fittings for domestic lighting. This firm also exhibit several of their well-known measuring instruments, arc lamps, dynamos, and other specialities. A search-light projector, of the Suez Canal type, manufactured by them, is also shown, and is used with great effect on the forest scene at the back of the hall.

St. Helens.—The Electric Lighting Sub-Committee of the St. Helens Corporation have had under consideration the question of electric lighting in the borough, and the town clerk, who was instructed to arrange terms with Mr. R. Hammond for a report as to the adoption of a scheme for the supply of electricity, reported at a subsequent meeting that Mr. Hammond had agreed to make such a report for the inclusive fee of 50 guineas, such fee in the event of his being engaged as engineer for the carrying out of the scheme to merge into his charges, which would be 5 per cent on the cost of the work. Mr. Hammond has paid a visit to St. Helens and discussed with the committee the local circumstances, the probable demand for and the best means of providing electricity for the purposes of his report upon the matter.

Monmouth.—On Monday, at a meeting of the Corporation, the official seal was affixed to agreements with Messrs. Bramwell and Harris, C.E., and Mr. Charles N. Lailey, C.E., London, for preparing plans and specifications and superintending the work of a combined scheme of drainage and electric lighting in the borough at an estimated cost of £17,600—£12,000 for drainage and £5,600 for electric light. The Corporation are to pay the engineers 5 per cent. on the total outlay, find a clerk of works, pay for advertising and out-of-pocket expenses. Mr. Lailey is engaged for the sewerage scheme, and Messrs. Bramwell for the electric light and pumping sewage to the purifying station. Both engineers agree to make any alterations in the plans which the Local Government Board may require without any extra cost to the Corporation.

Woking.—The Sanitary and Lighting Committee of the Local Board have reported that Messrs. New and Mayne expected to be able to light the streets, according to their contract, on the 8th inst. Mr Storey said the Lighting Committee found it advisable to make certain alterations in the positions of some of the lamps. On the other side of the station some of the lights were taken away, as it was found that the road got a considerable amount of light from the station lamps. One or two double lamps had been replaced by single ones. The plan was before the Board, and he proposed that the positions of the lights should be modified accordingly. Mr. Wenham seconded the motion, which was agreed to. Mr. Storey then proposed that the expense of lighting the Woking Station and Maybury Ward should be charged to that ward, and this being seconded by Mr. Wenham was also carried.

The Mildé Telephones and Electric Supply Company, Limited.—This Company has been formed (1) with the object of acquiring the sole right granted to Mr. M. Kotyra by Messrs. Ch. Mildé Fils and Co., of Paris, to sell their improved telephones in Great Britain and Ireland and the English colonies, and also to purchase certain royalty rights granted to Mr. Kotyra by Messrs. Mildé Fils and Co.; (2) to establish, local, provincial, and private telephone exchanges for hotel services, central railways, ships, mines, factories, public and private offices, clubs, works, and private dwelling-houses; (3) to carry on other branches of electrical works, such as electric light signals, lightning conductors, bells, etc.; and (4) to supply and fix all the appliances and fittings

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required in connection with telephones, and the distribution of electric current, whether for lighting or other purposes. The capital of the Company is £20,000 in 15,000 7 per cent. cumulative preference shares and 5,000 deferred shares of £1 each.

Redditch.—On Tuesday night Mr. Evans, at a meeting of the Local Board, read the report of the Electric Lighting Committee, who had engaged Mr. J. A. M'Mullen to prepare a scheme for and report upon the probable cost of lighting the town by electricity. Mr. M'Mullen had prepared two schemes. The first provided for lights amounting to 1,500 lamps at an estimated cost of £7,000 or £8,000; the other to provide 4,000 lamps at an estimated cost of £13,000 to £14,000. The committee found that by making a charge for the light equivalent to that now being paid for gas the first scheme would more than pay expenses, and that the second scheme, with charges on the same basis, would result in at least £1,200 per annum profit to the town. The committee suggested that as soon as promises for the adoption of from 1,500 to 2,000 lights had been obtained a provisional order should be applied for, but as the new Council would shortly be elected it would be advisable to postpone the decision.

Bristol.—The Lighting Committee reported on Monday to the Town Council that it was desirable in the interests of the citizens to adopt the electric light for the city, but that it should be carried out by the Urban Sanitary Authority, and that the town clerk should ascertain from other towns where similar works have been carried out the name of a competent engineer to advise the Authority, and report the same at the next meeting. After a long discussion, the recommendations of the committee were adopted. Messrs. Verrier's shops and warehouse have been fitted with 12 of Messrs. Johnson and Phillips's Brockie-Pell alternating-current arc lamps, each taking a current of 10 amperes, and burning for 10 hours before requiring to be recarboned. This is said to be the largest private arc lamp installation at present on the city supply mains. In connection with the Kingswood Electric Tramways, a gang of men employed by the tramways company commenced work on Monday in Bell-hill, St. George, pulling down a projecting house and excavating a high bank to widen the road preliminary to laying the rails. The narrowness of the road in many places between the present terminus of the St. George's line and Kingswood will necessitate many alterations of the existing street boundaries.

Aberdeen.—The city electrical engineer, Mr. E. T. Ruthven-Murray, has reported to a meeting of the Gas and Electric Lighting Committee of the Aberdeen Town Council that, in consequence of the large and increasing demand for electric energy, an extension of plant will be immediately required. He stated that there were now 80 consumers having in all 7,000 lamps connected to the mains. It will be remembered that the station was opened on February 28 last, and the fact that an extension is required in less than seven months shows with what popularity the light has been received. The progress of electric lighting in Aberdeen has been exceptionally rapid and successful. The supply was commenced at a most disadvantageous time, as the city is so far north that in summer there is practically no night. A large proportion of the load is shop-lighting, but it also includes three hotels, a few private houses, Robert Gordon's College, and the School of Art. The committee resolved that Prof. Kennedy should be requested to report as to what additional plant he would recommend should be provided. At Monday's meeting of the Town Council, the minutes of the Gas and Electric Lighting Committee stated that a letter had been submitted from Prof. Kennedy, in which he referred to the exceptionally rapid and successful progress in the demand for electric light, and stated that the limit of the capacity of the plant has been already reached. Prof. Kennedy further stated that although the plant was quite sufficient for present purposes, it would be necessary for the committee to consider the question of providing extended plant. Under the circumstances the committee resolved that Prof. Kennedy should be requested to report as to what additional plant he would recommend should be provided. This was agreed to.

Belfast.—An important change is about to take place in connection with the shipment of cattle to Belfast, and one which will give the greatest satisfaction to those in the trade. For some time past it has been in contemplation to commence the inspection of cattle by electric light, to obviate the inconvenience which arose from the enforcement of the order in Council, which prohibits the inspection of cattle after sunset. The Great Northern Railway Company have been the first to make a move in the matter, and they have now introduced the electric light at their cattle depôt. The installation and the arrangements made have been inspected by Mr. Prentiss, the travelling inspector of the Veterinary Department of the Privy Council, who arrived specially in Belfast for the purpose, and who was accompanied by Mr. Boal, the local portal inspector. It is understood that he was satisfied with the result of his inspection, and if the innovation meets with the approval of the Privy Council, and if it is calculated to prove the great advantage anticipated, no doubt the same mode of inspection will be adopted at the Belfast and Northern Counties and County Down Railway depôts, and at the cattle yard on the Lagan Bank-road. Alderman Pirrie has presented to the Town Council the report of the Electric Lighting Committee, which contained the following: "Your committee have to report that the time has now arrived to appoint an assistant to the resident engineer who will be capable of taking charge of the central station when Mr. M'Cowen is engaged on other duty, and they recommend that they be authorised to appoint a duly-qualified man at a salary of £120 a year." Councillor Andrews seconded the motion for the adoption of the report. Councillor W. M'Cormick said he supposed that the appointment would be made by the Council in committee. Alderman Pirrie said the committee would select five or six names, and leave it to the Council in committee to make the final appointment. The report was adopted.

Middleton.—A system of electric lighting is to be introduced at Middleton, near Leeds, which possesses novel features. Middleton is the property of the Middleton Estate and Colliery Company, Limited, and upon the estate are two mansions, a colliery, a village, having a population of 1,200, and provided with a church, schools, chapel, and workshops necessary for the maintenance of the colliery. The owners of the estate recently requested Mr. T. Harding Churton, electrical engineer, of Leeds, to prepare a scheme for lighting the greater part of the estate, including the mansions, church, schools, chapel, works, etc., by electricity, to be generated at the colliery, and the necessary work is now being carried out by Mr. Churton. A constant supply of electrical energy is to be developed at the colliery, the power being derived from a steam-engine, which is also used for ventilating the mine, and which has two cylinders of 24in. diameter and 6ft. stroke. The electrical plant will include an alternating-current dynamo capable of developing 20,000 watts when driven at a speed of 850 revolutions per minute, and is being constructed by Messrs. John Fowler and Co., Limited, of Leeds and London. A current of 20 amperes, at a pressure of 1,000 volts, will be available, and will be transmitted from the source of power to the several points at which it is to be utilised by means of an underground concentric cable, designed by Mr. Churton, and specially made for the purpose by Messrs. W. T. Glover and Co., of Salford and London. The length of this cable will be about 2,300 yards. Suitable transformers will be erected at each point where the cable is tapped, the pressure of the current in the buildings to be lighted being thereby reduced to 100 volts. In addition to the lighting above mentioned, a number of arc and incandescent lamps will be erected and installed at the colliery to light the colliery yard, buildings, and offices. It is expected that the work will be completed about the middle of November.

Battersea.—The special committee of the Vestry appointed to consider the question of electric lighting have presented a report. The committee had received letters from Mr. S. Morse, on behalf of the County of London and Brush Provincial Electric Lighting Company, Limited, and from the St. James's and Pall Mall Electric Light Company, Limited, enclosing notices of the intention of the companies to apply for provisional orders authorising them to supply electrical energy for public or private purposes within the parish of Battersea, and from Mr. A. J. Lawson, engineer and manager of the County of London and Brush Provincial Electric Lighting Company, Limited, relative to the application of the company for a provisional order, stating that the company had no desire whatever to use overhead conductors; that they intended themselves to carry out the undertaking under the powers of the provisional order; and that, if obtained, they had no intention of selling or otherwise dealing with such powers. The committee had also considered the reference of the letter from Mr. S. Morse, applying on behalf of the County of London and Brush Provincial Electric Lighting Company, Limited, for a right of way for the company's mains through the parish of Battersea, for the purpose of lighting the parish of Clapham from the central generating station in Wandsworth, the company having obtained a provisional order for electric lighting in the district of the Board of Works for the Wandsworth District. The committee were strongly of opinion that it would be most inadvisable to allow the powers of the Vestry to pass into the hands of a company. They were not, however, at present prepared to recommend the Vestry to take steps to obtain a provisional order for powers to light the parish by electricity, and the committee therefore recommended that the further consideration of the question be allowed to stand over for the present, and that Mr. Morse be informed that the Vestry intended to apply for a provisional order for lighting the parish with electricity, and that they could not grant the request contained in his letter. Mr. Willis presented the report, which was adopted.

Londonderry.—At Monday's meeting of the Lighting Committee of the Corporation the resident engineer (Mr. Christie) reported that since September 6 there had been 12 more breaks in the cable. Some of these had left 44 lamps in darkness on particular nights, and some of them a smaller number of lamps. In two or three instances the breaks had occurred during testing, but in the majority they had occurred during ordinary running. Councillor Thompson said in connection with the testing they would be astonished at the revelation he was about to make. Their engineer (Mr. Blake) drew up a specification, which was submitted to Dr. John Hopkinson, of London, for his approval. On Dr. Hopkinson approving of the specification tenders were invited. Messrs. Siemens Bros.' tender for the cables was accepted. A few days ago he asked regarding the tests that were to be given to the cables according to the specifications, and he was told that they had all been given. On making enquiry he got the original specification, sealed by Messrs. Siemens Bros., and he was astonished to find that the clause relating to the efficient test—the clause that was in the document submitted to Dr. Hopkinson and approved by him—had been struck out. In the document with which Messrs. Siemens accompanied the specification they said the tests as mentioned were impracticable. So far as he knew, it was not known by the Corporation when they accepted Messrs. Siemens's tender that it was minus the clause relating to the test. Alderman Bell said this was quite a revelation. The Mayor suggested the committee should adjourn and request the attendance of Mr. Blake. Councillor Turner said when he moved that the plant should be taken over from Messrs. Siemens he did so on the certificate that

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the work had been done to Mr. Blake's entire satisfaction. He knew nothing of any modification of the specification. A long discussion ensued as to what was best to be done in the matter, and eventually a motion was carried that, considering the gravity of the matter referred to, the meeting adjourn, and that Mr. Blake be requested to attend the adjourned meeting. Mr. Christie, in his report, added that one of Messrs. Siemens's head electricians, who had been sent over to look into the cause of the repeated flaws in the cables, was in the station when one of the breaks took place. He had now returned to London to report to Messrs. Siemens.

Dalton.—The Highways and Lighting Committee of the Local Board reported as follows: "Electric lighting: Read letter of 29th ult. from the clerk to the Ulverston Union Rural Sanitary Authority in reference to notice by the Windermere and District Electricity Supply Company, Limited, of intention to apply to the Board of Trade for an order authorising the supply of electricity within the area of the jurisdiction of the Rural Sanitary Authority, and suggesting the appointment of a committee of the Board to confer with that and other local authorities with a view to combined opposition to the application. Resolved that a sub-committee, consisting of Messrs. Lawn, Walton, and Wardley, be appointed for the purpose." Mr. Walton moved the adoption of this report. Dr. Challinor asked what were the grounds on which the committee recommended the Board to join the opposition to the Windermere and District Electricity Supply Company, Limited? How would it affect the Board? The Board had an order which cost them some considerable sum of money. The Clerk: The powers have lapsed some time ago. Dr. Challinor was not aware of that. Mr. Dickinson asked whether they were to oppose some progressive steps in the district. Personally he should be sorry to oppose any new industry in the neighbourhood. There was a great water power in the neighbourhood of Backbarrow which, it was supposed, would be utilised. The Clerk said there was no resolution to oppose. The resolution was simply one by which they would be able to get information. The Chairman observed that it said "with a view to combined opposition." Mr. Wardley said, if he remembered rightly, the committee did hesitate in the first instance as to the appointment of the committee, but the clerk thought it would be better to appoint one if only for the purpose of gaining information respecting this matter. They evidently knew very little about it. Dr. Challinor thought if they passed the resolution as it stood it meant opposition to the scheme of the company. The Clerk: No. Mr. Wardley: There is no intention to oppose. The Chairman suggested that the latter part should be struck out of the report, which would then end with "to confer with that and other local authorities." Mr. Walton understood that the resolution was framed simply as a means of getting information. The Chairman remarked that the Board had not the faintest idea of raising opposition to any progressive step. The report was adopted.

Leeds.—Electric lighting is making considerable progress here. It was in May last year that the works of the Yorkshire House-to-House Electricity Company were formally opened. Their capacity then was 600 i.h.p. Between June and December the number of 8-c.p. lights connected increased from 7,000 to 10,637, and for a short time before Christmas the company was compelled to decline further applications, the producing power being fully taxed during the time technically termed the heaviest load. The number of 8-c.p. lights now connected is over 15,000, and the mains extend about eight miles. Additional plant has therefore very soon become necessary, and this is now being laid down at the company's station in Whitehall-road. The engine-house has been considerably extended. Originally it was 68ft. long by 63ft. wide. Now its length is 124ft. The new plant comprises three additional Lancashire boilers, each 30ft. by 8ft., and capable of working up to 140lb. pressure; three horizontal condensing engines, each of 400 i.h.p., and three 200-kilowatt alternating-current dynamos. With the 600 i.h.p. now in operation, the capacity is thus being raised to 1,800 i.h.p. The three new boilers have been fixed, and two of the new engines constructed, and the entire installation will be completed before long. The additional plant has, of course, necessitated an extension of the switchboard. Wherever there is a sufficient demand for the light to warrant an extension of the mains it is to be met. Low-tension distributing mains are being brought into use in districts where consumers are closely grouped, and these are expected to give increased economy in working and greater convenience in connecting new customers. Already the light is being supplied to a large number of the public buildings and business establishments in the city, and the company expect to be called upon to illuminate the Town Hall and Municipal Buildings, the Corporate Buildings Committee having decided to recommend an agreement being made for a two years' supply. Offers have also been made to the Corporation to supply current for street-lighting and for the illumination of City-square and the public markets, and these are under consideration. The directors are naturally desirous of obtaining a consumption which will keep the plant fully employed, and, with this end in view, they have decided to supply current for motors, cooking, and heating purposes at a reduced price. An electric oven in one of the clubs is said to be giving very satisfactory results. At Wednesday's meeting of the Town Council, Alderman Sir Edwin Gaunt moved, "That the Corporate Property Committee be authorised to arrange with the Yorkshire House-to-House Electricity Company for the supply of electric light for the Town Hall and Municipal Buildings for a period of two years." It was, he said, absolutely necessary that something should be done at the Municipal Buildings, for with the present arrangements they constituted a nuisance to neighbours and a danger to property, while bad smells were given off, and the vibration of the engines was objectionable. A report had been furnished to the committee by the chairman of the Corporate Buildings Committee and the city engineer, which showed that the cost at present was 6·70d. per unit, while if they took it from the House-to-House Company the cost would only be 6·57d. per unit. There had been some talk of establishing a plant at Kidacre-street destructor, but that would involve an outlay of £11,300, and the cost of production would amount to 7·21d. per unit. They had spent a lot of money already, but he did not think that they had yet got a proper system. If they got the work done by the House-to-House Company for two years, they would be able to tell at the end of that time whether it would be profitable to carry on the installation themselves or not. The resolution was carried.

Worcester.—The sub-committee of the Watch Committee have recommended that the charge for electricity for motive power be 3d. per unit, and that a separate meter be used. The Mayor remarked that this was an inducement to manufacturers and others to take the current, which would be supplied by the day's load. They could afford to supply the current at 3d. per unit during the daytime. The price proposed to be charged was equal to 1s. 6d. per 1,000ft. for gas, so that any man who used electricity at 3d. per unit would be far better off than by using gas. The Sheriff: It does not require the attention or the space. The recommendation was adopted on the proposition of Alderman Hill. On the recommendation of the sub-committee, it was decided to extend the electric mains to comply with applications in College-street and Sidbury to the house of Dr. Walpole Simmons at an estimated cost of £35, and in Friar-street to the house of Mr. Andrews; also along Bransford-road, which, with the erection of the oil-tower in the Bull Ring, St. John's, will cost £210. Mr. Preece reported that he had temporarily engaged two engine-drivers, two dynamo men, two stokers, one trimmer, and two linemen to take over the working of the generating station at Powick on October 11. The committee confirmed this. It was decided to affect an insurance with the Engine Boilers' and Employers' Liability Company, through Mr. A. P. Watkins, on the boilers at the generating station in the sum of £2,000, at an annual premium of £12, to cover damage to surrounding property. Mr. Winwood asked why Barbourne streets should not be lighted, as the mains were to go to the waterworks. The Town Clerk pointed out that there were different mains required for street and house lighting, and that another main would be required to light the streets at Barbourne. Mr. Chaplin remarked that it seemed to him a pity there should be so many separate applications. If they were to first lay down the mains through an important thoroughfare like Sidbury, they would get a lot of applications. The Mayor: All the citizens have to do is to apply, and they will get the light in due course. Mr. Davenport (Mr. Preece's representative) reported that the equivalent number of 8-c.p. lamps wired at present was 3,850, being equal to 400 h.p., and independent of the waterworks, pumping, and street-lighting. Several prominent places were being wired—viz., St. George's and St. Michael's Churches, the Union Club, Shire Hall, etc. Mr. Chaplin asked whether the application from Malvern was still under consideration. The Mayor replied in the affirmative, and said Mr. Preece would report upon it, but they did not expect to do anything more before October 11. There was a very great disposition on the part of prominent residents at Malvern to have the light, and if any solid move were made he thought the scheme would go well. Alderman Hill expressed the hope that the committee would see Worcester safe, and the arrangements here satisfactorily carried out before undertaking further work.

Folkestone.—The peculiar position of electric lighting schemes is shown by a long report of the proceedings of the Town Council on Wednesday of last week, published in the *Folkestone Herald* on Saturday. The position is summed up editorially by that paper as follows: "There is something of a comical side to the new attitude taken up by a majority of the Folkestone Corporation with regard to the introduction of electric lighting into this borough. The doings on Wednesday may fairly be said to have beaten the record. To understand them aright, it is necessary to give a *résumé* of the action hitherto taken on the subject of lighting the town, or a section of it, by means of electricity. For several years the most forward advocates of local improvement have been insisting that, until the electric light is installed amongst us, the town of Folkestone can only claim a subordinate position in the list of popular watering-places. Gradually, the inhabitants came over to that view. At length, however, it emerged into practical domain, and the Corporation found it expedient to humour the popular taste. A committee of enquiry was appointed, with instructions to take professional advice and to bring forward a scheme. Those instructions were acted upon, and a scheme was in due time formulated, which was said to secure all the advantages of the high and low tension distribution. We may say, in brief, that it was a £35,000 scheme; the various details of which could be reduced ratably if a smaller area were decided upon. It was claimed for this scheme that its producing capacity would be equal to any demand that might arise in the town for many years to come; and it was further contended that the cost of the working expenses would fluctuate in proportion to the demand for the new light. It is now a matter of local history that this important aspect of the question was almost completely ignored. The opposition to the scheme fastened itself to the outlay of £35,000, and the popular mind became alarmed at this expenditure. A most amusing incident occurred at this stage. The knot of so-called 'Reformers,' who had inscribed 'Electric Lighting' on their banner, turned

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round and swallowed their own professions, giving the scheme the most determined opposition that it was possible for them to command. The scheme was thus rejected by the voice of a public meeting at the Town Hall, and that rejection had its natural effect within the Council-chamber. A smaller scheme, of some £12,000, was talked of as an alternative proposal, and was strongly championed by a member of the Corporation who had led the opposition to the original scheme. Such was the position of the question on Wednesday last, and on that occasion a new departure was resolved upon. During the interval the old scheme—that of £35,000—had remained in a state of suspended animation. It had not been formally rejected by the Corporation, nor had the Electric Lighting Committee been discharged from its original function. On Wednesday, with the old committee in existence, and the old scheme in a pigeon-hole, a motion was made and carried that a new committee be appointed to go into the matter, to employ another expert, and to present an alternative and entirely independent scheme involving a capital expenditure of some £12 000. This is the comical side to which we have referred above. The new committee does not include a solitary member of the old committee except the Mayor, who is *ex-officio* a member of every committee of the Corporation, at least in theory. Here, then, we have two rival committees appointed to deal with one question, each committee having its own electrician, and each empowered to expend 50 guineas on professional advice. This is a ludicrous situation, and is scarcely consonant with business habits and procedure. As to the remarks made, either on Wednesday or previously, against the professional status of either of the two experts, no sensible person will attach the slightest importance to them. They are utterly beside the mark. They can have no effect upon public opinion except to evoke a feeling of regret that two sections of a public body should be so wanting in taste as to identify professional men with their own quarrels. Nothing said on Wednesday in the Council-chamber can add to or detract from the reputation of Mr. Parker or Mr. Medhurst, and it was exceedingly indecorous to drag that element into the discussion."

PROVISIONAL PATENTS, 1894.

SEPTEMBER 25.

18153. **Improvements in electricity meters.** John Perry, 31, Brunswick-square, London.

18172. **Improvements in and apparatus for the extraction of gold by electrolysis.** Joseph John Maclean, 78, Fleet-street, London.

18177. **Improvements in electrically-actuated brakes and belt-shifting devices.** Paul Auguste-Godchaux, 6, Lord-street, Liverpool.

18188. **Improvements in and relating to electrical fittings.** Emil Hungerbühler and the Electrical Company, Limited, 151, Strand, London.

18196. **Improvements in current collectors for overhead electrical conductors.** Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Messrs. Siemens and Halske, Germany.)

18202. **Improvements in and connected with primary batteries.** Howard Vivian Coad, 37, Cursitor-street, Chancery-lane, London.

18206. **Improvements in utilising residual products obtained in working certain kinds of voltaic batteries.** William Walker, jun., and Frank Richard Wilkins, 7, Staple-inn, London.

18217. **Improvements relating to the transmission of telephonic messages between the shore and a lighthouse, ship, or other signal station.** Lucien Ira Blake, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

SEPTEMBER 26.

18273. **Improvements in electric motors.** John Imray, 28, Southampton-buildings, Chancery-lane, London. (La Société Anonyme pour la Transmission de la Force par L'électricité, France.)

18274. **An improvement in electric arc lamps.** James Brockie, 28, Southampton-buildings, Chancery-lane, London.

18288. **Improvements in secondary or storage batteries.** Charles Riordon, 4, South-street, Finsbury, London. (Complete specification.)

18289. **Improvements in electric motors.** James Harry Keighly McCollum, 4, South-street, Finsbury, London.

SEPTEMBER 27.

18297. **Improved electric apparatus for striking bells and the like.** Denys Mathieu, 27, Martin's-lane, Cannon-street, London. (Complete specification.)

18328. **An improved method of duplex telegraphy.** George Edwin Fletcher, The Homestead, Call Green, Stockport.

18339. **Improvements in and connected with carbons for electric lamps or for other purposes.** Edward Goodrich Acheson, 55, Chancery-lane, London. (Complete specification.)

18359. **Improvements in or connected with electrical elevating mechanism.** Benjamin Willcox, 47, Lincoln's-inn-fields, London. (The Eisenwerk, late Nagel and Kaemp, Actien-Gesellschaft, Germany.)

SEPTEMBER 28.

18427. **Improvements in electrical traction and apparatus therefor.** Maurice Hutin and Maurice Leblanc, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

SEPTEMBER 29.

18480. **Improvements in automatic electrical gaslighters.** William Neely Jaskey and Edward Samuel Else, 18, Fulham-place, Paddington, London. (Complete specification.)

18501. **Improvements in or relating to incandescent electric lamps.** Walter Thomas Kerr, 232, High Holborn, London.

18507. **A quick-break electric lampholder.** Charles Otto Duetschmann, 8, Nag's Head-road, Ponders End, London.

18522. **Improvements in electric arc lamps.** William Smith Pendleton, 24, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, March 6, 1894, being date of application in United States.) (Complete specification.)

SPECIFICATIONS PUBLISHED.

1890.

12475. **Electrical smelting.** Taussig. (Second edition.)

14181. **Electrical railway fog signals.** Andrews. (Third edition.)

1893.

15050. **Electric bells.** Oppenheimer.

17521. **Illuminating by the electric arc.** Jackson and Dixon.

18115. **Electric arc lamp.** Borland.

20723. **Electric measuring instruments.** Goolden and Evershed.

20883. **Brackets for telegraphic, etc., insulators.** Bullers, Limited, and Chambers.

20915. **Alternate-current synchronisers.** Ayrton and Mather.

21327. **Electric meters.** Bergmann and Erben.

1894.

9862. **Primary batteries.** Morison.

14602. **Electromotors.** Canet and Hillairet.

15174. **Electrical rolling contact making and breaking device.** Ast.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	5	5¼-5½
Bournemouth Electric Company	—	—
Brighton and Hove Company Original	100	207-212
—— "A" Ordinary	—	158-163
Brush Company, Ordinary	3	2¾-3
—— Nom. Cum., 6 per cent. Pref.	2	2¼-2¾
—— 4½ Debenture Stock	100	109-112
Charing Cross and Strand	5	4¾-5¼
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	13-14
—— 6 per cent. Cumulative Pref.	10	14¾-15¼
—— 5 per cent. Debenture Stock	115	131-133
City and South London Railway, Consolidated Ordinary	100	36-38
—— Debenture Stock	100	121-123
—— 5 per cent. Pref. Shares	10	13-14
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	94-99
Electric Construction, Limited	2	¼-¾
—— 6 per cent. Debentures	—	87-92
—— 7 per cent. Cumulative Pref.	2	1½-2
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1⅝-1¾
Elmore's French Company	2	3/16-5/16
Elmore's Wire Company	2	1¼-1⅜
Fowler-Waring Cables	5	¾-1¼
W. T. Henley's Telegraph Works, Ordinary	10	8-8½
House-to-House Company, Ordinary	5	1-1¼
—— 7 per cent. Preference	5	5¼-5½
India Rubber and Gutta Percha Works	10	24-25
—— 4½ per cent. Debentures	100	102-104
International Okonite, Ordinary	—	—
Kensington and Knightsbridge	5	4¾-5¼
—— 6 per cent. Pref.	—	6¼-6¾
Liverpool Electric Supply, Ordinary	5	6¾-7
—— Pref.	—	—
Liverpool Overhead Railway	10	7¾-8¼
—— Pref.	10	13-13½
—— 4 per cent. Mortgage Debentures of £100	100	111-113
London Electric	5	¾-1⅛
Metropolitan Electric Supply	10	9¼-10¼
—— 5 per cent. Reg. Debentures, 1-10,000 in Bonds of £10, £20, and £40	—	—
National Telephone, Ordinary	5	4¾-5¼
—— 6 per cent. Cum. First Pref.	10	15-15½
—— 6 per cent. Cum. Second Pref.	10	14-15
—— 5 per cent. Nom. Cum. Third Pref.	5	5¼-5¾
—— 4½ per cent. Deb. Stock	—	109-112
Notting Hill Company	10	5¼-6¼
Oriental and Electric Company, £1 shares	1	1-1½
—— £5 Shares	—	7-7½
—— £4½ shares	—	5¾-6¼
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7-7½
—— 7 per cent. Pref.	5	8½-9
Swan United	—	—
Telegraph Construction and Maintenance	12	41-43
—— 5 per cent. Bonds	100	105-106
Westminster Electric Supply, Ordinary	5	6¼-6¾
Yorkshire House-to-House	4½	4¼-4¾

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NOTES.

Electric Lighting at Bombay.—The lighting of the Crawford Markets, Bombay, by electricity has been tried experimentally.

Electric Lighting at Colombo.—The electric light is being largely adopted in Colombo in various premises and for different objects.

Chinese and Indian Telegraphs.—A convention has been signed in connection with the Chinese and Burmese-Indian telegraph systems.

Electric Lighting at Buenos Ayres.—It is stated that a big syndicate of British capitalists has been formed to start in Buenos Ayres great works for the electric illumination of the city.

Electric Traction in Switzerland.—One of the electric tramways undertaken by the Compagnie de l'Industrie Electrique in Geneva was opened last month. The trolley system has been adopted with some modifications.

Award.—We are informed by Mr. C. A. Müller, of Bradford, who represents Messrs. Schuckert and Co., Limited, in this country, that the company have been awarded a *grand prix* for their exhibits at the Antwerp and Lyons Exhibitions.

Another Electric Light Installation in Calcutta. The United Service Club, Calcutta, has been fitted up with the electric light, and the installation will be ready in a week or so. The Madras Club has had the electric light for several years.

Institution of Civil Engineers.—This institution will continue to hold its meetings during the approaching session in the old theatre at 25, Great George-street, notwithstanding that the library and offices have been temporarily removed, during rebuilding, to No. 9 in the same street.

Indian Telegraphs.—The Indian Telegraph Report for 1893-94 has been submitted to the Government. It is believed that, excluding the cost of free and State messages, the interest on the capital is 2½ per cent.—the highest yet paid. Including the cost of free and State messages, the profit is about 4¾ per cent.

Cable Companies and the Chinese-Japanese War.—The cable companies must be profiting by the war. The long account of the battle of Yalu from the Central News correspondent cost no less than £300 to cable. There was also a telegram in the *Times* from Chefoo which must have cost as much to cable.

Telegraph Posts and Advertisements.—The City Council of Wellington, New Zealand, has passed a resolution "that the Government be requested to keep the telegraph posts free from advertisements, in view of the by-law passed by the Council which forbids the placing of advertisements on the electric light posts."

The Madras Electric Tramways Company, Limited.—The first 50 cars intended for this company have been fitted up at the Perambore Railway Workshops, and will shortly be made over to the tramway authorities. The cars are 24ft. long and 8ft. broad, and have compartments for first, second, and third class passengers.

Electric Lighting in Australia.—The Ballarat Electric Supply Company, Limited, of Ballarat, are going to erect a central station, the cost of which is estimated at £40,000. The local railway station and yards have agreed to take current. The consulting engineers to the company are Prof. Threlfall, Sydney, and Mr. Ellson, Adelaide.

Tramway Traction for Paris.—The deputation sent by the Paris Municipality, which consisted of Messrs. Rousselle, Thuillier, Attout-Taillefer, and Puech, to study foreign tramway systems, have returned. They have visited Zurich, Vienna, Budapest, Milan, and Geneva. They will draw up a report for presentation to the Municipal Council.

Institution of Engineers and Shipbuilders.—The eleventh annual meeting of the North-East Coast Institution of Engineers and Shipbuilders will be held in the lecture-hall of the Literary and Philosophical Society, Newcastle-upon-Tyne, on Tuesday next, at 7.30 p.m. The president, Mr. Thomas Richardson, will deliver his inaugural address.

Indian Electric Lighting Bill.—The public of Calcutta are greatly interested in the introduction of electric lighting, and now that it is known that the wave of enterprise is stemmed by the proposal to legislate in the matter, the enquiry is pretty general as to when the Bill is likely to be passed. We certainly agree, says *Indian Engineering*, that the delay already recorded is not creditable.

Electrolytic Production of Caustic and Chlorine It was mentioned on Wednesday at the annual meeting of the Aluminium Company, Limited, that the plant erected at Oldbury during the year for working the new electrolytic process for the production of caustic and chlorine had been in operation since the middle of July, with results which had more than confirmed the directors' most sanguine expectations.

"Elektrotechnische Zeitschrift."—Messrs. Gisbert Kapp and Jul. H. West have entered upon their duties as editors of the *Elektrotechnische Zeitschrift* with the current issue, dated 4th inst., and Mr. F. Uppenborn, the late editor, has retired, but will continue to contribute. Mr. Gisbert Kapp contributes an article on the lighting of Arundel Castle, respecting which he naturally knows more than a good many people.

The Hermite Electrical Sanitation Process.—The Ipswich Town Council decided at their meeting on Wednesday to adopt the Hermite process. This decision was unanimous, and resulted from the favourable report submitted by the Sewerage Committee on the trials which have been made on the main sewers of the town during the last three months. The permanent installation is to be proceeded with as rapidly as possible.

The Proposed Pacific Cable.—A cablegram from Ottawa (Ontario) says that, from information received by the Department of Trade and Commerce from a variety of sources, it is safe to predict that a considerable number of proposals will be received for the laying and operation of the proposed Pacific cable. It is expected that all the leading cable-making establishments of the world will be in vigorous competition with each other for the contract.

Electric Lighting in Austria.—The Government have approved of the successive introduction of the electric light into the various institutes of the university, according to as how funds permit thereof. During the summer the demand for electric light from the Internationale Elektricitäts-Gesellschaft, of Vienna, has been making rapid headway. The total number of lamps is over 92,000, and every day orders are coming in for more lamps to be connected and also for current for motors.

Books Received.—We have received the following new works: Fourth edition of Mr. Gisbert Kapp's "Electric Transmission of Energy" (Messrs. Whittaker and Co.); Mr. W. J. Buckley's "Electric Lighting Plants" (William

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Johnston Printing Company, Chicago); "Durham College of Science, Newcastle-on-Tyne, Calendar" (Messrs. Andrew Reid and Co. and Messrs. Whittaker and Co.); and Mr. Herbert Laws Webb's "The Telephone Handbook" (Electrician Publishing Company, Chicago).

Prizes for Best-Kept Electrical Sections.—It will be recollected, says the *New South Wales Railway Budget*, that about a year ago the commissioners announced that prizes would be presented for the best-kept electrical sections, and prizes were presented at the time. Another year's results have now returned, and on the recommendation of the responsible officers the commissioners have approved of the prizes—£10 first and £5 second—being awarded to Mr. E. Jeator, relieving district electrical inspector, Eveleigh, and Mr. W. Barton, district electrical inspector, Hornsby.

Large Travelling Cranes.—With reference to our note in our issue of August 31 about the 60-ton overhead electric traveller at Messrs. Cockerill's works at Seraing and our query as to whether there were larger ones in existence, the *Western Electrician* of Chicago informs us that at the United States Government arsenal at Watervliet, New York, a 120-ton electric travelling crane is in operation. This crane is used in transporting the huge masses of metal that are worked up into the great guns turned out at the Watervliet works, and is probably the most powerful electric crane in the world.

Kashmir Postal and Telegraph Employes.—A large number of the employés of the Kashmir Postal and Telegraph Departments has addressed a memorial to the Maharajah pointing out that owing to the transfer of the State Post Offices and a greater portion of the telegraph lines to the Imperial Government, they are threatened with being thrown out of employment, and as they have spent the best part of their lives in the service of the State, they do not know where else to look for their livelihood. They pray that his Highness will take the petitioners' helpless state into favourable consideration and to represent their case to the Imperial Government with a view of inducing the latter to retain their services.

Electric Traction in Austria.—As we have already stated, a preliminary concession has been granted by the Government to the Länderbank for various electric tramways in Vienna. An official intimation has now been given by the Ministry of Commerce, allowing the bank to make technical preparations for the following underground electric lines: (1) from Ferdinandsbrücke under the Dominikanerbastei, the Woolzeile, the Stefansplatz and the Kärntnerstrasse to the Elisabethbrücke; (2) for a line from the Elisabethbrücke under the Operngasse, the Opern-Burg and Franzernsring, the Schottengasse, Freiung, Renngasse, the Concordiaplatz and the Heinrichsgasse to the Franz Josef-Quai; and (3) for one of two described lines from Opernring to the West railway station.

Medical School of the Yorkshire College.—The new medical school and the college hall of the Yorkshire College at Leeds were opened on Friday last by the Duke and Duchess of York. In honour of the event a conversazione, to which about 1,500 guests were invited, was held on Monday evening in the medical school, which was beautifully decorated for the occasion. The building, which is a handsome example of Tudor architecture, is one of the most perfectly equipped of its kind in the country. Lighted throughout by electricity, the arrangements of the lights bears witness to much careful consideration of the requirements for practical work, while at the same time, as was seen on Monday, a very pleasant and effective light is obtained for general purposes, and the entire installation, which has been carried out by Mr. T. Harding Churton, of Leeds, is very successful as regards both efficiency and effect.

Hong-Kong Electric Company, Limited.—The report of the Board of Directors to the fifth ordinary yearly meeting of shareholders, held at the Company's offices, Hong-Kong, on Monday, June 25, expressed their satisfaction at being able to point to a steady progress in the Company's business, the working account showing a credit balance of 6,310dol. 94 cents, which, transferred to profit and loss account, left a balance to the credit side of 7,248dol. 47 cents; while the amount overdrawn at the Company's bankers has during the year been reduced from 12,267dol. 17 cents to 6,339dol. 97 cents. Although there had not been that rapid extension of the Company's operations which the directors had hoped for, there was a steady increase in the amount of house-lighting, and the benefit from the installations now being fitted would soon be showing itself in the earnings. It was not intended to fill the vacancy on the Board caused by the death of Mr. J. S. Lapraik.

Electric Lifts on Board Ship. — Mr. Arthur L. Gibson, secretary to the Otis Elevator Company, writes to the *Times*: "I note in your issue of the 5th inst. a communication from 'A Traveller,' in which he asks if it 'would not be possible to have lifts constructed in the floating hotels which now cross the seas in every direction, by which invalids could be carried up and down from the levels of their berths.' In the *Mechanical World* of August 31, 1894, on pages 86 to 88, 'Traveller' will find illustrations and plans of the new American steamship 'North-West,' with a length over all of 383ft., and a gross registered tonnage of 4,244 tons. This ship was built for service on the great lakes. It is a first-class passenger steamer, and, among its other fittings, is provided with an electric lift from the cold storage rooms to the galleys, pantries, etc. From this to the provision of a lift for passenger service is but a step, and we may perhaps expect to see in the not distant future large passenger ships supplied with electric lifts for the use of passengers."

Electric Lighting in Germany.—At Hamburg the electric mains have been completed for some time in the town proper, and they are now being laid in St. Georg and in the Steindamm. Mr. Hippmann, the owner of the Kurgarten at Munich, has expressed himself willing to undertake the electric lighting of the Nymphenburg. At Altena, near Plettenberg, Messrs. Basse and Selve, the owners of some large copper-rolling mills, will light their works electrically, and also supply current for the lighting of the railway station and the neighbouring streets. Seven firms have tendered for the central electric light station at Görlitz. Mr. Friedr. Ross, of Vienna, has been selected to adjudicate upon the various plans. A central electric light station has been established at Eibau by Messrs. Nitzschmann and Zschockelt. Plans are being made for a transmission of power and lighting plant at Gersthofen-Augsberg. The local authorities at Laibach propose to introduce the electric light, the water power of the Save being utilised for the purpose. Messrs. Brandes and Co., who have the concession for the electric tramway between Brunswick and Wolfenbüttel, propose to light the Neue Weg there by electricity.

Mason College, Birmingham.—For several years it has been the custom for Mr. Turner, the late lecturer on metallurgy at Mason College, to give a short course of evening lectures on some subject connected with local metallurgical industries, and these lectures have been very

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well attended. His successor, Mr. W. G. McMillan, proposes to continue these lectures, and has issued the syllabus of a popular course on "The Scientific Principles of Electro-Plating," to be given by him at Mason College on five Thursday evenings, at eight o'clock, commencing yesterday. Mr. McMillan, who is the author of the treatise on electro-metallurgy in Griffin's Scientific Text-book Series, proposes to deal with the subject in the following manner: (1) Chemical and physical laws influencing electro-deposition; some characteristics and sources of the electric current. (2) Depositions of metals by simple immersion; cause and limitation of such deposits; conditions favourable to such depositions, and character of the deposits. (3) Deposition by separate currents; effect of current strength on the character of deposits; disposition of plant; relations between electrodes, solution, and current strength; use of insoluble anodes. (4) Conditions governing purity of deposit; deposition of alloys; secondary or chemical action of the solution upon deposits; refining of metals. (5) Stripping, cleansing, and polishing of surfaces; tests of materials used in electro-plating. An additional course of study in general practical metallurgy may be followed on Friday evenings from seven to nine, beginning on 12th inst., in the metallurgical laboratory. The subjects specially dealt with will be fuel, iron and steel, copper and its alloys, the precious metals, and electro-metallurgy. At least 20 lessons will be given.

The Bankside Accident.—Mr. A. W. Wyatt has held an inquest at Southwark on the body of Henry Hearne, 29, a fitter's labourer, in the employ of the Brush Electric Light Company, 64, Bankside, Southwark. John Gales, a fitter in the same employ, said deceased had worked under him about two months. About four o'clock the previous Sunday afternoon witness noticed that the machinery worked stiffly, and ascended to the top of the switch pillar of one of the alternators to see where the mistake was, and left deceased standing at the foot of the ladder. About 20 minutes afterwards witness heard a scream, and upon looking round he saw Hearne lying on the ground at the foot of the next pillar with the ladder lying beside him. Finding him unconscious, the manager and a doctor were at once sent for. The switch pillar that witness was attending to was not in use, and was consequently termed "dead." Witness could not say why Hearne attempted to climb on to the next pillar, which was "alive." Witness did not see him take the ladder away. He did not send deceased to No. 6 pillar for anything. Deceased should have remained at the bottom of the ladder till witness had finished the job. Hearne had been cautioned by the witness and the manager on several occasions not to touch anything without receiving instructions. The Coroner: Do you think he got tired of holding the bottom of the ladder, and climbed on to the live pillar out of curiosity? Witness: I cannot say. I know of no reason why he should go there. Witness had never known Hearne to leave his work before. The distance between the pillars was about 19ft. A Juryman: Can you suggest the cause of deceased falling? Witness: The ladder might have slipped while he was ascending it, and clutching one of the rods to save himself received the shock. Arthur Henry Foster, practical engineer to the company, said that he was in his office last Sunday afternoon, and noticed the lights suddenly flicker. Upon going to the pioneer station to ascertain the cause, he was informed of the occurrence. He saw the deceased being supported by two men. Artificial respiration was resorted to, but without success. The machine in question was sufficiently powerful to kill a man. The flickering was very noticeable, and occurred three times in succession. The switches on the top of the pillars were always "alive" unless under repair. Witness was totally at a loss to account for the accident. Dr. J. G. Garbett, of 49, Sumner-street, Southwark, stated that upon his arrival life was extinct. Witness had made a *post-mortem* examination, and found the heart contracted. There were several marks on the outside of the right arm, with corresponding holes in the shirt sleeve, and the skin was stained red. The cause of death was stoppage of the heart's action, consequent upon electric shock. The jury returned a verdict that death was due to electricity through touching a charged portion of machinery, but for what purpose there was no evidence to show.

Electric Aura in Varicose Ulcers.—The effect of static electricity on the healing of certain skin diseases and ulcers has been studied by Prof. Doumer, of Lille, says the *Lancet*. In the case of ulcers of the leg he has obtained very satisfactory results. The ulcer is first washed with some antiseptic solution, and then covered with a thin layer of absorbent cotton wool. The patient is then placed on an insulating stool and connected with the negative pole of an electrical machine. The positive electrode is now brought near enough to the ulcer to cause the passage of the electrical aura, but not that of any spark. This aura is allowed to play on the part affected for about 10 minutes, and cotton wool dressing is then applied. These sittings are repeated twice a week. Where the ulcer is due only to a varicose condition or a blow, immediate improvement is generally manifested, the pain and itching disappearing very quickly and afterwards the swelling, the ulcer ultimately healing over. Where, in addition to the varicose condition, the patient is greatly debilitated by old age, Bright's disease, or other chronic affection, the action of the electric aura is far less effective. M. Marquant, who has published an account of Prof. Doumer's observations, mentions, amongst others, the case of an elderly man who had formerly been given to drink, and who had large varices. In consequence of a blow an ulcer appeared on the leg, measuring ultimately 20 millimetres by 17 millimetres; it was insensitive, and secreted a sanious discharge, the surrounding skin being of a violet colour. The tibia was swollen for seven centimetres of its length. Near the centre of the bony swelling, close to the ulcer, there was a fluctuating surface of the size of a two-franc piece, very sensitive to pressure, and here the finger came upon a cup-shaped depression in the inflamed periosteum. This patient was treated for three weeks with antiseptic dressings without any marked change. The electric aura was then resorted to with immediate benefit; the sittings were continued daily, and from the third the pain and swelling decreased. A few days later the size of the ulcer had diminished, the periosteal infiltration had disappeared, and the patient could walk without limping. In three weeks cicatrisation was complete and the ulcer has shown no signs of returning

Halifax Central Station.—Seven months ago building operations were started in connection with the central electric light station, but the change made at the bottom of Foundry-street, where the works are situated, is remarkable. An old stone mill and a reservoir have disappeared, and on the same site there has risen an extensive building. The boiler-house is large enough (140ft. by 50ft.) to contain nine boilers, each of 300 h.p. The three laid in their beds now are the make of Messrs. Yates and Thom, of Blackburn, and a fourth is to come. Beside them, fixed in the main flue, is one of Green's economisers of 240 pipes; the chimney, of stone, will rise beside this building some 150ft. The boiler-house has a steel roof, level with the

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adjacent railway. This has been so constructed to admit of a small siding being made, whereby trucks of coal can run direct on to the aforesaid roof, which will be utilised as a coal-store. The store will have a capacity of 1,000 tons, and the coal will be passed into the furnaces by mechanical stokers. The water for condensing purposes will be drawn from four springs which have been bored in the property, and it will be stored in a cement-lined tank capable of holding 100,000 gallons. On the upper side of the boiler-shed is the engine and dynamo room, lofty, well lighted, and its lining of white glazed bricks gives it a very smart appearance. The room is 110ft. long and 55ft. wide. It is proposed to erect here five engines, two of 200 h.p. each, one of 100, and two engines of 25 h.p. each, the first three being supplied by Messrs. Pollit and Wigzell, of Sowerby Bridge, and the small engines by Messrs. Robey, of Lincoln. One of the large compound condensing engines has been embedded this week. The room is large enough to accommodate twice the number of engines on order, and several beds are to be prepared ready, in anticipation that they will be required before long. To facilitate such works, and the repair of the engines, a crane that will lift 15 tons travels overhead. The dynamos are of the same power as the engines that drive them. The three laid down will supply current for 4,500 lamps of 16 c.p. Twenty miles of cables have been laid in the town, and about 100 applications have been made for the light, representing about 2,500 lamps. The Joint-Stock Bank directors have placed one of the most recent orders for the light, and other banks, it is believed, are considering a similar policy. Nearly all the tradesmen in Crown-street are going to have it, and connections have been made in the cases to a few private houses. Mr. Wilmshurst, the engineer, states that in about six weeks' time he hopes to be able to supply current for the whole of the mains laid. Mr. Wilmshurst, questioned as to whether the introduction of the electric light so extensively would not act detrimentally upon the gasworks, answered in the negative, his reason being that there was an ever-increasing demand for gas for engine and heating purposes, and the very fact of one tradesman having electric light would either induce his neighbour to go in for the same illuminant or for an additional power of gas.

The Cost of the Electric Light.—Mr. Henry A. Mavor writes to the *Glasgow Herald* on this subject as follows: "I agree with you that the main line of comparison between gas and electricity for street-lighting must proceed on the question of cost. Electric light on streets is no better than gaslight *per se*. The comparison of cost must, however, be made fairly—light for light, and total cost against total cost. It will not do to compare the two on the simple basis of cost of gas supply against cost of electric supply at the ordinary rates to consumers. Further, it is not quite safe to settle the question generally from the conditions in any one town. For the present purpose, however, we may consider the case of Glasgow on the lines which you have chosen. I am unable to check your figures of gas consumpton in Welsbach burners, but assume their correctness as a basis of calculation. Turning now to your comparison of costs, I would point out that your estimate of the light per Board of Trade unit is approximately correct for small incandescent lamps, but is not nearly so for large incandescent lamps or for arc lights. The actual state of affairs is thus:

Incandescent lamps of 16 c.p.	3 watts per candle-power.
,, ,, 150 c.p.	2 ,, ,,
Ten-ampére arc lamps of 1,000 c.p.	½ ,, ,,

(In this connection it should be noted that in street-lighting the arc lamp is at its best advantage, for the most effective part of the area of light is exactly where it is wanted, there being no walls or ceiling to illuminate.) Now, as to the price per unit. The price of 6d. charged to the public is no guide to the cost of street-lighting. It will be seen that the street-lighting which goes on during all the hours of darkness—viz., about 4,000 hours per annum—is very much more profitable work for the machinery than private lighting, which gives an average use of less than 500 hours. Taking the price of £26 per 1,000-c.p. lamp per year of 4,000 lighting hours, as stated in your article, the cost per unit would be 3·12d. With these corrected figures the cost of the electric energy against gas would be, on the same basis of comparison as given in your article—

Electric arc light—amount of light obtained for 5s. at the rate of 3·12d. per unit is 38,460 candle-power hours	5s.
Ordinary gas burners, taking five cubic feet for 20 c.p. for one hour—9,615 cubic feet at 2s. 6d.	24s. 0½d.
Regenerative burners	11s. 4d.
Incandescent gaslight	5s. 8d.

(In the latter three cases the ratios of cost are taken from your article.) It will thus be seen that, light for light, the arc lamp, so far from costing more than 12 times the incandescent gaslight, is actually cheaper. Time does not permit me to show in this letter a comparison between smaller electric lamps and the incandescent gas lamp, but the calculation is a simple one, the items on either side being:

Electric.	Gas.
Cost of current.	Cost of gas.
Repairs and renewals of lamps.	Repairs and renewals of mantles.
Wages of cleaners.	Wages of cleaners.
(No lamplighters.)	Wages of lamplighters.

In Glasgow it would probably be found that it would be cheaper to use gas lamps in the suburbs, but it seems doubtful whether the following disadvantages of incandescent gas lamps can be overcome so as to warrant the abandonment of the present system of gas burners: (1) skilled labour fixing and maintaining mantles; (2) reduction of downward lighting power by form of burners; (3) loss of mantles and funnels from draught; in short, all the difficulties which have prevented the adoption of regenerative burners, and which appear with tenfold force in the Welsbach system."

Electricity v. Gas.—The first of a series of popular lectures for the session at the Merchant Venturers' Technical College, Bristol, was delivered by Prof. J. Wertheimer, B.Sc., B.A., principal of the college, his subject being "Electricity *v.* Gas." After explaining the methods of producing gas and electric current, he summarised the arguments for and against the adoption of electricity in place of gas. It was pointed out that, if electricity were carefully used, it was scarcely, if at all, dearer than gas, and that it was certainly cheaper for illuminating large areas. The only possible argument against electricity was its cost; and it was exceedingly likely that electricity would become very much cheaper as improvements continued to be made, and that it would ultimately come to a figure at which it would easily compete favourably on this score also with gas. "So much the more reason to delay the use of electricity till the time when it should be economical," said the opponents of electric lighting. But they might fairly reply to that—that the least expensive article was not always the cheapest in the best sense of the word; for coal gas, as compared with electricity, must be placed on the disagreeable list of things which were cheap and nasty; for they must remember that fresh, pure air was one of the most important health factors, especially in great towns, where the air was at best never too pure. Those who had ever been in that or any other crowded room when lit by gas, and visited it under similar circumstances when electricity

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had been substituted, would fully realise the force of this remark. It was sufficient to remember that three gas jets in a moderate-sized room spoiled an enormous quantity of air in an hour, while an equivalent quantity of light produced by electricity would not affect the air at all. It must, moreover, be remembered that gas lighting was a fertile source of dirt, while nothing of the kind occurred with electric lighting, and that when electricity was suitably dealt with it was absolutely safe. They might then confidently predict that the gradual replacement of gas by electricity would tend to lengthen the lives of all by removing a constant and all-pervading source of air contamination, and that this fact alone would settle the question as to which was to be preferred, except for those persons who did not consider the extension of their lives worth the comparatively small difference in cost which would exist where electricity was not carefully used. When once such individuals had been eliminated by the action of the survival of the fittest principle, they would find coal gas consigned to its proper place, and used only in the production of heat, or as a source of motive power in gas-engines. Under the auspices of the Corsham Technical Instruction Committee, Prof. W. Wilson, M.A., one of the extension lecturers of the Merchant Venturers' Technical College, Bristol, has delivered a lecture in the Town Hall on "Electricity and its Applications." The chair was occupied by Mr. G. P. Fuller, M.P., and there was a very large attendance. The lecture was fully illustrated by means of experiments and lantern slides. The lecturer explained the elementary principles of magnetism, pointing out the importance and meaning of magnetic fields. He explained what was meant by the term electric current, and showed by experiments the various effects which a current can produce. He next showed the production of the current by chemical, thermal, and magnetic means, pointing out that in every case energy was required for its production. Proceeding to deal with the applications of electricity, the lecturer demonstrated the elementary facts of telegraphy, telephony, and electroplating. The very important development of the utilisation of electric currents for mechanical purposes by means of electromotors was fully explained.

Durham College of Science.—Two new wings of the Durham College of Science, which was commenced in a modest way in Newcastle some 24 years ago, were opened on Tuesday by the Mayor, Alderman Stephen Quin. The College of Science represents in Newcastle the faculties of science and engineering in the University of Durham, and its students obtain the science degrees and engineering diplomas of the parent university. The first portion of the college built was the north-east wing, opened in 1888. The buildings opened on Tuesday were the south-east and south-west wings of the college, forming two sides of the quadrangle. The new portion comprises a large central tower and the chemical lecture theatre, together with the whole of the buildings for the engineering and art departments. In the centre of the south-east wing is the Royal Jubilee Exhibition Tower, which forms the permanent and only memorial of the Jubilee Exhibition. The gateway forms a noble carriage entrance to the quadrangle, the roof being groined in stone, with red brick filling the spandrels. In the front of the tower are the Royal medallion and the college arms. The gateway is surrounded by four octagonal "sentinel" turrets, each 95ft. in height, and surmounted by ornamental ironwork. The turrets are made to serve respectively for (1) chimney; (2) ventilating-shaft; (3) experimental tower, with a mercury column 100ft. high for testing gauges; and (4) a coal hoist and staircase. Above the gateway are the following rooms: in the Jubilee Tower—classroom for general purposes, two private rooms for professors, common room for art masters, and professors' common room. On the right of the gateway are the following rooms on the ground floor: chemical lecture theatre, which is very similar to the physical lecture theatre, and above the theatre are five rooms intended for special and advanced work in chemistry, but some of which at present afford accommodation for the agricultural department. A large classroom occupies the mansard roof above the last-mentioned rooms. Between the north-east wing and the gateway is the boiler-room, affording accommodation for two Lancashire and one marine boilers, with measuring tanks and other appliances for conducting efficiency and other tests. It is a single-storey building enabling the boiler to be placed quite outside the main building. On the other side of the gateway, on the ground floor, are the following rooms: metallurgical laboratory, with wind furnaces, muffle furnaces, and assay furnaces, and fitted with working benches for 24 students; next to it the engine-room, where the principal electric light engines are accommodated. This room is situated in the south corner of the building, and adjoining it, forming the ground floor of the south-west side of the quadrangle, is the George Stephenson engineering laboratory. The principal portion of the laboratory is 123ft. long and 35ft. wide, but this is supplemented by an annexe 9ft. wide throughout the greater part of its length. A bust of the late George Stephenson, presented by Mrs. Robert Stephenson, adorns one end of the laboratory. Above the George Stephenson engineering laboratory is the engineering drawing office and mechanical museum. Next to the drawing office in the south corner is the engineering lecture-room, and adjoining this is the metallurgical lecture-room. The whole of the second floor of the building is devoted to art. The whole buildings will be heated by exhaust steam from the main engines, and will be lighted by electricity. The Stephenson laboratory will contain the 100-ton testing machine given by Mrs. William Clarke, the experimental marine engines, oil-testing engine, bar-testing machine, dynamometers, tools for the construction of the apparatus for test pieces, and all the varied experimental apparatus for mining, naval construction, and applied mechanics. Power will be available at all points in the laboratory. The architects for the college buildings have been Mr. Johnston, F.S.A., and Mr. Frank W. Rich. The portion yet to be built is the main wing, facing the Castle Leazes, and some £90,000 is required to complete the college buildings and to relieve the council of their liabilities. Among the professors and lecturers in the college may be mentioned: Principal, the Rev. Henry Palin Gurney, M.A. (Cantab.), F.G.S. Mathematics: Prof. R. A. Sampson, M.A.; lecturer, C. M. Jessop, M.A. Physics: Prof. H. Stroud, M.A., D.Sc.; hon. professor of physics and experimental philosophy, A. S. Herschel, M.A., D.C.L., F.R.A.S.; lecturer, R. J. Patterson; assistant lecturer and demonstrator, Victor A. Mundella, B.A., B.Sc. Chemistry: Prof. P. P. Bedson, M.A., D.Sc., F.T.C., F.C.S.; lecturer, Saville Shaw, F.C.S. Engineering and naval architecture: Prof. R. L. Weighton, M.A.; lecturer in engineering, R. M. Ferrier, B.Sc., C.E. The secretary of the college is Mr. H. F. Stockdale. Among those who have made gifts of appliances and other requisites to the engineering laboratory are the following: Messrs. Scott and Mountain, Newcastle; Messrs. Palmer and Co., Jarrow; Messrs. Clarke, Chapman, and Co., Gateshead; Messrs. Tangyes, Birmingham; and Messrs. Pyke, Harris, and Co.

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THE ELECTRICITY WORKS AT WORCESTER.

NOVEL WATER-POWER STATION.

General Remarks.

The undertaking which was inaugurated yesterday by the Corporation of Worcester is one of the most interesting and novel central electric light stations in the United Kingdom. The utilisation of water power, as is the case in that city, has met with little support in this country, and the Corporation of Worcester are to be congratulated upon having been the first to practically demonstrate on a fairly large scale what can be accomplished in this direction for both public and private lighting.

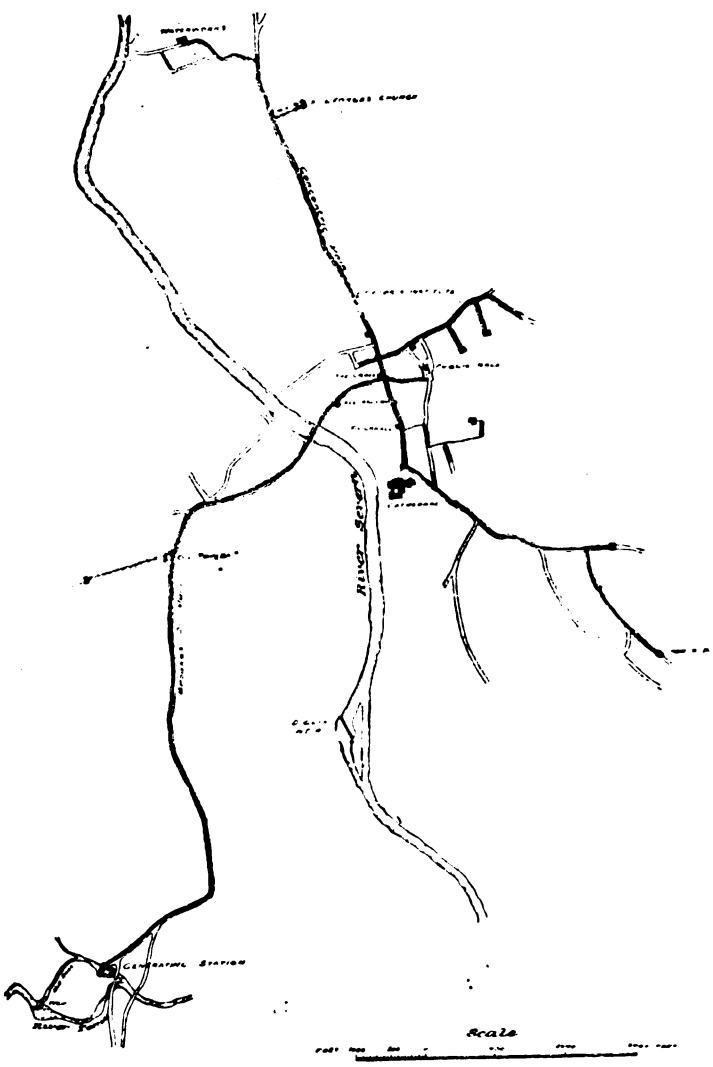
A few private individuals, as will be recollected, have in operation small installations, the power for which is obtained from a fall of water. At Keswick, for instance, water power is employed, whilst at Blockley, a village not many miles from Worcester, there are some 20 or 30 incandescent lamps energised from a water-power station. A curious feature—a fact we are assured—is that the tiny Blockley central station is worked by the village blacksmith. If this is correct, the owner doubtless understands sparking as much as anyone. From the present, Worcester will stand forth as the first important example of the use of water power in England.

MR. THOMAS CAINK,
Electrical Engineer to the Worcester Corporation.

But the Corporation have gone further. They have combined water-power plant with steam-engines, and have brought to a satisfactory conclusion a central station which deserves the particular attention of municipal authorities, engineers, and others concerned with the practical applications of electricity in everyday life. Provision has already been made for a day load at the waterworks (to which reference will be subsequently made), whilst it is proposed, on the completion of the projected new sewerage works for the treatment of the sewage before being discharged into the Severn, to pump the sewage by electricity. In fact, the electricity works have been planned and carried out in such a manner that it is expected the steam plant will only be used during the hours of heavy load in the evening, and in this way it is anticipated that the most economical working results will be obtained.

Municipal Works.

A very ancient city is Worcester. Like most cathedral cities, it has frequently been characterised as sleepy. It has, however, not only kept abreast of the times, but also in advance of most cities of this nature. It is governed by a Mayor and Corporation, consisting of 12 aldermen and 36 councillors. A complete main drainage scheme was carried out in 1856, and the present waterworks are the property of the Corporation. The town is provided with a public library and reading-room, and a natural history museum. The library and museum will shortly be removed from the present building into the block of buildings now being erected at a cost of over £20,000 for that purpose, and also for technical schools. A new infectious diseases hospital is shortly to be built, and an extension of the waterworks and a new high-level reservoir, at a cost of £15,000, have just been completed. Besides the foregoing works, and the £50,000 borrowed for electric light, the Corporation have subscribed towards the improvement of the Severn navigation, and they have also just decided to purchase Pitchcroft for a public recreation ground at an ultimate cost of £14,000 to £15,000, and have also carried out a large number of street improvements, including the



Worcester Central Station.—Map of District, showing the Site of Generating Station and Lines of Mains.

paving of nearly the whole of the footpaths and courts within the city boundary. Thus it will be seen that the Worcester Corporation is a fairly progressive body. The Board of Guardians have expended £40,000 on a new workhouse and cottage homes.

The most prominent of the public buildings in Worcester is the cathedral. Among others may be mentioned the Guildhall, in Queen Anne's style, and here the public offices are situated. An external view of the Guildhall (which is situated in High-street, a main thoroughfare) is annexed. The county offices, including the assize courts, are located at the other end of the town from the Guildhall. These form a block of buildings in classical style, standing well back from the road. The Corporation also own the building in which an electrical exhibition was opened yesterday.

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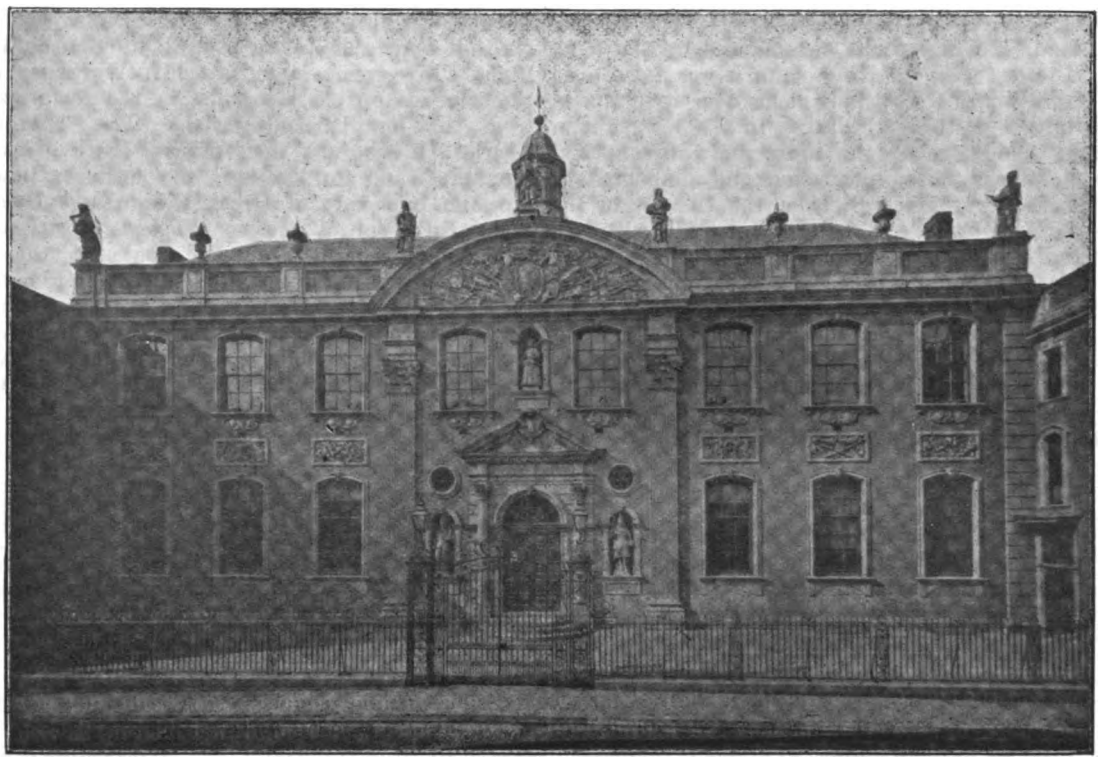
This building is known as the Public Hall, and it is used for concerts and public meetings. The theatre, termed the Royal, is situated in Angel-street.

Historical.

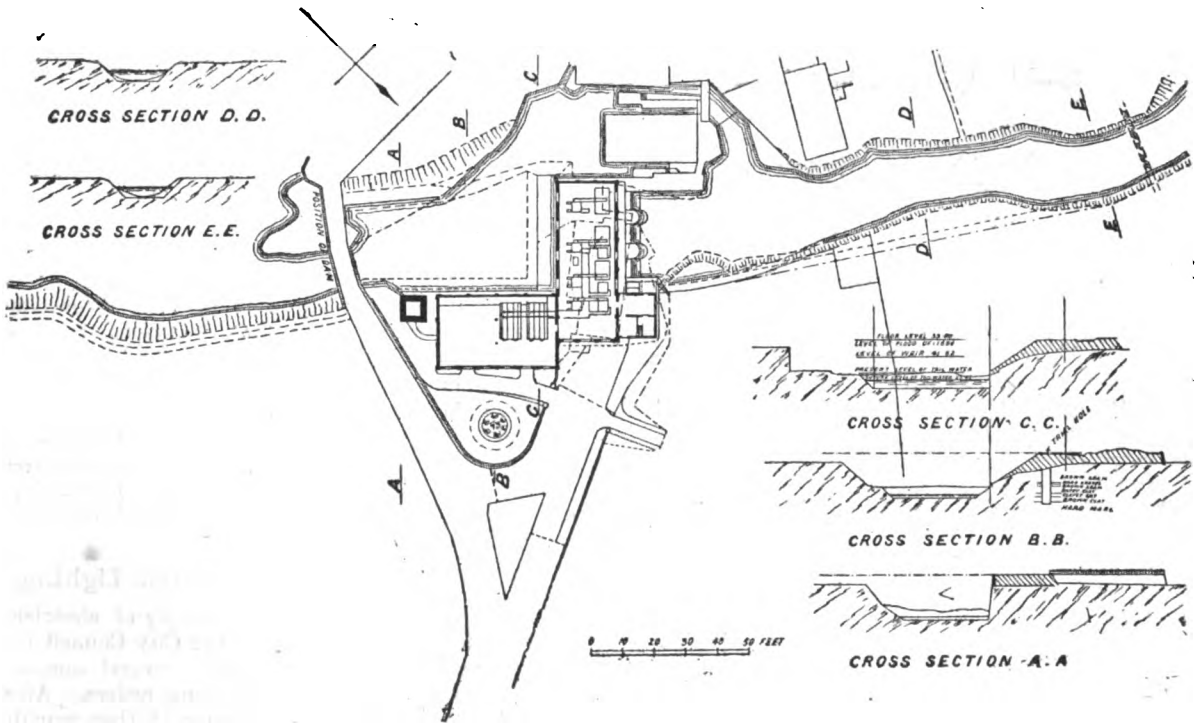
As already remarked, Worcester is a very ancient city, with a long history of war, siege, fire, and plague. The



Worcester Guildhall

The town is well provided with markets, including one for cattle, a fruit market, one for poultry, vegetable and meat markets, and a large corn exchange. One of the most important local industries is the hop trade. The other leading branches are the manufacture of porcelain, gloves, sauce, and an extensive vinegar manufactory.

town, which was generally supposed to have been founded by Constantus Chlorus, was called by the British "Caer Wrangon," or "Caer Guorangon." It was afterwards taken by the Romans, and called by them Vigornia. It was next occupied by the Saxons, during which time it was constituted a city by Wulphere, king of Mercia.



Worcester Central Station.—General Plan of Works.

Among the miscellaneous factories are two large signal and general engineering works, each of which employ a large number of men. The population of Worcester comprises some 43,000 persons, and the town covers an area of 3,185 acres.

After the union of the Saxon kingdoms the Bishop of Worcester obtained certain Royal grants from Offa and Edgar, which enabled him to fortify the cathedral and close, parts of which remain, known as the Edgar Tower, bearing the date, to the present day. The city was twice

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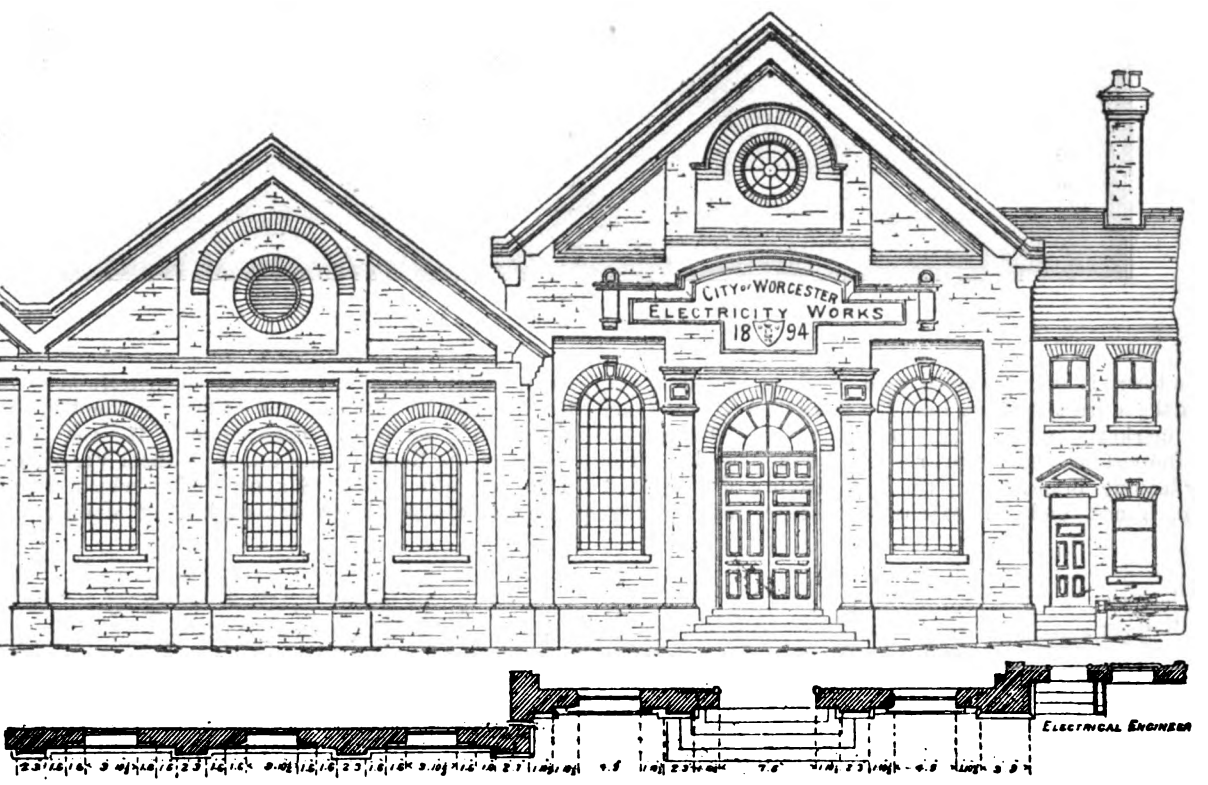
destroyed by the Danes. In the time of the Conqueror, Worcester was an important place, and had a mint. At that time it repeatedly suffered from the inroads of the Welsh. The castle was then built, the ruins of which have recently been laid out as a promenade by the Dean and Chapter. Worcester was sacked and burnt by the Empress Maud, and afterwards taken and burnt by King Stephen. In the reign of King John it was taken and retaken several times. The king at his own request was eventually buried in the cathedral. In 1263 Sir Simon de Montfort laid siege to the town, and after several unsuccessful attacks seized possession and plundered it. In 1265 Prince Edward escaped from the custody of the barons at Hereford Castle and fled to Worcester, where he speedily raised an army, which enabled him shortly afterwards to defeat the barons in the famous battle of Evesham, which victory again restored the regal power to England.

An interesting municipal event occurred in 1281, when it was recorded that Godfrey Giffard, Bishop of Worcester, laid the first stone of the pavement of the town. In 1299 the wooden bridge across the Severn was destroyed by fire; a new stone bridge was built in 1313. In 1401 Worcester was again burnt and plundered, this time by Owen Glendower's troops with their French auxiliaries. In 1484 a flood took place, which carried away men, women, and children. This was called the Duke of Buckingham's water, because he lay with an army of Welsh ready to attack Richard III., but was stopped by this flood, which was so sudden that in one night it rendered the passage everywhere impossible. While waiting for the flood to subside, his men, for want of provisions, deserted him, and so this inundation secured Richard III. in his usurped dominion. In 1637 a plague raged in the city, causing the inhabitants to fly on to the island of Beveré, in the Severn, and the city remained deserted and desolate for some time.

During the time of the King and the Parliament Worcester repeatedly suffered, and was laid siege to in 1642 by the Earl of Essex. After a siege of several days one of the first battles of the Civil War took place on Pitchcroft (acquired by the Corporation for a public recreation ground) between the Royalists, commanded by Prince Rupert and Prince Maurice, and the Parliamentarians, by Colonel Sandys. As a result the Royalists were routed, and the city was taken the next day by the Earl of Essex, and again the town was terribly plundered. But Worcester was too loyal a city to long remain under the Parliament. Thus, in the year 1646, the Mayor and Corporation, after the Parliamentary troops had left the city, declared the city in favour of the King, and immediately commenced to raise money to rebuild the fortifications for the King. This again brought the Parliamentarians down upon them. A long siege ensued, and the citizens were finally starved out, but were able to capitulate this time on honourable terms. Five years later, in 1651, Worcester was again the scene of terrible bloodshed, as the town was wrested from the few Parliamentarians then holding it by Charles II., who was then received with great state by the Mayor and Corporation, who solemnly proceeded to proclaim him king of Great Britain and Ireland. The great battle of Worcester followed shortly afterwards, this ending in the complete route of the Royalists. Worcester was once more pillaged and burned, and the walls thrown down. Thus, as the historian says, England's troubles began and ended at Worcester.

Since these troublous times Worcester has shared in the prosperity and vicissitudes of the country generally. A very interesting fact is that the city seems to have been amongst the foremost towns in the adoption of improved systems of public lighting. It is recorded that in 1794 Worcester was amongst the many towns that, "availing itself of the essential benefit derived from paving and lighting on the improved modern plan, carried both into the fullest effect under an Act of Parliament passed in the year 1783." Gasworks being opened in the year 1819, this quickly superseded the oil lighting "on the modern improved plan of 1794." To the modern improved plan of 1894, just a century later than the introduction of oil illumination, a longer life is, of course, anticipated.



Worcester Central Station.—Portion of North-East Elevation.

Preliminary Steps in Electric Lighting.

The subject of introducing a supply of electricity was first brought under the notice of the City Council in 1889, when intimation was received from several companies of their intention to apply for provisional orders. After due consideration, the Council in October of that year decided to apply for electric lighting powers. Originally, the capital outlay for the proposed electric light works was estimated at £15,000, but only a small area of the city was intended to be lighted. The provisional order was granted by the Board of Trade, and the Confirmation Bill received the Royal assent on August 4, 1890. The order authorised the Council to supply electricity throughout the whole

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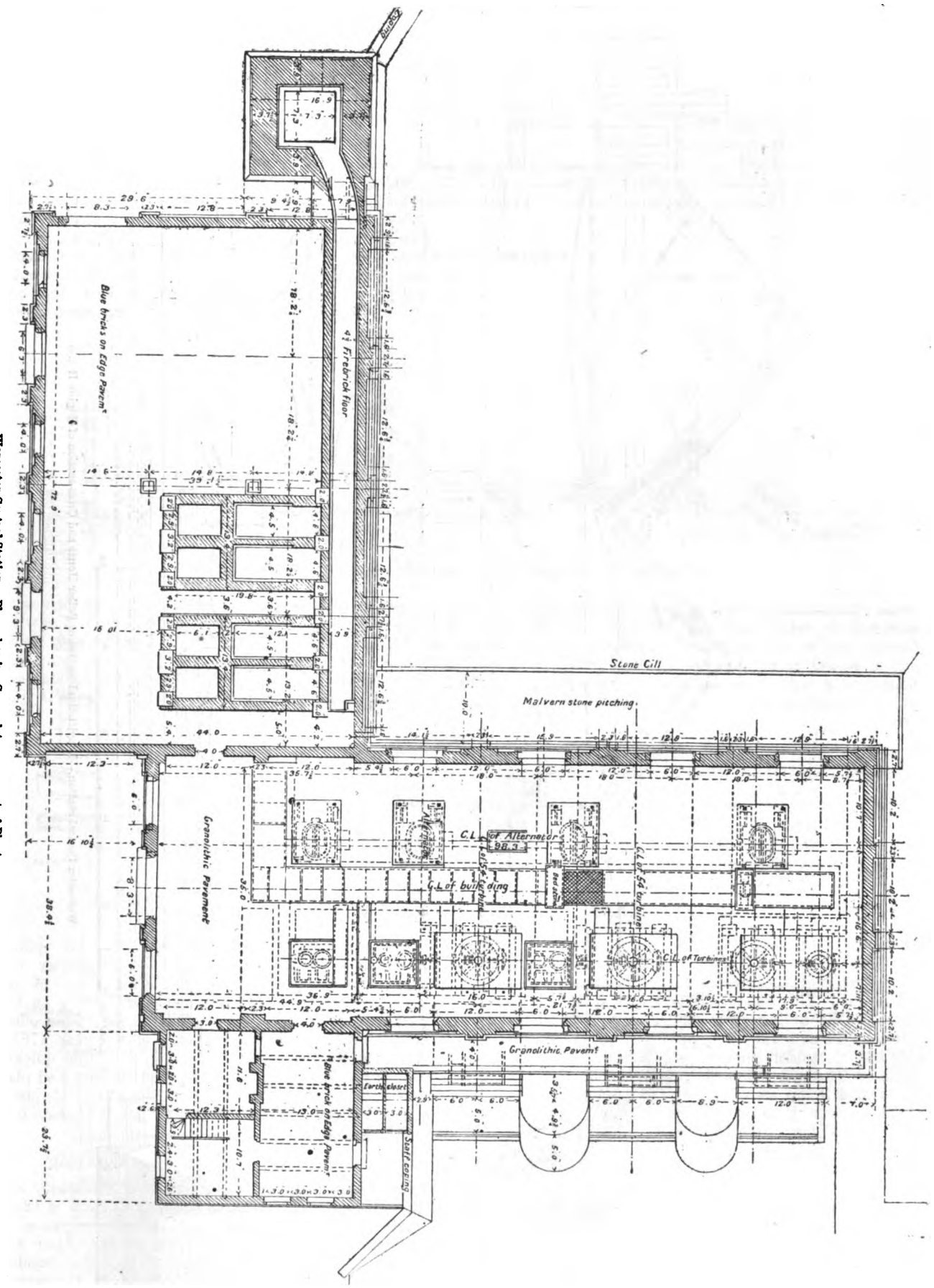
city, but the streets in which the supply was made compulsory were confined to the centre of the city. The maximum charge authorised by the order was 8d. per unit The Council on October 7, 1890, decided to consult Mr



Worcester Central Station.—Plan, showing General Arrangement of Plant.

G. E. Pritchett as to the best way of carrying out the order, and whether the work should be done by the Council or handed over to a company. Mr. Pritchett in his report presented in November, 1890, while recommending that the Council should establish a municipal supply, suggested that a decision on this point should depend upon the probable demand for light. The report contained the first practical reference to the use of water as a motive power for the Worcester works, it being suggested that the Diglis weir should be used for this purpose.

The report having been discussed, the matter remained in abeyance until May 15 of the following year, when Mr. J. Millington, the present city high sheriff, offered to accept a transfer of the Council's powers under the provisional order, and to repay to the Council the cost of obtaining that order. This offer was declined, and the Watch Com-

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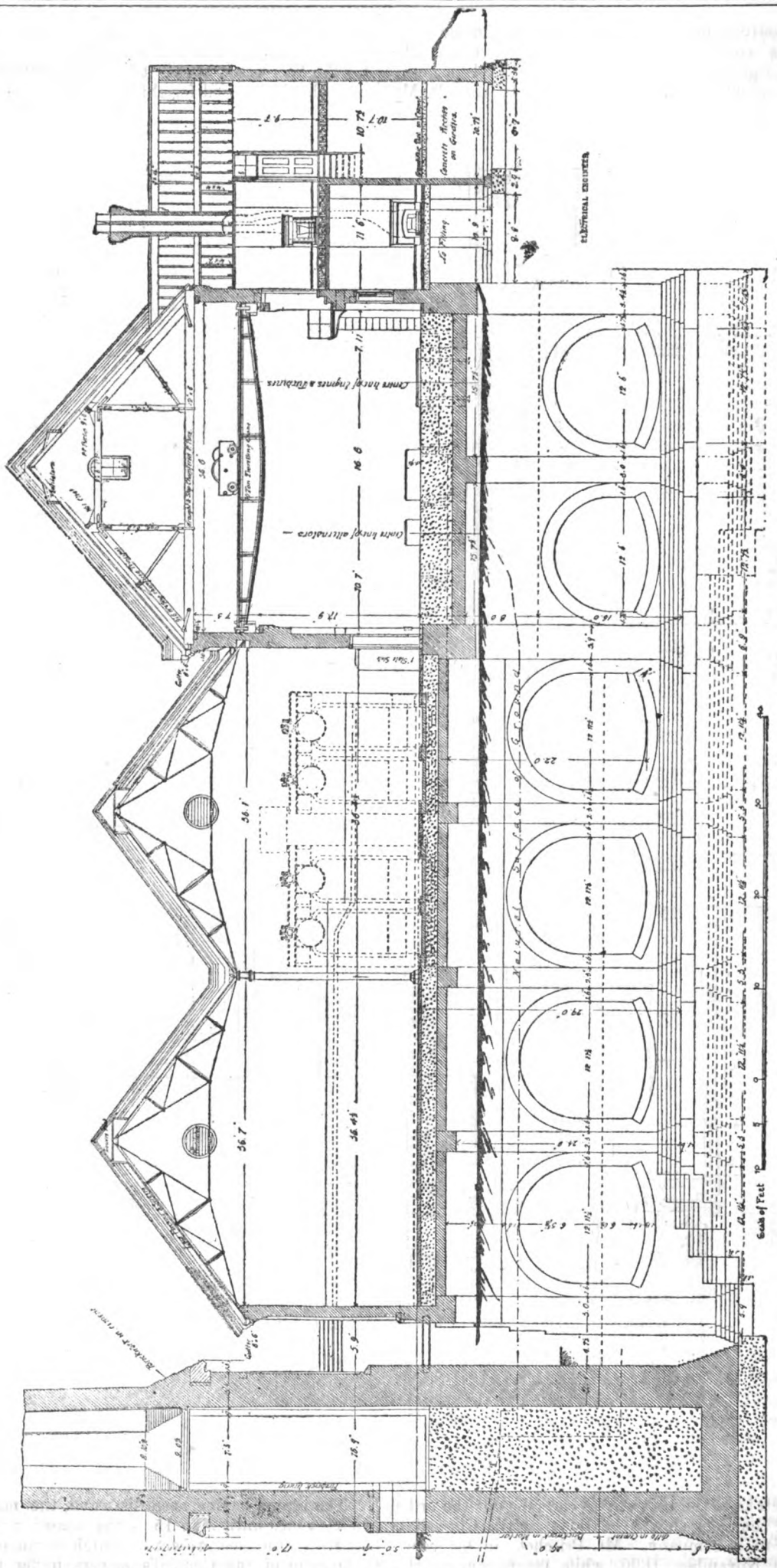

Worcester Central Station.—Longitudinal Section of Boiler House and Cross-section of Engine House

mittee then requested Mr. Oswald R. Swete to ascertain the probable demand for electric light. As a result, applications for the equivalent of 14,000 10-c.p. lamps were obtained. Reassured in this manner, the Council in

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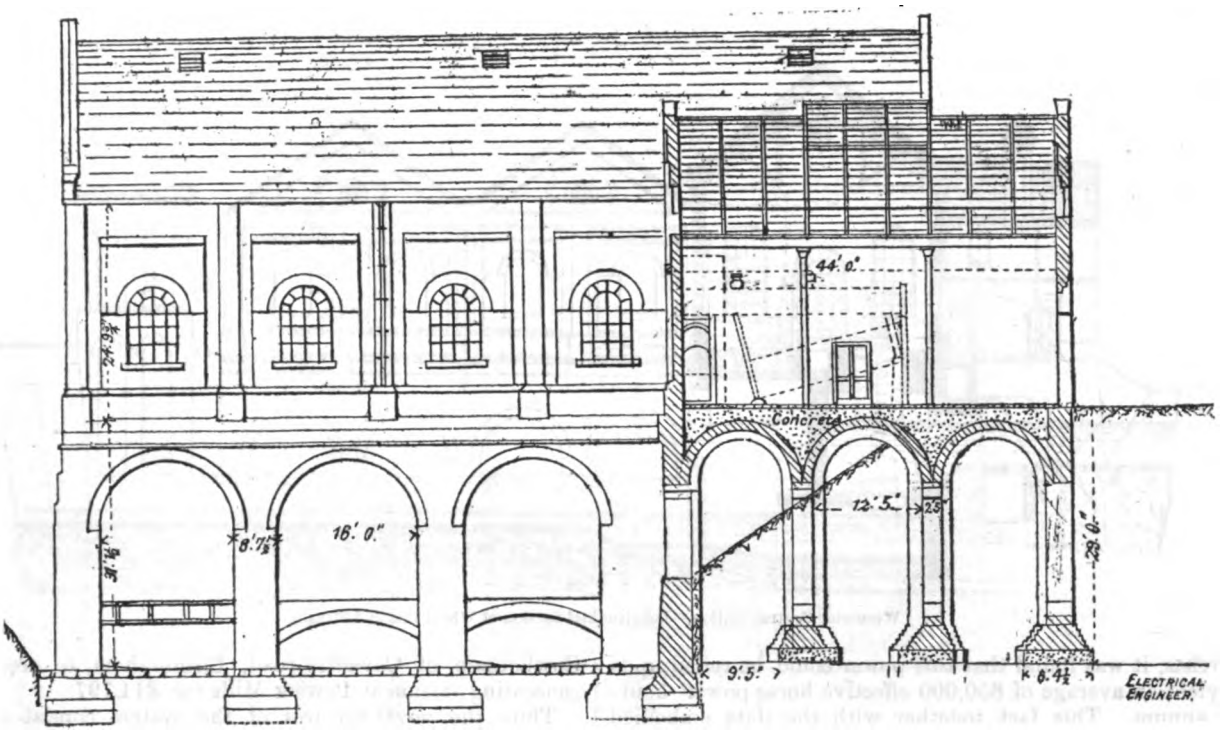
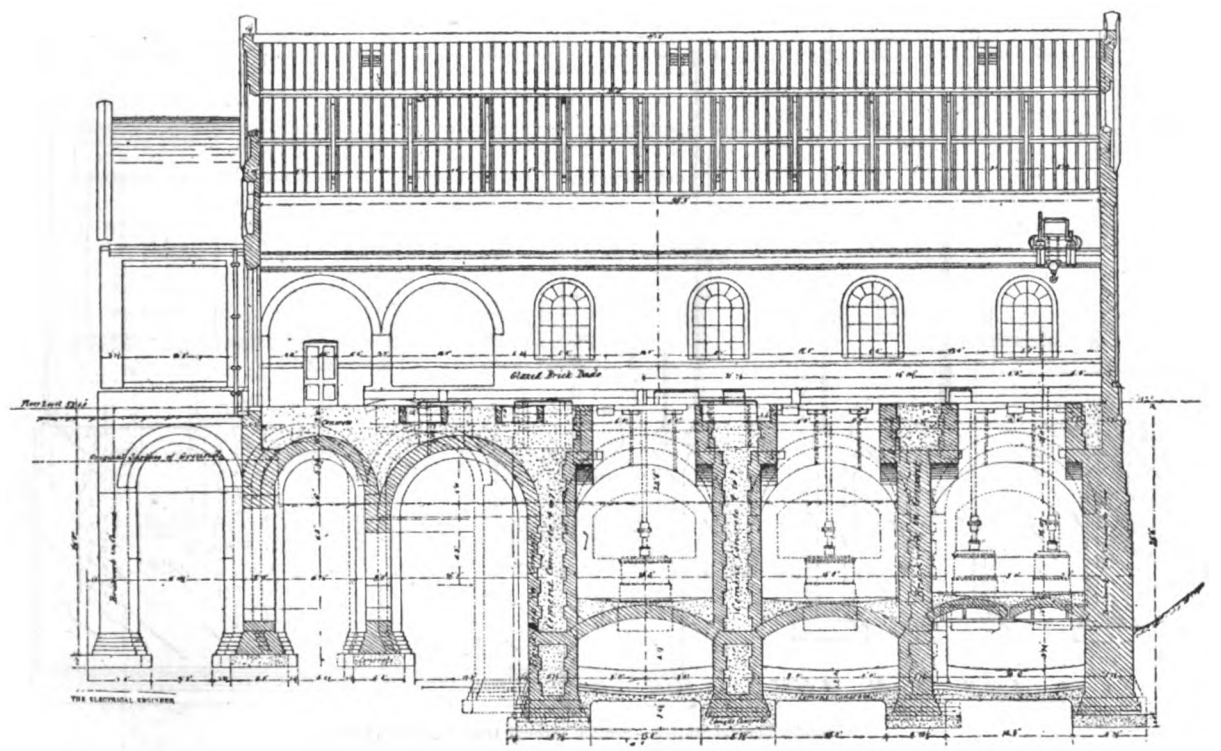
November, 1891, invited tenders for the construction of works to supply current to 12,000 10-c.p. lamps. The question as to what system should be adopted led to a contest between the partisans of the different methods, but the Council declined to accept a motion in favour of the storage system, and resolved to leave the matter open to those who tendered. The tenders, of which 15 were sent in, were referred to Mr. W. H. Preece, C.B., F.R.S., to examine and report. Eventually Mr. Preece recommended the acceptance of the tender of the Brush Electrical Engineering Company, Limited, for a combined steam and water power plant, at the sum of £21,005, with additions for buildings, street-lighting, etc., not covered by the tender, amounting to £19,970. The system proposed by the Brush Company was alternating, and the water power was originally intended to be obtained from the Severn near Diglis weir. This report was endorsed by the Watch Committee, but on its coming before the Council in April, 1892, the opposition to the alternating-current system, and in favour of a storage system, was so strong, that the committee's recommendation was not carried; but a motion was adopted in favour of printing the two lowest tenders for the Council's information. The controversy between the advocates of the two systems was the chief subject of discussion at meetings of the Watch Committee, but at the Council meeting on June 14, 1892, the opinion in favour of the alternating current had so far advanced that the Council affirmed the desirability of accepting the tender of the Brush Company, delaying its actual acceptance for further enquiry as to whether water power should be employed as an auxiliary to steam power. Obstacles placed in the way by the Severn Commissioners resulted in the abandonment of the proposal to use the Diglis weir for motive-power purposes.



Worcester Central Station.—Elevation of Engine House and Transverse Section of Boiler House.



Worcester Central Station.—Longitudinal Section of Engine House, showing Wheel Pits.

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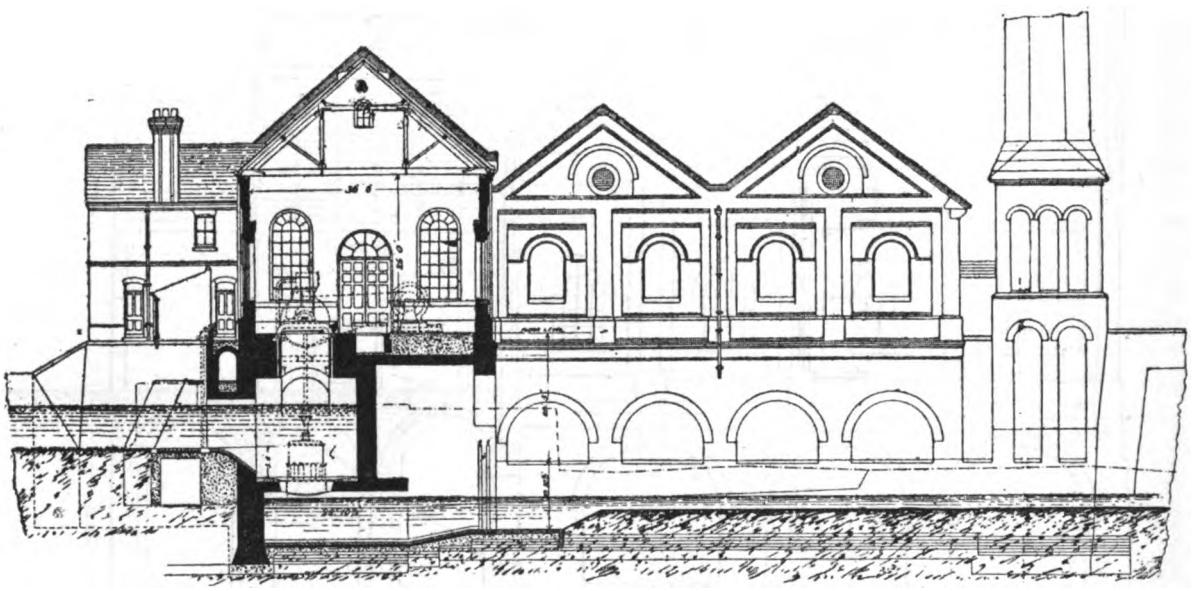
It was then suggested by the late Mr. S. G. Purchas (who at that time was engineer to the city), ably seconded by his assistant, Mr. Thomas Caink, A.M.I.C.E., that the Corporation should negotiate for the purchase of the water power available on the River Teme at Powick. As a result of careful observations and measurements made by Mr. Purchas, it was found that this power could be relied upon to yield an average of 850,000 effective horse-power hours per annum. This fact, together with the data embodied in a report which was submitted to the Watch and Lighting Committee by their engineer, led them to recommend the purchase of the Powick Mills and to adopt the revised scheme submitted by the Brush Company. The Council, adopting this suggestion, resolved in December, 1892, to acquire the mills for £5,000. Mr. Purchas, in conjunction with Mr. Caink, subsequently got out the plans.

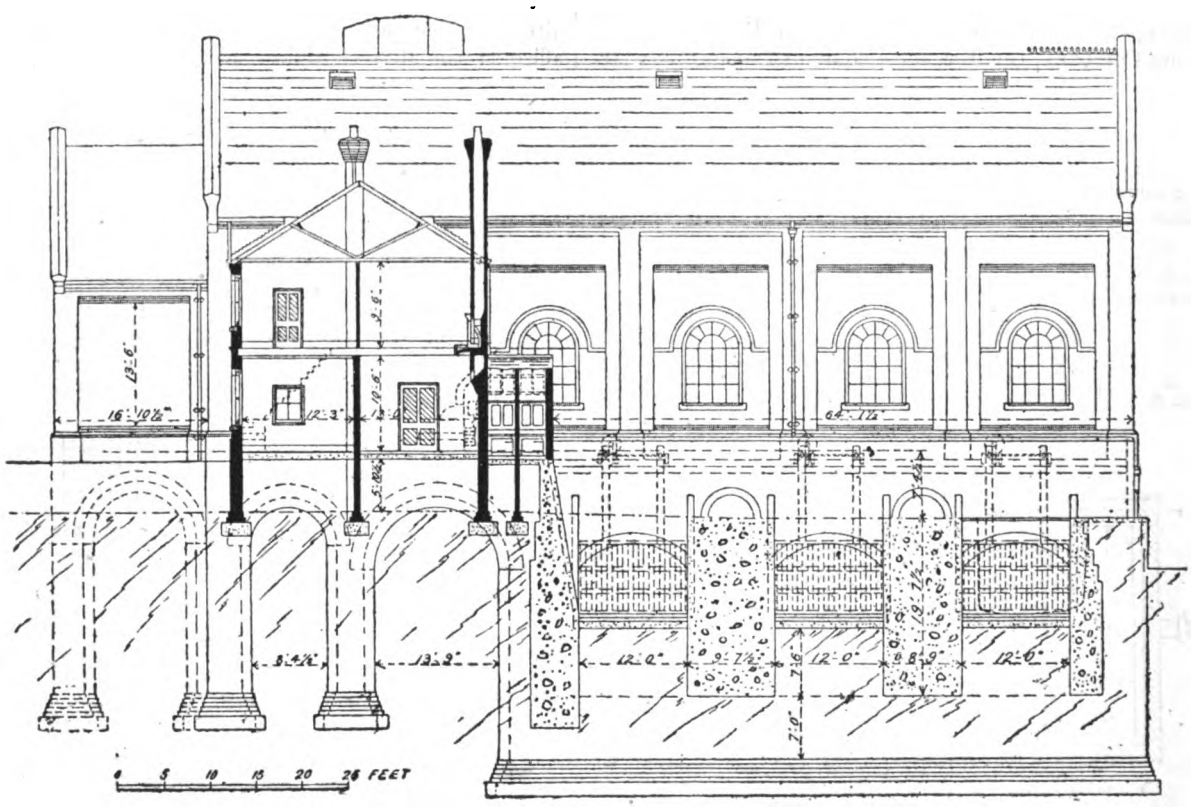


Worcester Central Station.—Longitudinal Section of Wheel Pits and Stream.

The Adopted System.

At the same meeting the Brush Company's revised tender was accepted, comprising a combined steam and water plant to the aggregate capacity of 400,000 watts, with an additional 60-h.p. turbine and alternator, and the mains, etc. In consequence of the great difficulty experienced in securing a good foundation for the generating station buildings, the cost was found to be much in excess of the sum originally named; but in August of last year the Council accepted the tender of Mr. Thomas Rowbotham, of Coventry-road, Birmingham, to erect the generating station at Powick Mills for £14,797.

Thus the novel features of the system consist in the combination of the water-power plant and steam-engines and alternators, the like of which is not to be found in any other town in this country. Mr. W. H. Preece was retained to supervise the work connected with the generating plant and mains, and Mr. Leonard Wigan, A.M.I.C.E., was appointed clerk of the works. Shortly afterwards the work of erection was commenced. Another matter closely connected with the scheme was the proposal to utilise electric motors for pumping at the municipal waterworks. This plan, it was submitted, would provide a means of using the water power at Powick during the daytime, when the demand for current in the city was low. The Council



Worcester Central Station.—Section through Offices and Head Race.

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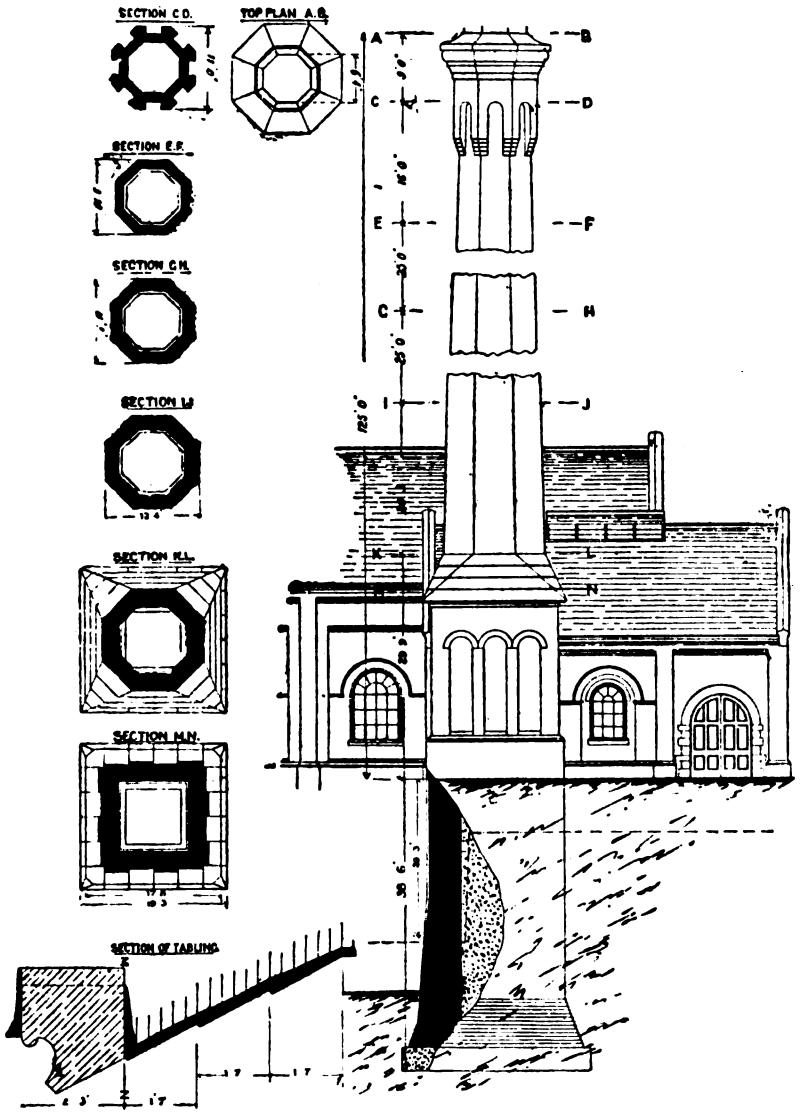
adopted this view, and voted £2,089 for motors and other machinery and the extension of the mains.

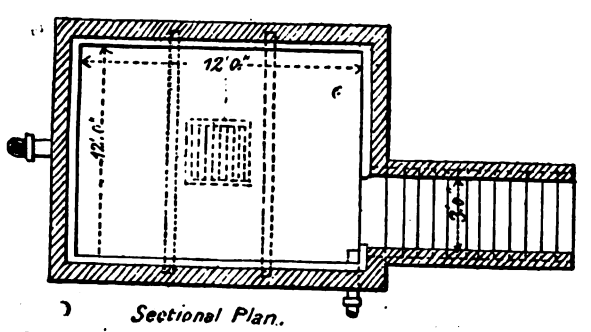


Worcester Central Station.—Elevation and Details of Chimney, the sections showing the diameter at intervals of 25ft.

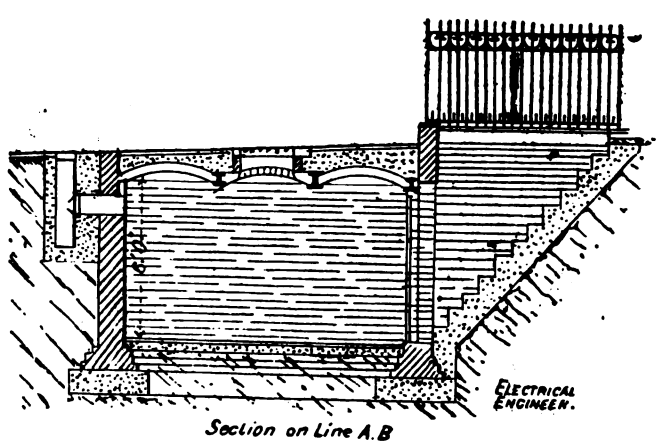
The members of the Watch and Lighting Committee are as follow:

THE MAYOR (MR G. H. WILLIAMSON), CHAIRMAN.

MR. J. MILLINGTON (Sheriff).	MR. HARRY DAY.
ALDERMAN HILL.	,, WALTER CALDICOTT.
,, CALDICOTT.	,, J. STALLARD, JUN.
,, ERNEST DAY.	,, JOSEPH COCK.
,, BUCK.	,, WINWOOD.
,, HOLLAND.	,, JOSELAND.
HON. A. PERCY ALLSOPP, M.P.	,, CHAPLIN.



Worcester Central Station.—Plan of Main Transformer Station.



Worcester Central Station.—Section of Main Transformer Station at All Hallows.

The Site.

The site of the electricity works, as shown on the accompanying plan, is on the River Teme, just above Powick Old Bridge, and two miles distant from the centre of the town. In this connection it is interesting to note that water power has been utilised at this spot for many centuries. In Doomsday Book mention is made of two mills at Wick belonging to the Bishop of Westminster. The mills were situated on Langherne Brook, which flowed into the Teme immediately below the bridge. They remained in the bishop's hands until 1290, when Bishop Godfrey Giffard presented them to the Abbey of Malvern, to which they belonged till the dissolution, when they passed into the possession of the Crown. About this time was cut the channel which conveys from the Teme to the mills, joining the Langherne Brook a short distance above the mills. This gave rise to dispute between the owners of the mills and the persons through whose land the channel passed.

(Continued on page 427.)

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CENTRAL-STATION STEAM-BOILERS.

We must confess that it has long since passed our comprehension why the water-tube design of steam-boiler should ever have obtained not only such an *extensive*, but in many cases also such an *exclusive*, use in the generation of steam for electricity works. Again and again have the deficiencies of this type been pointed out in these pages, while at the same time admitting its good points. No one would care to claim a special amount of engineering skill or wisdom in taking this position: it is a matter of ordinary common sense based on admitted fact. Yet consulting engineers and contracting firms, or whoever it may be upon whom rests the responsibility of designing central stations, have persisted in relying wholly upon water-tube boilers for the steam supply to these stations: and even at the present time, after some considerable experience has been gained in their working for this purpose, it is only in some of the provincial towns and cities, where local boilermakers obtain preference for their manufactures, that the single or double flue cylindrical boiler is adopted without question.

Granted at once that for quick steam raising the water-tube boiler easily takes first place, it does not follow by any means that this quality is the most fundamental one to consider in designing a central station. Of what possible good is it to the engineer in charge that he should be able to raise steam in half an hour or less to full pressure in a water-tube boiler, as against a longer period in the Lancashire type, when a sudden overload comes on through fog or other reasons in less than five minutes? There is no steam space worth talking about in a water-tube boiler: and probably a fifty per cent. overload above normal output would empty the boilers of steam, and run down the pressure to a point at which regular engine running is impossible, before a reserve boiler can be brought up to full pressure. A Lancashire boiler, on the other hand—although it takes more time and coal to get up a full head of steam—does not waste the heat energy spent on it thus: it is as good a thermal store as any yet devised, and will stand sudden demands for a length of time amply sufficient to get up steam in reserve boilers, especially if these be of the water-tube type.

Herein, therefore, lies to our mind the true and profitable employment of both kinds of boilers. We do not for a moment expect or wish to avoid the use of water-tube boilers. They have, as already stated, at least the one very great advantage which alone is enough to secure its adoption. But it is not as the "stock" boilers that they will serve best; they ought more especially to be the "stand-bys" or reserve. Of course, a great amount of scope is left in practical everyday working to the skill of the engineer in charge, though he cannot anticipate sudden overload arising from fog, and must simply scramble through it as well as he may. But it is absurd to expect heavy demands for electric energy to be met by boilers of such small storage capacity as those of the water-tube type, even although a reserve boiler can be introduced on very short notice.

A quarter of an hour's interval in the lighting

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supply is a *hiatus valde deflendus* by shareholders and consumers alike: yet it is not only the most probable thing that might happen, but has actually occurred more than once in the Metropolis, too, of all places. The injury thus done to electric lighting is almost incalculable, for in many cases a sufficient amount of confidence has otherwise grown up in the warehouses, offices, banks, shops, and private houses to cause reliance entirely upon electric lights rather than gas. A breakdown, even for ten minutes, is therefore a matter of enormous importance when everyone requires light for private purposes and the street lamps must also be kept going.

Suppose Lancashire boilers are used for normal working, in case of a sudden call for double the current—such as often happens in winter when a fog comes on—there is, or should be with careful stoking, amply sufficient steam storage for a length of time which will allow not only reserve boilers under easy steam to be fired up to full pressure, but also those of the water-tube type to be brought into service even from a cold condition. By this time probably the demand may have become slightly easier, but at any rate there is breathing space enough to take prompt action.

If those whose duty it is to decide upon such points should cause the exclusive adoption of water-tube boilers for central-station work in the future, we should feel inclined to say that they are courting endless trouble and annoyance, not only for those who own the electricity works, but also the unlucky consumers depending upon it for light or power.

REVIEWS.

The Telephone Handbook: By HERBERT LAWS WEBB. *Electrician* Publishing Company, Chicago. Price 1dol.

This is a small handy book of nearly 150 pages, and like all Mr. Webb's work is carefully done. It is what it professes to be—"a practical book on telephone working and management," as exemplified by American practice. A brief *resume* of telephonic discovery is followed by a description of the various pieces of apparatus generally in use, of wiring, of batteries, and of methods of exchange working. The text is illustrated as required, and the information is reliable and of just that character that the ordinary worker requires. In form it is well within the capacity of the ordinary reader, hence should be extensively read. The practice in England is not altogether on all fours with that in America, so that the work will hardly appeal to so large a class of readers here as there. Mr. Webb is to be congratulated upon the care and industry he has shown in the preparation of this book.

Electric Lighting Plants.—Their Cost and Operation: By W. J. BUCKLEY. Wm. Johnston Printing Company, Chicago. Price 2dols.

This book is more of the nature of a price-book—and such we should term it on this side—than as belonging to any other class. The larger part, therefore, is of more interest in America than here, because the prices given are those which rule in that country. The smaller part, however, appeals to all users of electric lighting plant, and some portions are exceedingly interesting to both users and manufacturers wherever they may reside. It is interesting to know that "of the operating stations 12·6 per cent. are losing money; with 10·8 per cent. the receipts barely cover the running expenses, while 76·6 per cent. are making money ranging from two to fifty-one per cent. yearly on the undertaking." That being so proves electrical supply to be a good sound commercial investment. Another important question wherein we quite agree with the author, is in the employment of a "capable consulting engineer." Such employment "will not only prevent expensive mistakes, but frequently effect a saving in operation of many times his commission." The introductory suggestions as to size of building are also good. After this introductory matter, we get the cost of coal, labour, etc., in producing motive power, a list of boilers, method of setting, prices, efficiencies, etc., and information of a similar nature as to chimneys, to engines, dynamos, shafting, belting, dynamos, and other parts of a central station equipment. The explanatory curves are numerous, as are the tables. Of course, as above stated, these prices must be corrected for English apparatus.

THE ELECTRICITY WORKS AT WORCESTER.

(Continued from page 425.)

Some of the most severe fighting in the battle of Worcester took place there, the mills being held by the Royalist sharpshooters, from which they commanded the bridge, and these were only dislodged by firing the mill. The only relics of the battle found are two clay pipes and a cannon-ball, which were picked up in the excavations for the foundations of the generating station buildings. When the Corporation purchased the site there existed three mills—a corn-mill on the east with two wheels; a mill in the centre with two wheels which for the last century and a half have been used to grind the material for the manufacture of the famous Worcester china, from whence it is carted to the factory in Worcester; on the west is another mill with three wheels, known as the "forge mill," this having been used in former times as a forge, the iron being brought up by water.

The Station Buildings.

The Corporation pulled down the East Mill and built the engine-house on the site, the boiler-house being arranged along the bank at right angles to the former. The external dimensions of the engine and dynamo house, of which plans and elevations are given herewith, are 102ft. long, 42ft. wide, and 40ft. high. The floor level is 36ft. above the foundations, being 3in. above the level of the highest recorded flood. The engine-house is supported upon arches springing from four parallel walls forming the piers and abutments of the turbine races, 5ft. 7½in. thick above the footings, consisting of an outer casing of brickwork, 1ft. 1½in., with a core of concrete 3ft. 4½in. The whole of the brickwork and concrete up to the floor line is built in Portland cement. Two of the turbines are fixed on stone seatings supported by a brick arch, the turbine-pits being 16ft. wide. The other two turbines are arranged in one pit, the width being 17ft. These are fixed on stone seatings resting upon two small brick arches, the whole being carried on cast-iron girders, as there was not sufficient room to carry them entirely on brick arches, as in the other two cases. The small turbine is 30in., and the large one 40in. The other two water-motors are each 54in.

The maximum difference between the head and the tail race in dry weather is nearly 12ft. The normal working head is 10ft., and in very dry weather 11ft. 6in. The water is conveyed to the engine-house by a channel about a quarter of a mile long and 30ft. wide, there being, under ordinary circumstances, 8ft. of water in the channel.

The Boiler-House.

The boiler-house is 44ft. wide and 72ft. long, the chimney, 160ft. high and 7ft. 3in. internal diameter, occupying the ground between the boiler-house and the main road. As will be seen, there is ample provision for additional boilers.

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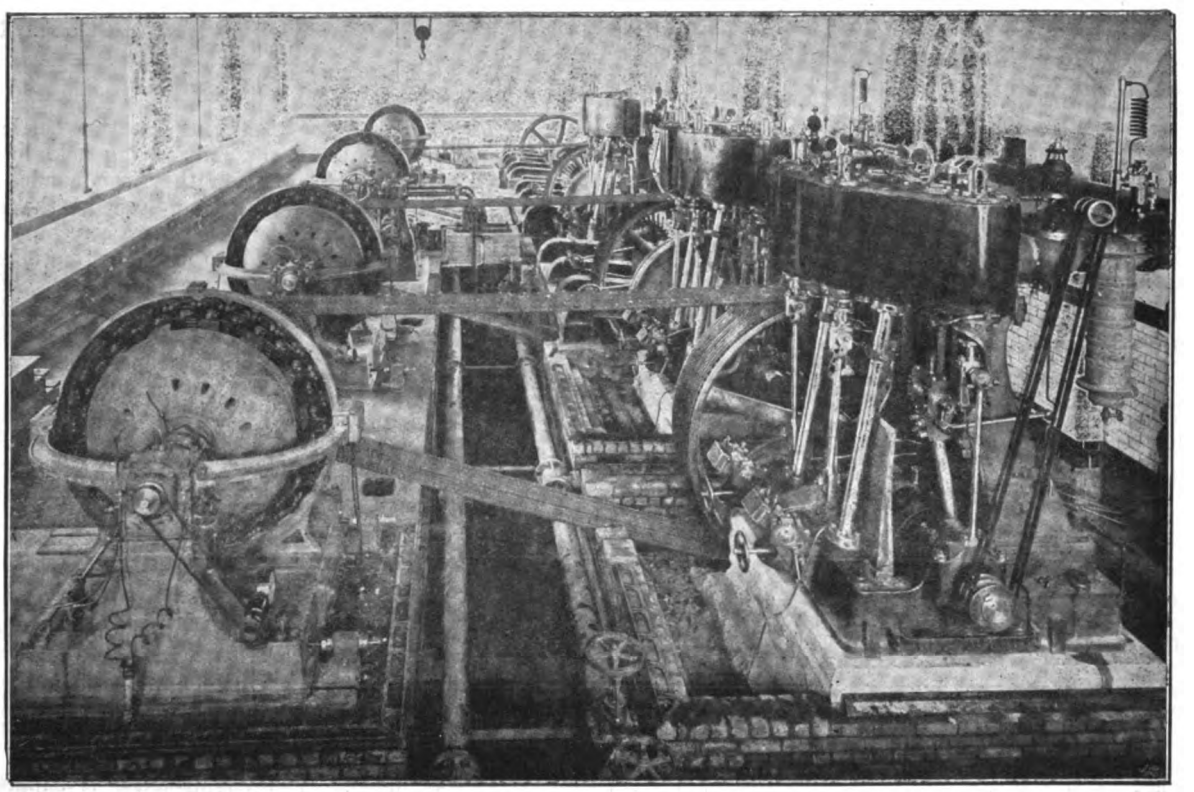
Coal will for the present be brought to the works by road. Eventually, however, it is probable that the Corporation will have the Teme dredged, so that barges may be brought up the river and coal discharged direct from the barge into the boiler-house.

The engines are supplied with steam from four 124-h.p. Babcock and Wilcox water-tube boilers arranged in two batteries. Each boiler has a heating surface of 1,411 square feet, with a grate area of 26½ square feet. The drums are 36in. by 23ft. 7in. long, and are provided with two stop-valves, one dead-weight safety-valve, and all the latest improvements. The boilers are constructed for a working pressure of 120lb. per square inch, and are easily capable of evaporating 4,000lb. of water per hour. The firing is done by hand.

The main steam-pipe, which is arranged in ring form, is of wrought iron 6in. in diameter, having valves so arranged that any portion may be easily isolated without interfering with the working of the engines. The branches from the main pipe to the engines are 4in. in diameter. The valves



Worcester Central Station.—Internal View of Engine and Dynamo Room.

are of the parallel slide type, which allow of a clear open passage for the steam. Water separators are provided in the main steam-pipe as well as on each engine, which are drained by Geipel's expansion steam traps. The exhaust piping, which is of cast iron, is 7in. in diameter, each engine exhausting direct to the atmosphere. The contractors did not consider it advisable to put down condensers, although abundance of water is at hand. There are two feed pumps, of the duplex type, 6in. by 4in. by 6in. stroke, one of which is illustrated. Each pump (which has been made by the Smith and Vaile Company, and supplied by Mr. F. Nell, of Mark-lane, E.C.) is capable of supplying 2,500 gallons of water per hour. They are arranged to pump direct from the river or from a feed tank, which is heated by the exhaust steam from the feed pumps. The feed pipes, which are of galvanised wrought iron, are also arranged on the ring system, being provided with suitable valves for isolating any section. These pumps are also utilised for drawing water from the Teme into the tank for supplying the water service throughout the buildings.

The Steam-Engines.

The steam motors comprise three main engines, each capable of developing 286 h.p. They are of the well-known Brush compound vertical type, having cylinders 15in. by 25in. by 16in. stroke, and run at 167 revolutions per minute. The high-pressure cylinders are provided with piston valves, and the low pressure with ordinary slide valves.

The steam is controlled by means of highly sensitive equilibrium governors, and the low-pressure slide valves are provided with Hackworth gear for varying the cut-off in the low-pressure cylinder whilst running. One engine is fitted with a grooved flywheel for driving one of the alternators; the other two are provided with disc couplings for connecting each engine to another shaft which carries the grooved pulley for driving the alternators, this arrangement being made to allow of their being driven either by the engines or turbines.

The engine-room is equipped with an overhead traveller, made by Messrs. R. C. Gibbins and Co., of Berkeley-street, Birmingham, and a view of the crane is given. The crane is made for lifting 12 tons, 35ft. 8½in. span. The main beams are rolled-steel plated girders, and are bolted to strong castings at each end. The crab has single and double purchase lifting gear, lifting its full weight with return chain and block, which can be detached if required, thus giving the crane four speeds of lift. It is fitted with powerful lever brake and transverse travelling gear. The longitudinal travelling gear is fixed at the end of the crane, and is arranged to be worked either single or double purchase. This traveller has proved of great service in the laying down of the whole of the machinery.

The Turbines.

We now come to the first novel feature in this station—namely, the use of turbines. Special interest is attached to the ingenious method of working these motors. They are "cylinder gate" Victor turbines, the installation having been designed and carried out by Mr. Frederick Nell, of 16, Mark-lane, E.C. Annexed are illustrations of the turbine, head gate, and governor used. Two of the turbines are 54in., capable of developing 211 h.p. when working under a fall of 12ft., and using 11,700 cubic feet of water making 75 revolutions per minute. These two turbines are arranged side by side with two of the 15in. by 25in. by 16in. steam-engines, and are geared to the grooved

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pulleys by means of clutches. These clutches, known as Snyers, may be roughly described as "brushes and combs." They are of a divided disc form, the one half carrying a number of steel brushes, and the other half having teeth, or a comb-like arrangement. The brushes are caused to grip the teeth, and so form a mechanical clutch. There are also one 48in. turbine capable of giving 162 h.p. when working under a fall of 12ft., and using 8,950 cubic feet of water and making 84 revolutions per minute; and one 30in. turbine capable of developing 62 h.p. under a fall of 12ft., and using 3,450 cubic feet of water and making 134 revolutions per minute. These two turbines are placed side by side, so that either or both of them can be coupled by means of mill clutches to the grooved driving pulley. By this arrangement during times of low water the small turbine may alone be used, so that the best efficiency is secured, while, when there is sufficient water, the full output of the alternator—namely, 125 kilowatts—may be obtained by using both turbines. Similarly, when the water power is insufficient for the whole of the turbines, it is, of course, possible to reinforce that power by running the steam-engines in conjunction with the turbines of the respective alternators. Each turbine is provided with an automatic governor for regulating the speed. There are three sets of sluice-gates, 12ft. by 8ft., and arrangements for keeping back floating matter from the turbines. The gear for transmitting the power from the turbines to the driving pulley comprises two bevel-teethed wheels, the larger wheel having wood teeth, being fixed at the top of a vertical shaft, on the bottom of which the turbine wheel is fixed. The working of the wood teeth is almost noiseless.

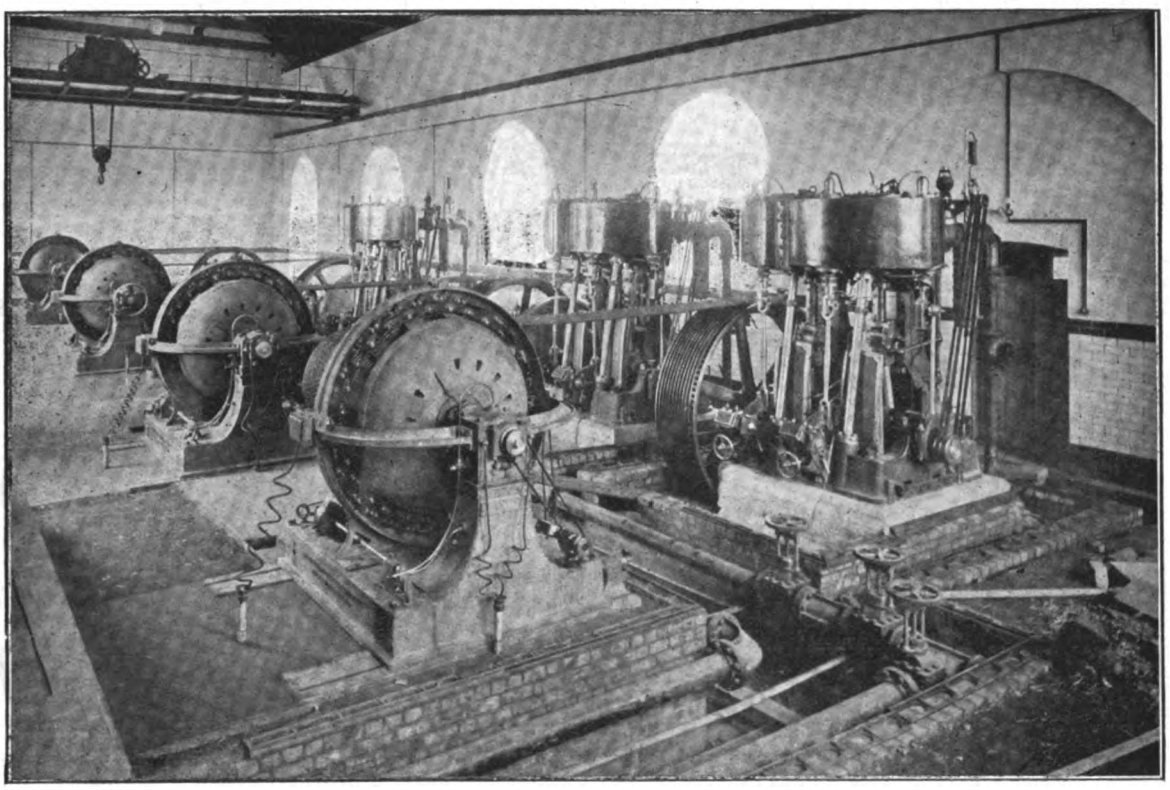
The Alternators and Exciters.

The four alternators, which are of the well-known Mordey-Victoria type, are driven from the above engines and turbines by means of 10 separate cotton ropes. Each machine runs at 430 revolutions per minute, and has a capacity of 58 amperes, the working pressure being 2,200 volts. The armatures are stationary, and the field magnets revolve. The lubrication of the bearings is automatic, being effected by means of small pumps, which keep up a constant circulation of oil.

The exciting plant comprises two Brush-Victoria dynamos, each having an output of 5,830 watts, and driven by means of leather belts direct from pulleys keyed to the shafts of two of the alternators, and a Brush-Victoria dynamo having an output of 6,500 watts. The latter machine is coupled direct to a 7in. by 6in. vertical Brush engine, mounted upon a common bed-plate. This latter is capable of exciting all the alternators, and in this way ample provision is made to meet both full and day load requirements economically.

The Switchboard Arrangements.

The well-known switch-pillar method devised by Mr. J. S. Raworth, and which we described some time ago, has been introduced into this station. Each alternator is controlled by its own switch pillar, which contains a system of interlocked switches which make it impossible for the attendant to close the main circuit before the field circuit is closed, and likewise when the main switch is closed the field switch is locked and cannot be opened before the main switch. These switch pillars are built entirely of cast iron, and include also the main ammeter, the field ammeter, synchroniser switch, and a pair of high-tension fuses.



Worcester Central Station.—Internal View of Engine and Dynamo Room.

Underneath each pillar is placed a rheostat for compensating the change in resistance of the field circuit due to temperature variations. The current from the alternators passes through these pillars on to the main station omnibus bars, one of which runs direct from the pillars to the circuit-boards, the other being led to the main ammeter-board, on which are also fixed the lamps and switches used for synchronising. Switches are provided on this board for shunting the main ammeter when required. From this board the outer main is led through the registering meters to the circuit-boards. At present there are only two circuit-boards fixed, each containing a main ammeter and double-pole high-tension switches and fuses. The synchroniser and circuit-boards consist of polished marble slabs mounted in handsome wood frames. The whole of the high-pressure switching arrangements are grouped together and operated from a platform about 3ft. above the engine-room floor. Each exciter is controlled by one of the Brush Company's latest type of exciter pillar. This contains Raworth's switch for automatically closing and opening the circuit of each exciter according as its E.M.F. is sufficient for supplying the circuit, so that to switch an exciter into circuit it is merely necessary to open the steam stop-valve, while it is switched

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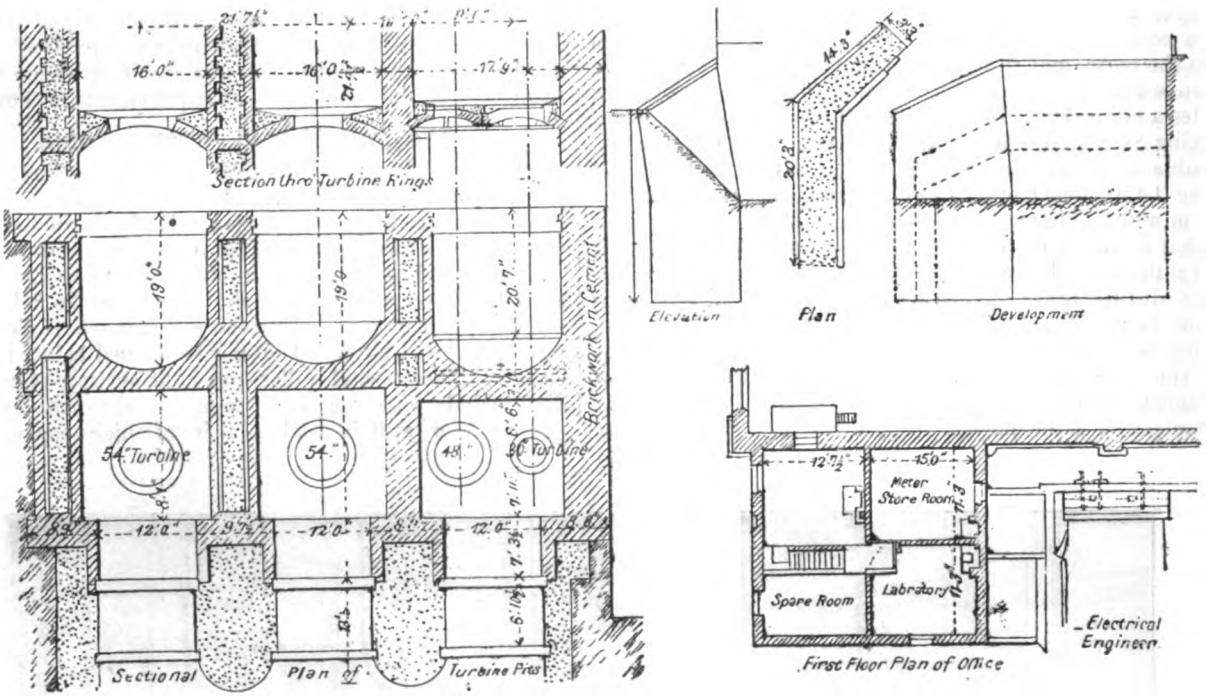
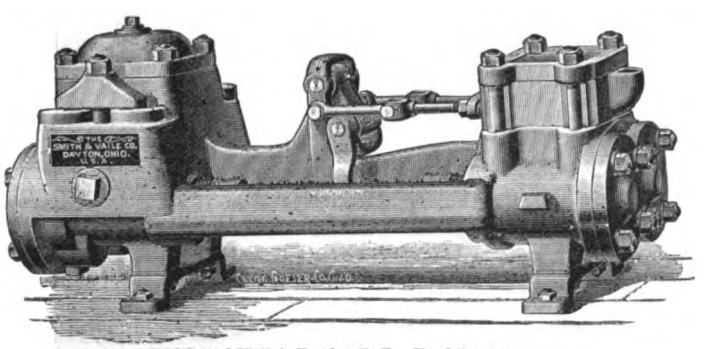
out of circuit by merely shutting down the steam. Each pillar carries an ammeter and voltmeter for regulating the exciters. The rheostats are grouped together and fixed on the switch platform under the main station voltmeter, the exciter pillars being fixed close to their respective exciters.



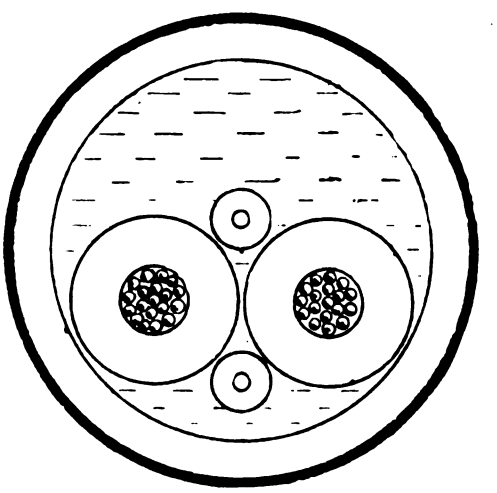
Worcester Central Station.—Sectional Plan of Turbine Pits.

Method of Distribution.

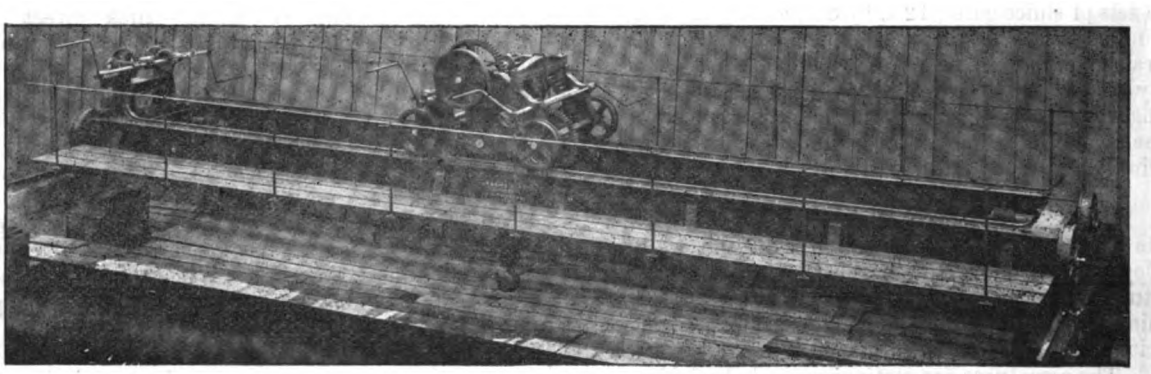
The main feeders from the generating station at Powick are laid underground, and are led to the high-pressure distributing sub-station at All Hallows, a plan and section of which are subjoined. These main feeders are laid on the Brooks system of oil insulation, which method has proved so satisfactory at Chatham, Rochester, Keswick, and other places, where it has been in use for some years. These feeders consist of three heavy wrought-iron tubes, the metal having a minimum thickness of ·25in., and an internal diameter of 2in. The conductors drawn into two of these tubes are made up of two $^{19}/_{14}$'s and two pilot wires, laid up together into one cable, the remaining tube being left spare. A section of the tube and conductors is annexed. Special joint and junction boxes are placed at various points along the line, from which branch connections may be taken as required. Midway along the line an oil pressure tower, which is illustrated herewith, has been erected, this allowing for expansion and contraction (due to variations in temperature) of the thick heavy insulation oil. During the laying, a very careful test was kept on the cable, and they were



Smith and Vaile's Duplex Boiler Feed Pump.



Worcester Central Station.—Section of Main Feeder from Powick to All Hallows.



Worcester Central Station.—Side View of Overhead Traveller.

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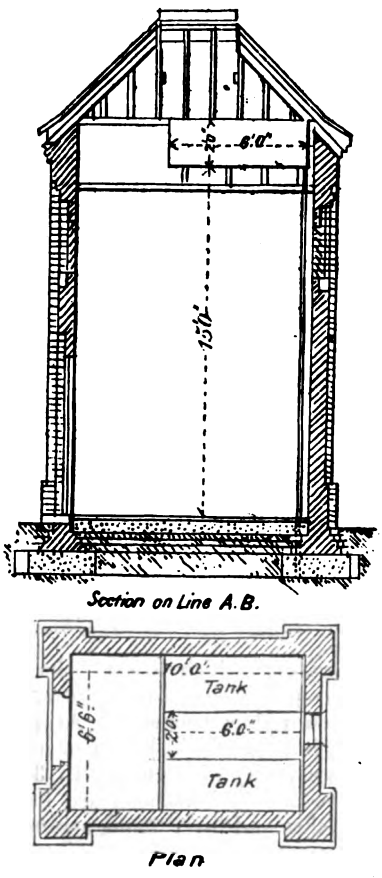
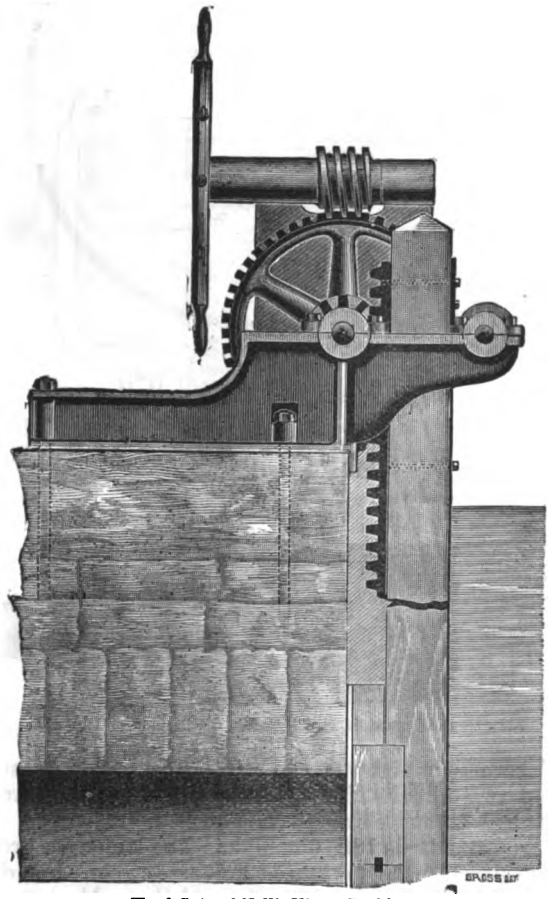
finally flashed with double the working pressure—namely, 5,000 volts. The contract for the supply and laying of these feeders was given to Messrs. Johnson and Phillips,



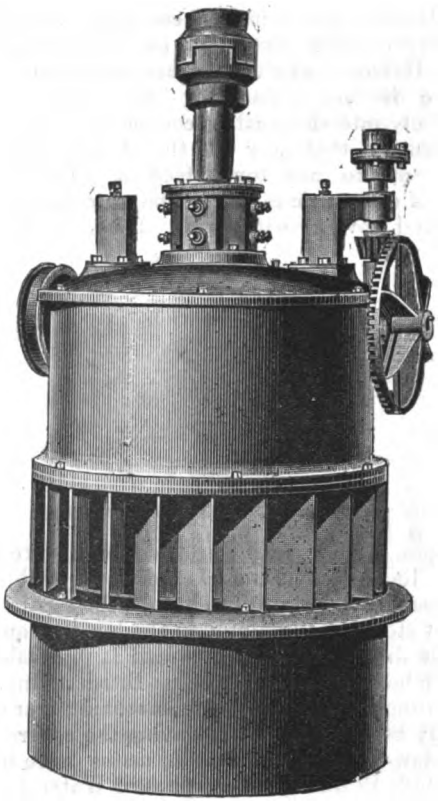
Worcester Central Station.—Section and Plan of Oil Tower at St. John's Green.



Head Gate of Nell's Victor Turbine.

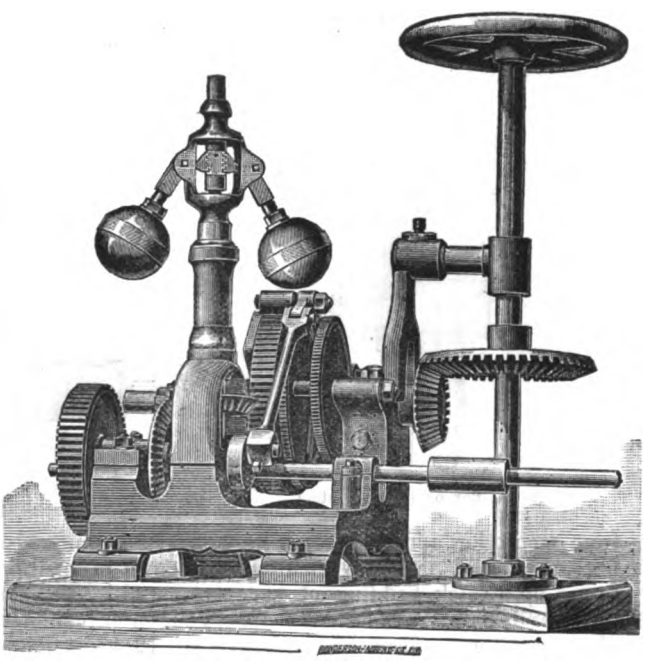
of London and Charlton, who are the sole makers of this system, which there is little doubt will be more generally used.

A few further remarks, which by the aid of the accompanying illustrations of the mains, junction and terminal boxes, and house service boxes, will be rendered more explicit, will be interesting to those who have not investigated the Brooks system of oil insulating mains. Although the above-mentioned tubes are 2in. in diameter, they may in other cases be less, often not exceeding an inch bore, and bare copper wires can be laid through the



The "Cylinder Gate" Victor Turbine.

tubes with only a slight serving of yarn to keep them from actually touching one another. The guttapercha or indiarubber insulation, which in the ordinary way would be given to the conductors, is here replaced by a thick viscid oil. It is injected into the tubes after the conductors have been laid, so as to fill up all the spaces completely, from a portable cauldron. By this means



Nell's Victor Turbine Water Wheel Governor.

the temperature of both wire and oil is raised to about 360deg. F., so as to drive away any moisture from the covering. The boxes at which the oil is thus forced into

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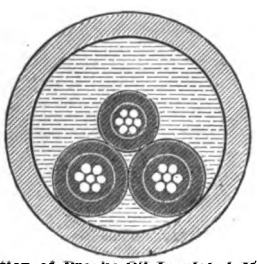
the mains are situated usually about 100 yards apart, and are made of malleable iron, with screw-covered lids. The operation of splicing consists simply in jointing the separate wires of the cable ends, and slipping over them a neat sleeve of insulating material to keep them apart, after which the hot oil is poured in and the cover screwed down. The makers state that the Brooks system of oil-insulated cables is cheap, and that it affords a permanent and reliable insulation.

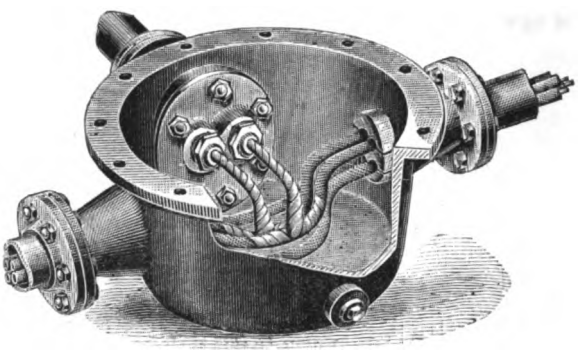
As already mentioned, these main feeders terminate at a circuit-board fixed in an underground chamber at All Hallows, where they are connected to the high-pressure feeders, circulating throughout the city by means of interchangeable connectors, the latter being so arranged that any of the Brooks mains may be thrown on to any town feeders. The town feeders consist of concentric cables insulated with specially-treated paper and covered with lead. They are drawn into cast-



Section of Brooks Oil Insulated Main.

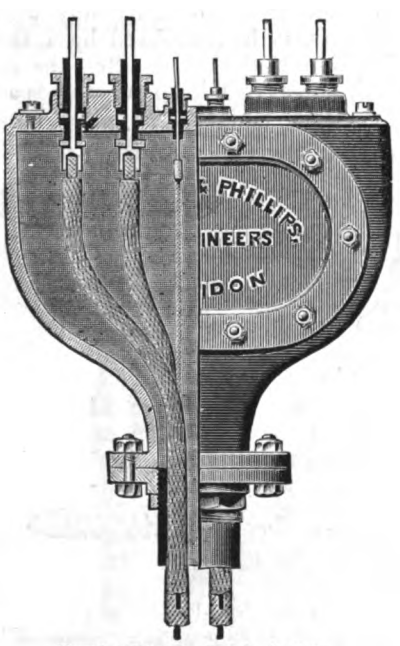
iron pipes. These mains are laid on a system devised by Messrs. Raworth and Geipel, and which enables any of the high-pressure feeders to be shut off for repair or extension without stopping the supply in the low-tension distributors. Suitable draw-boxes are provided at intervals, and special junction-boxes designed by the Brush Company are used for jointing; the joints, being mechanical, are easily made and may be inspected by removing the cover.

The low-pressure distributing mains have been made by Callender's Bitumen, Telegraph, and Waterproof Company, Limited, of London and Erith, and have been laid under the supervision of Mr. Moir, the Callender Company's resident engineer at Birmingham. The mains consist of concentric cables, with each of the conductors insulated from each other and from earth by means of a bitumenised fibre, then lead sheathed with a heavy cover of lead, protected by a thick bedding of yarn, armoured by two steel tapes, and double yarned over all. The outer conductor of these cables is formed in each case of 19 wires divided into two segments, so that it is possible to cut into the cable and tap on to the inner strand without absolutely destroying the continuity of the outer conductor. These cables are laid direct in the ground, as they require no protection other than that afforded by their own armour. The sections used are ·10, ·15, ·20 of a square inch. They have been made specially for the work in such lengths that they will reach without joint between two sub-stations, thus making an unbroken network. There is, therefore, no fear of any faulty connections on the distributors. These low-tension mains are laid on both sides of High-street, the Cross, Foregate, and Broad-street, and on one side of College-street, Bridge-street, and St. Nicholas-street. Orders have already been given for extensions in Sansom-street, Mealcheapen-street, Sidbury, and in St. John's. A number of consumers have already been connected with the mains, and the work of connection is being carried out by the Callender Company's men, under the direction of Mr. Davenport.

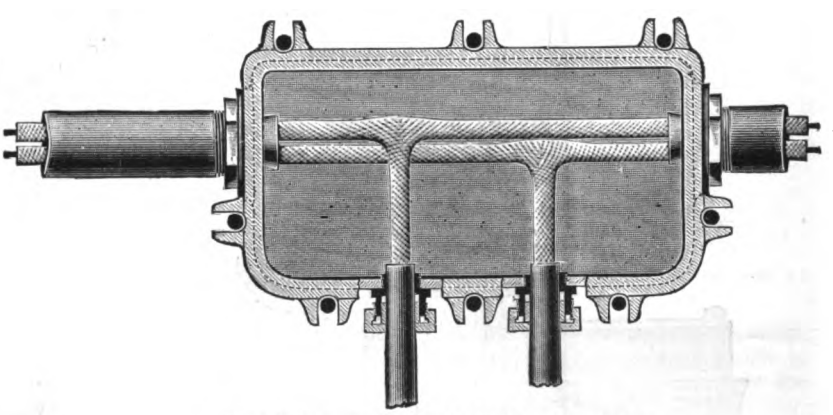


Junction Box on Brooks System.

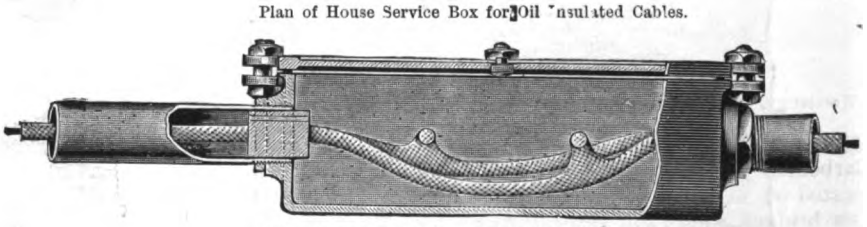
The transformers, which are of the Mordey-Victoria type, are mostly placed in sub-chambers, either under the pavement or on public property. At present there are seven of these, in each of which two or three transformers are placed of a capacity of from 24 to 36 kilowatts. At these points the current is transformed from 2,000 volts to 100 volts, switches and fuses being arranged on both sides of each transformer for throwing into and out of circuit without affecting the continuous supply of current. In the outskirts of the city it has not been thought advisable to lay low-tension mains; but as the high-pressure feeders are so easily laid, and at a comparatively small cost, the Corporation have had no hesitation in supplying customers in such districts by means of isolated transformers.



Terminal Box on Brooks System.



Plan of House Service Box for Oil Insulated Cables.



Elevation of House Service Box for Oil Insulated Cables.

The public lighting comprises 27 arc lamps, supplied from two circuits from All Hallows. These lamps, of which a corner elevation is annexed, are carried mostly on iron standards 18ft. 6in. high. The lamps are erected in High-street, the Foregate, Foregate-street, Broad-street, St. Swithin's-street, and in the old Corn Market. These thoroughfares constitute the principal streets. The lamps are Brush 15-ampere double-carbon lamps, fitted to ornamental posts and brackets, and enclosed in japanned copper hexagonal lanterns. The lamps are worked off a separate

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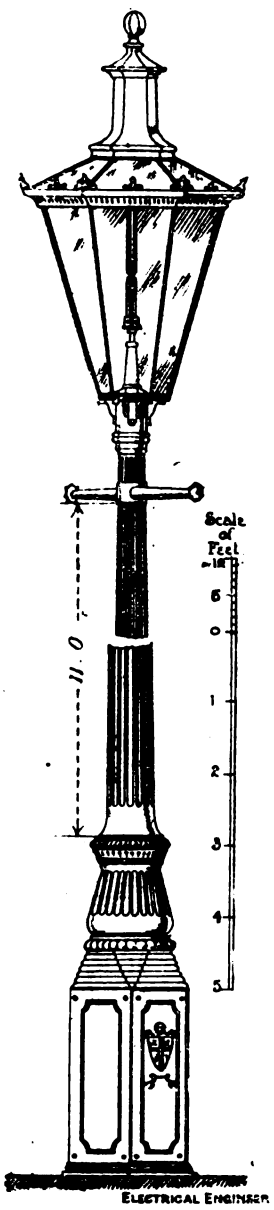
main divided into two circuits; the conductors consisting of concentric cables, insulated with pure and vulcanised india-rubber, taped and compounded, and drawn into galvanised iron pipes. These mains are connected to small transformers specially designed to fit into the bases of the lamp-posts. Each lamp has therefore been provided with its own independent supply, and can be turned on and off without in any way interfering with any of the others. The lamps are arranged on alternate circuits, so that half the lamps may be switched out after midnight by opening one of the switches at All Hallows.

Electric Pumping Plant.

The idea of pumping the city water by means of water power, as about to be exemplified at the waterworks, is not new for Worcester, as it was pumped in this manner



Worcester Central Station.—Corner Elevation of Brush Arc Lamp Standard.

at least 200 years ago. In 1794 the new waterworks at Barbourne were completed. The old waterworks were located on an island in the Severn, between the old and new bridges, where the Severn water was pumped up to the reservoir in the centre of the town by a waterwheel driving a pump. This waterwheel was, of course, driven by the water of the Severn, but it does not appear to have given universal satisfaction, as Wash, the historian, writing a few years later, says of it: "Lately, a machine has been erected and pipes laid to convey the river water to every part of the town, although this, like other public works, has not been conducted with the greatest frugality, or in the best manner. The wheel at the waterworks was at first too small, which, being afterwards enlarged, renders it too great for other parts of the work. The reservoir would have been better placed near the and at the head of the pipes, and some think that the bore of the pipes and the pumps are not in due proportion. In floods or low water (especially the latter) there is not the quantity of water thrown into the town that there ought to be." The water-engine was abandoned in 1807 in favour of a fire-engine, which was to be of sufficient power to pump 126,000 gallons to a height of 70ft.

However interesting this historical fact may be, even greater interest will be excited in the laying of a main from the generating station to the municipal waterworks for the operation of electric pumping plant by means of alternating-current motors. Here the electrical energy brought by the high-pressure mains is transformed by means of two 30-kilowatt transformers to 100 volts, at which pressure the motors are arranged to work. There are two three-throw horizontal plunger pumps, with rams 6in. by 15in. stroke, each set capable of pumping 10,000 gallons of water per hour against a vertical height of 300ft., through 5,000 yards of 10in. pipe, at a speed of 45 revolutions per minute. Each set is fitted with a second motion shaft, spur wheel and pinion, and fast and loose pulleys with striking gear complete. The pumps are placed side by side upon a strong cast-iron bed-plate of sufficient length to take the driving gear. Each pump is fitted with brass suction and delivery valves, glands, and stuffing-boxes bushed with brass. The pump rams are of cast iron, turned and fitted with guide shoes and steel pins. The two motors, which are of the Brown type, which has been largely adopted in Switzerland, are each capable of developing 30 b.h.p.; they are of the non-synchronous type, running at about 500 revolutions per minute.

Charges for Current.

The price for current will be at the rate of 5d. per Board of Trade unit for lighting, and 3½d. for motive-power purposes. The following discounts in respect of the consumption of electricity will be allowed: for an annual bill amounting to £25 and under £50, 3 per cent.; to £50 and under £100, 5 per cent.; and to £100 and upwards, 10 per cent.

The Corporation will lay the service line from the main to the meter, and, with the exception of the portion of the service line extending from the main to a point 10ft. within the boundary of the consumer's premises, or to the meter, if it be situated within that distance, will charge the consumer for the whole thereof. The portion excepted will be laid without charge to the consumer.

The charges to consumers for service line to supply 16-c.p. 60-watt lamps, or their equivalent, will be as follows: not exceeding 15 lamps for a distance of 50 yards, 3s. 6d. per yard; not exceeding 15 lamps for a distance of 100 yards, 3s. 10d. per yard; exceeding 15 lamps and not exceeding 20 lamps for a distance of 50 yards, 3s. 8d. per yard, etc. The meter and service switch will be supplied by the Corporation to the consumer on hire at rents varying from 4s. 6d. per quarter for 15 lamps to 12s. per quarter for 300 lamps.

Conclusion.

As mentioned early in this article, the Brush Electrical Engineering Company, Limited, have, with the exception of the erection of the buildings, carried out the whole of the undertaking, Mr. W. Geipel, their superintending engineer, having control of the work, assisted by Mr. S. A. Mahood, their resident engineer. The general supervision of the station has been in the hands of Mr. W. H. Preece, who had been aided by Mr. A. H. Preece, Mr. T. Caink (the borough engineer), and Mr. F. R. Davenport, whilst Mr. Leonard Wigan, A.M.I.C.E., has been clerk of works. To Messrs. Geipel, Caink, and Wigan, and others interested in the station we have to tender our thanks for their kind assistance in the preparation of this article.

The Worcester electricity works have been well designed and brought successfully to their present position, and both the contractors and the Corporation are to be congratulated upon the fact. There are about 10,000 houses in the city, and apart from the arc lighting, the central station commences with the satisfactory number of 4,000 lamps connected to the mains. Mr. T. Caink, whose portrait is reproduced at the commencement of this description, will

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act as electrical engineer, and under his guidance the station promises well.

The supply of gas which is provided by the Worcester New Gaslight Company is sold at 3s. 7d. per thousand, with a discount of 10 per cent. on quarterly accounts paid within a month. At this rate, and bearing in mind the charge of 5d. per unit for current, the Corporation electricity works should prove to be a formidable competitor. In conclusion, two more interesting facts are worthy of record. One is that the lodge gates belonging to the Hon. A. Percy Allsopp, M.P., whose residence is situated four miles from the generating station, are opened and closed by electric motors energised from a main laid down specially for the purpose. The second fact is that applications for a supply of some hundreds of lamps have been received from Malvern, seven miles distant.

ELECTRICAL EXHIBITION.

In connection with the opening of the station, an electrical exhibition is being held in the Public Hall—it being opened yesterday afternoon. It will remain open until the 20th inst. The arrangements of the exhibition have been carried out by Mr. F. R. Davenport, who has been testing the mains. The exhibits include all kinds of electrical lamps, fittings, and appliances, electric motors, dynamos, engines, and other applications of electricity. The small hall is occupied by Messrs. Crompton and Co. with an exhibition of appliances for electric cooking, special demonstrations being given. The exhibitors include Messrs. Phillips, 175, Oxford-street, W.; Mr. J. F. Santouna, 34, Sidbury, Worcester; Messrs. F. and C. Osler, 100, Oxford-street, W.; Messrs. B. Verity and Sons, London; the Edison and Swan United Electric Light Company, Limited, London; Messrs. T. W. Scott and Co., 28, Broad-street, Birmingham; the Brush Company; the New British Installation Contractors, Limited, Worcester; the National Telephone Company, Limited; Messrs. Wyndham and Seward, 57, Oxford-street, Derby; and Messrs. John Cam and Sons, Shambles, Worcester.

CITY AND GUILDS OF LONDON INSTITUTE.

LECTURE V.—FORMULÆ AND EXAMPLES CONNECTED WITH OHM'S LAW.

(Specially contributed.)

I have referred to the various tables supplied by manufacturers. In almost every case the area of the conductor is given both in English and French measurements—the one in square inches, the other in square metres or square millimetres. In fact, all business men have now to familiarise themselves with both systems of measurement. Thus while our standard of length is the yard, that of the French is the metre. Our yard is 36in. long, the metre is 39·37in. This standard is divided into tenths, hundredths, etc.; the tenths are called decimetres, the hundredths centimetres, and the thousandths millimetres—thus:

One metre	= 39·37	inches.
One decimetre	= 3·937	,,
One centimetre	= ·3937	,,
One millimetre	= ·03937	,,

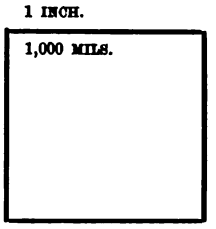
On the other hand,

One inch = 25·4 millimetres.
,, ,, = 2·54 centimetres.

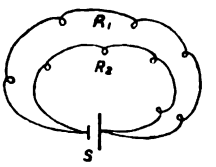
There is just one other measure I would mention now. It is called a *mil*, and is one-thousandth of an inch.

One inch = 1,000 mils.
One mil = ·001 inch.

This latter is an important measure, for many of our rules and regulations are based upon a current of 1,000 amperes per square inch as the maximum allowable; and as one square inch contains 1,000 × 1,000 square mils, this current gives one ampere to every 1,000 square mils. The greatest currents used are those in connection with electric welding. Thus for welding copper some 60,000 amperes per square inch of metal are required, which is 60 times the maximum allowed for lighting purposes.



It is seldom that resistances are in series, so that the total resistance of a circuit is seldom the sum of the separate resistances. Suppose we have a circuit with two



external resistances arranged as in the diagram: The total resistance of that circuit is

Internal resistance of battery + external resistance.

The external resistance is the joint resistance of the two resistances.

Call these resistances respectively R_1 and R_2;
the joint resistance R;
the internal resistance r.

Let us assume r to be so small as to be negligible

Now current C_1 through $R_1 = \frac{E}{R_1}$;

,, C_2 ,, $R_2 = \frac{E}{R_2}$;

and if total current = C,

then $$C = C_1 + C_2 = \frac{E}{R_1} + \frac{E}{R_2}.$$

If E = 1,

this becomes $$C = \frac{1}{R_1} + \frac{1}{R_2} = \frac{R_2 + R_1}{R_1 R_2}.$$

But current C is inversely as resistance R, therefore the total resistance R must be $= \frac{R_1 R_2}{R_1 + R_2}$.

If we have three parallel resistances, R_1, R_2, R_3, then the joint resistance is

$$R = \frac{R_1 R_2 R_3}{R_2 R_3 + R_1 R_2 + R_1 R_3}.$$

If there are n such resistances, then total resistance is

$$\frac{\text{Product of } n \text{ resistances}}{\text{Sum of products of resistances taken } (n-1) \text{ together}}.$$

Example.—Find the joint (total) resistance of two conductors having respectively four and five ohms resistance:

$$R = \frac{R_1 R_2}{R_1 + R_2} = \frac{4 \times 5}{4 + 5} = \frac{20}{9} = 2\cdot\dot{2} \text{ ohms.}$$

Example.—Find joint resistance of three conductors having respectively four, five, and six ohms resistance:

Putting values in formula,

$$R = \frac{4 \times 5 \times 6}{(4 \times 5) + (4 \times 6) + (5 \times 6)} = \frac{120}{74} = 1{\cdot}6 \text{ ohms.}$$

If the several resistances making up the circuit are similar, and each of the same resistance, then

$$\text{Total resistance} = \frac{\text{Resistance of one branch}}{\text{Number of branches}} = \frac{R_1}{n}.$$

Example.—What is total resistance of 10 conductors each having five ohms resistance?

$$R = \frac{5}{10} = \tfrac{1}{2} \text{ ohm.}$$

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Example.—The joint resistance of two wires in parallel is two ohms. One wire has a resistance of five ohms: what is the resistance of the other?

$$R = \frac{R_1 R_2}{R_1 + R_2}, \text{ or, putting in known values, } 2 = \frac{5 R_2}{5 + R_2}$$

$$= 10 + 2 R_2 = 5 R_2 — i.e., 3 R_2 = 10, R_2 = \frac{10}{3} = 3\cdot\dot{3} \text{ ohms.}$$

I have said that the total resistance of the circuit is the sum of the internal and external resistances. This must never be forgotten. Usually it is the resistance of the external circuit that can be varied at will, and the internal resistance may generally be taken as constant.

We may take an example or two where French measures are used. Thus:

Example.—Two wires of same length and material have resistances four and nine ohms respectively. The diameter of one wire is 1mm. (millimetre), what is the diameter of the other?

$$\frac{R}{R_1} = \frac{d_1^2}{d^2};$$

putting known values,

$$\frac{4}{9} = \frac{d_1^2}{1^2}, \text{ or } \frac{4}{9} = d^2,$$

whence

$$d = \sqrt{\frac{4}{9}} = \frac{2}{3} = \cdot\dot{6}\text{mm.}$$

Example.—A mile of wire 2mm. in diameter has a resistance of 13 ohms: what is the resistance of 440 yards of wire of similar material 0·8mm. diameter?

$$\frac{R}{R_1} = \frac{L d_1^2}{L_1 d^2};$$

putting known values,

$$\frac{13}{R_1} = \frac{1{,}760 \times \cdot 8^2}{440 \times 2^2},$$

$$\frac{13}{R_1} = \cdot 8^2,$$

whence

$$R = \frac{13}{\cdot 64} = 20\cdot 3 \text{ ohms.}$$

Perhaps you will think I am giving you too much of these calculations, but, as I have before said, you must familiarise yourselves with them, and cannot work too many examples. It may be that the various tables give most of the results required in practice, and a glance shows the maximum current allowed for the various wires. Thus $^7/_{18}$'s S.W.G. have an area of ·0129 square inch, or, say, $\frac{13}{1000}$ of a square inch. If, then, one square inch, or $\frac{1000}{1000}$, carries 1,000 amperes, the $^7/_{18}$'s may carry 13 amperes. Similarly, $^7/_8$'s have an area of ·1435 square inch, and so may carry 143 amperes.

Once more let us look at the formula which symbolises Ohm's law—

$$C = \frac{E}{R}, \text{ or amperes} = \frac{\text{volts}}{\text{ohms}}.$$

We have seen how the total resistance of the circuit is made up, but we have not as yet considered its variability. The resistance of any circuit—simple or complex—is only constant when the temperature is constant. In some cases the raising of the temperature increases the resistance of the conductor; in a few cases the resistance diminishes with rise of temperature. At present I shall only touch upon the fact that ordinary copper conductors rise in resistance as the temperature rises. In England rise or fall of temperature is usually expressed in degrees Fahrenheit, though in scientific circles and abroad it is usually expressed in degrees Centigrade. The Fahrenheit scale marks freezing point at 32deg., and boiling point at 212deg., while the centigrade scale marks freezing point at 0deg., and boiling point at 100deg.—that is:

180deg. F. = 100deg. C.
9deg. F. = 5deg. C.
1deg. F. = $\frac{5}{9}$deg. C.
$\frac{9}{1}$deg. F. = 1deg. C.

It has been found by experiment that the resistance of pure copper increases by ·215 per cent. per degree Fahrenheit, or ·387 per cent. per degree Centigrade.

Messrs. Glover and Co. give the following table relating to resistance and temperature:

Metal.	Variation of R for Temp. Fahrenheit per deg. per cent.	Centigrade per deg. per cent.
Copper	·215	·387
Iron	·388	·700
German silver	·024	·044
Platinum-silver (2oz. silver, 1oz. platinum)	·017	·031
Manganin (manganese, nickel, copper)	·000025	·000045

Now, in actual work all conductors are heated by the passage of a current, and unless the current is too strong they are heated to such a temperature that the radiation of heat from the conductor is exactly equivalent to the heat generated by the current. If the current is too strong the temperature of the conductor continues to rise till it gets red, white hot, or fuses. You will at once understand that if a conductor is continuously radiating heat, and the heat thus radiated is renewed by the action of the current, there must be a continuous loss, a loss measured by the amount of heat radiated. I shall have to deal more fully by-and-by with this heating effect. Meanwhile we will restrict our attention to the increase in resistance.

An increase of resistance of ·215 per cent. means that a resistance of 100 ohms would increase to 100·215 ohms by a rise in temperature of 1deg. F. If the rise was 20 deg., then the resistance would be

$$100 + (20 \times \cdot 215);$$
$$= 100 + 4\cdot 3;$$
$$= 104\cdot 3.$$

You will see that this rise of temperature, a rise which is not infrequent, plays its part in working operations. The voltage that will drive a required current through a circuit of 100 ohms resistance will not drive that current through a circuit of 104 ohms resistance. Hence, if the current must be constant, a little higher voltage must be had when the circuit is raised in temperature than when at the lower temperature. I think I have now given you general notions sufficient to enable you to see the relations between current, resistance, and E.M.F.—that is, between amperes, ohms, and volts—that will be required for our immediate purpose.

MESSRS. SIEMENS BROS. AND CO.'S WORKS.

On Tuesday last a visit was paid by the Society of Engineers to Messrs. Siemens Bros. and Co.'s works at Charlton. Among those present were Mr. George A. Goodwin (president); Mr. H. Adams, Mr. C. Gandon, and Mr. J. W. Wilson, jun. (past-presidents); Mr. G. M. Lawford (member of council); Messrs. A. J. Bailey, W. Benbow, D. B. Butler, P. J. Dawson, B. P. Ellis, G. Garnett, E. E. Glaskin, P, Griffith, N. Harker, W. F. C. Hill, F. Hovenden, T. Huard, W. R. Manning, C. Mason, M. Mildred, J. A. Mingay, H. F. Packham, J. W. Ransome, W. F. Richmond, F. A. Robinson, S. Simmelkjor, E. H. Toulmin, A. Wollheim, R. G. Young, and G. A. Pryce Cuxson (secretary). All the machinery in the shops is driven by electric motors.

(1) *New Dynamo-Shop.*—The work carried on consists of the construction and erection of dynamos and alternators. The plant comprises two overhead travellers—(*a*) mechanical, lifts 10 tons, power transmitted by square shaft and gearing; (*b*) electrical, lifts five tons, one motor for each motion. Motors are 7 h.p., 6 h.p., and 5 h.p. respectively. Large facing lathe for central plates of alternators. Various lathes for turning and for boring out gap for armature in magnets. Drills, working up to a hole 4in. in diameter. Planing machines, the largest working over a surface 16ft. by 6½ft. (The steam-engine here is used only for testing dynamos, and does not drive the countershafting.)

(2) *Old Dynamo-Shop.*—General erecting work is carried on here. Small lathes, drills, and boring-machines. Punching-machines for iron cores of armatures, and copper end connections.

(3) *Milling-Shop.*—This contains milling-machines for small parts of machines which are required in large numbers. Capstan-headed lathes for screws, nuts, etc. Grinding-machines.

(4) *Gallery.*—Shaping and insulating parts of dynamo armatures and commutators.

(5) *Bobbin-Shop.* — Winding armatures and electromagnet bobbins.

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(6) *Fitters' Shop.*—General fitting work. Lathes, drill, etc. Several driven by separate motors directly geared to them.

(7) *Carbon-Shop.*—The raw material is ground under edge-rollers, mixed, warmed, moulded into a round block, and then placed in the hydraulic press, whence it issues as a carbon rod. These are cut to length and then baked in ovens, first at a red heat, then at a white heat, after which they are slowly cooled down. Each furnace holds about 4,000ft. of 10mm. carbons.

(8) *Rubber-Shop.*—The raw rubber passes first through the washing-rolls, under a stream of water to rid it of mechanical admixtures such as sand, bark, sticks, etc. It is then dried for some time, after which it goes to the mixing-rolls, where various mineral substances are incorporated with it, according to the nature of the use which is to be made of it. The mixing-rolls are hollow, and steam or water can be allowed to circulate through them. The prepared rubber is then passed through the calendering-rolls, after which it is ready for the covering machines. Three layers are generally put on the stranded conductor—firstly, the brown pure rubber, then the white separator, and, finally, the pink jacket; the wire is then taped and taken to the vulcanisers, which are heated by steam. After vulcanising, the wire may be finished off in different ways—as braiding, covering with ozokerit, sheathing, etc.

(9) *Central Power and Lighting Station.*—The plant comprises three tubular boilers of gunboat type (two more in course of erection), each 18ft. long by 9ft. diameter, 400 i.h.p. each, 140lb. steam pressure (steam is largely used for heating purposes as well as for the engines). Four engines: one Belliss compound vertical enclosed, 300 i.h.p., running at 350 revolutions per minute; cylinders, 15in. and 23in. by 10in. stroke. Three Willans compound transfer condensing, I I I type, 300 i.h.p. each, running at 350 revolutions per minute; cylinders, 14in. and 20in. by 9in. stroke. Four dynamos, coupled direct to above engines, Siemens H.B. $^{21}/_{30}$ type for 120 volts, 2,000 amperes. Switchboard with regulating switches and measuring instruments. The distribution of the electrical energy is by means of underground lead-cased cables. Over the boilers are the condensers, consisting of 27 double-concentric cylinders; the steam passes through the annular space, while cooling water runs down inside and out. This water is used over and over again. There are in all 54 electric motors in the works: 13 of 40 h.p. each—four of these in the rubber-shop are directly connected by spur gear to the rolls; seven of 20 h.p. each; two of 15 h.p. each—these are directly coupled to a worm shaft driving the calendering-rolls in the rubber-shop, and are constructed to run at two different speeds; eight of 10 h.p. each—one of these is directly coupled to a cable machine, another works the lift in the rubber-shop; 24 of various powers, from 10 h.p. to ½ h.p., mostly directly coupled to lathes and other machine tools.

(10) *Switchboard Erecting-Room.*—All the regulating and starting switches and measuring instruments required for large central stations are put together here on massive slate slabs.

(11) *Cable-Shop.*—The deep-sea section of the third Atlantic cable for the Commercial Cable Company is in the course of manufacture. The served core passes into the rear of the machine through the hollow shaft which carries in an iron frame the bobbins for the sheathing wires. On rotating the frame carrying the bobbins, the cable being at the same time drawn along, the wires are laid spirally round the core. The bobbin carriers are actuated by cranks worked by an eccentric, so as to maintain always the same relative horizontal position, thus obviating any twist in the wires. After the sheathing wires, the cable receives finishing layers of jute yarn and compound. With "Jumbo," the largest cable machine, 64 sheathing wires can be put on in one operation. The rate of working is about five nautical miles of deep-sea cable per machine per 24 hours.

(12) *Tank-Houses.*—From the cable machines the cable is led directly into cylindrical iron tanks, where it is coiled away and kept under water. There are 10 tanks each for 150 to 200 knots of cable, and eight tanks each for 400 knots of cable.

(13) *Lead Cable-Shop.*—For the manufacture of lead-cased iron-sheathed cables for the underground distribution of large currents for electric light and power. The large stranding machine can lay up 37 wires at one operation. This strand is then covered with jute, dried, soaked in insulating material, and passed up through an hydraulic press. In this latter is a large ingot of cold lead, which under a pressure of 400 atmospheres is forced to flow out of the nozzle in a continuous pipe surrounding the wire. The final operation consists of serving it with jute and sheathing it with steel bands. These cables are intended to be buried directly in a trench dug in the ground.

(14) *Showroom.*—A museum of all kinds of electrical and telegraphic instruments and apparatus, both historical and novel.

Brazilian Submarine Telegraph Company.—The directors propose a balance dividend of 3s. per share, making a total distribution of 6 per cent. for the year ended June 30, and a bonus of 1s. per share. The sum of £15,000 is to be added to reserve, leaving £1,501 to be carried over.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Wootton-under-Edge.—Tenders are wanted for lighting the town.

London, W.C.—Mr. John Annan, manager for Mr. Samuel Wheeler, "Official Receiver in Companies' Liquidation," acting as liquidator of J. W. Hobbs and Co., Limited, is prepared to receive tenders for the supply and erection on foundations, etc., provided by contractor in the hotel in course of completion on the Salisbury Estate, Victoria-embankment, of the following plant: (Section A) boiler-house plant—boilers and fittings, feed heaters, electric feed pump, injector, water-tank, steam, exhaust, feed, blow-off, and sundry pipes and valves, etc.; (B) engine-house plant—oil-tank, steam dynamos, oil filter, workshop fittings, ventilating fan, etc.; (C) switchboard, instruments, and meters. Tenderers are at liberty to tender for any section or sections, or for the whole of the sections, but not for part of a section. The ground plan of the buildings, and the specification, with terms and conditions of tender and contract, may be obtained at the offices of Mr. R. Hammond, the consulting engineer, Ormond House, Great Trinity-lane, London, E.C., on payment of £2. 2s. Tenders to be addressed to Mr. J. Annan, 2, New-court, Carey-street, Lincoln's-inn, London, W.C., by 26th inst.

RESULTS OF TENDERS.

Lancaster.—The tender for the roof over the economiser at the central electric supply station, for the Town Council, by Mr. W. Richardson, has been accepted at £43.

BUSINESS NOTES.

Nottingham.—Many of the roundabouts at Goose Fair are lighted by electricity.

Western and Brazilian Telegraph Company.—For the past week the receipts were £3,186.

Appointment.—The City of Belfast want an assistant electrical engineer, at a salary of £120 a year.

Hull.—It is possible that the tramway system will be acquired by the Corporation and that electric traction will be introduced.

Bermondsey.—The electric light has been installed by Messrs. Tickner and Partington in the mills of Spratt's Patent, Limited, Bermondsey.

Colchester.—The Town Council have decided not to take at present any further steps for carrying out the provisions of the provisional order.

La Boite Magique, Limited.—This Company has been registered with a capital of £3,000 in £1 shares to carry on business as mechanical engineers, electricians, etc.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending 7th inst. amounted to £908, as compared with £666 in the corresponding week of last year.

Worthing.—The Town Council have adopted without discussion the minutes of the Electric Lighting Committee, which recommended the employment of a consulting electrical engineer to furnish plans and information.

Church-Lighting.—A large congregation attended on Sunday evening at Castle-gate Congregational Church, Nottingham, when the electric light was used for the first time. The work has been carried out by Messrs. Thomas Danks and Co., of Thurland-street, Nottingham.

Bangor (Wales).—The Town Council want an extension of the borrowing powers for gasworks. In a discussion on this subject Dr. Grey Edwards, one of the Council, objected to unnecessary expenditure on the works, seeing that there was a possibility of the electric light superseding gas.

Poplar, E.—The Board of Guardians have referred to a committee a letter from the Poplar Board of Works asking the Guardians whether, in the event of the Board installing electric light in the district, they would be prepared to take the same for their premises for a stated period.

City and South London Railway.—The receipts of the Company for the week ended October 7 were £892, against £816 for the corresponding week of 1893, or an increase of £76. The total receipts for the current period of the present half-year amount to £12,011, as against £11,296 in the corresponding period of 1893, an increase of £716.

Submarine Cables Trust.—This Trust notifies that on and after October 15 the sum of £1. 15s. on account of the coupon due the same date will be paid by Messrs. Glyn, Mills, and Co., of 67, Lombard-street, between the hours of 10 a.m. and 2 p.m. The coupons should be left with the bankers for examination four clear days before payment.

Fareham.—The sanction of the Board of Trade with reference to the purchasing of the Fareham Electric Lighting Company by the Local Board has been received. The central body state that they will "consent to the transfer of the undertaking on being assured that the electric lines referred to in the 82nd section of the order have been placed underground."

T. and R. Boote, Limited.—This Company has been registered, with a capital of £50,000, to acquire as a going concern the business of earthenware and tile manufacturers, stone and flint grinders,

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and manufacturers of electrical apparatus and appliances, now carried on at the Waterloo Potteries and Patent Tileworks, situated at Burslem, Staffordshire, under the style of T. and R. Boote.

Colchester.—The Lighting Committee of the Town Council have reported that only 14 replies had been received to the circulars sent to the inhabitants of the district it was proposed to light by electricity, the total number of lamps required being 152. The committee therefore recommended the Council not to take any further steps at present. The recommendation was adopted.

Change of Address.—Mr. A. H. Bayes, late of 34, Newnham-terrace, Westminster Bridge-road, has removed to 23, Western-street, Midland-road, Bedford. Messrs. Gilbert and Co. have now removed from Hanway-street to their new and more extensive works at 142A, Oxford-street, W., where they have increased facilities for manufacturing their specialities. Their office address will be at Kensington, as before.

Carlisle.—The Carlisle Gas Committee have considered the notice of application for a provisional order to supply Carlisle with the electric light, sent to them some time ago by the Brush Company, of London. They came to the conclusion that the best course to pursue would be to recommend the Council to apply to Parliament themselves for a provisional order to enable them to supply electric light to the citizens, and they accordingly passed a resolution to that effect.

Elmore Copper Tubes.—We are informed that Elmore copper tubes have been adopted by her Majesty's Government, and by the leading railway companies as a direct result of tests made in every instance. A number of steamships have also been fitted throughout with Elmore steam-pipes. It is stated that the prices at which Elmore tubes of 4in. diameter and upwards are now offered will render unnecessary the further use of brazed copper tubes, even on the plea of cheapness.

Bury.—At a meeting of the Electric Lighting Committee on September 4 there were present the Mayor (chairman), Councillors Butcher, Collinge, and Thornley. The borough engineer reported upon the tenders for the electric lighting plant and machinery, and the County Council this week resolved that an opportunity be given the whole of the persons originally tendering to submit fresh tenders for the continuous-current plant already adopted, and that the time for tendering be extended to October 15.

Wells.—The Lighting Committee of the Town Council have reported that it was desirable in the interests of the citizens to adopt the electric light for the city, but that it should be carried out by the Urban Sanitary Authority, and that the town clerk should ascertain from other towns where similar works have been carried out the name of a competent engineer to advise the Authority, and report the same at the next meeting. After a long discussion the recommendations of the committee were adopted.

Cheltenham.—The Mayoress (Mrs. Wethered) has laid the memorial-stone at the new electric lighting station, at the ash-destructor, near the Midland Railway. The system of lighting adopted is that of the high-pressure alternating, and the current will be supplied to customers at the price of 6d. per Board of Trade unit, with rebates to large consumers. The undertaking is in the hands of the Corporation, who will for the present confine their attention to supplying private customers. The question of street lighting by electricity remains over for further consideration.

Edinburgh.—It has been remitted by the Town Council to the Cleaning and Lighting Committee to consider and report on the subject of lighting by electricity the following streets—viz., George-street, St. Andrew-square, South St David-street, South St. Andrew-street, South Hanover-street, South Frederick-street, South Castle-street, South Charlotte-street, Hope-street, and Charlotte-square. It was reported that the deputation to London to inspect the electric arc lamps had cost £29. 16s., equally divided between the two members, Bailie Dunlop and Mr. Mackenzie.

City of London Electric Lighting Company, Limited.—The return for the quarter ended September 30 states that the revenue from the sale of current for public lighting amounted to £3,142, as compared with £3,027 for the corresponding period of last year; that from the sale of current for private lighting £7,677, against £3,552, and the estimated revenue from other sources was £416, against £441; the gross amount being £11,235, an increase of £4,214. The equivalent of 8-c.p. lamps connected on September 30 shows an increase during the quarter of 13,724, the increase during the corresponding quarter last year being 7,526.

Wimbledon.—The Road and Drainage Committee of the Local Board have recommended that the Board take the necessary steps to carry out the surveyor's recommendation for a dust destructor. Mr. Casswell, in moving the adoption of the recommendation, said the amount of refuse to be disposed of was so large, and the sewage farm was being so overdone with sludge, that a destructor was becoming absolutely necessary. Mr. Olley seconded. Mr. Crickmay, in proposing that the matter be allowed to stand over for three months, said he was as much opposed to the scheme now as he had ever been. Mr. Donaldson seconded, and the amendment was carried.

Cartmel.—A correspondent has written to an Ulverston paper in regard to the want of railway communication. He says that the vale of Cartmel is not approached from either end save by the old mode of locomotion. He suggests that a meeting of the inhabitants of the several parishes in Cartmel should be convened to discuss the question whether it is not possible to prevail upon one of the railway companies to take the matter up, or in the alternative to form an independent company with a limited capital for the construction of an electric railway from Cark or Kents Bank, through the vale of Cartmel to Newby Bridge and Bowness, with a possible extension in the future to Coniston and other parts of the Lake District.

Portsmouth.—The electric light in Portsmouth is an almost unqualified success, says the *Hampshire Telegraph*. The street-lighting is brilliant, and in spite of its greater cost than gas the inhabitants in some districts not served by it are pleading for an extension of the system. As for the house and shop lighting, it has given general satisfaction. All who use the incandescent electric light are loud in its praises. They speak of the purer atmosphere, the better light, and the greater comfort in working. With regard to the cost, they say the extra sums they have to pay are more than outweighed by the advantages, especially in those businesses where the use of gas has a deteriorating effect upon the goods exposed to it.

Motherwell.—The Motherwell Police Commissioners have received a report from Mr. Mavor, electrical engineer, Glasgow, regarding the introduction of electric lighting into the burgh, in which he stated that electric lighting might be introduced with good prospects of success. The cost of erecting a station in Motherwell he estimated at £12,500, including the cost of obtaining the provisional order and making suitable provision for possible extension. The Board, having regard to the fact that a private company intended to apply shortly for a provisional order to light the town, agreed unanimously to adopt the report, and take the necessary steps to carry out the scheme, which, it is believed, will not increase the rating of the burgh.

Liverpool.—Mr. Meade-King, at a meeting of the Town Council, drew attention to the lighting of St. George's Hall and the Municipal Offices, and said he thought the time had arrived when the incandescent electric light, which had been so generally adopted, should be used in those buildings. Alderman Rathbone said the question had been before the sub-committee over and over again, and was still before it, and he thought they could go into the question next year. A great many experiments had been tried with regard to electric lighting, some of which had not been successful, and it was simply a question as to when was the best time to make the change. No doubt such a change would have to be made; it was only a question of time.

Hampstead.—The Vestry have decided to insure the electric supply station and plant against fire for £15,000 on a general policy, the boilers for £2,000, and the economiser for £300. Mr. Preece is to report whether, in the event of the mains for the private lighting being extended, it is advisable to lay at the same time an extra main for the public lighting. A memorial has been received from a number of shopkeepers in Fairfax-road, asking that the electric light might be supplied to their places of business. A letter has been received from Messrs. R. Dellagana and Co., of 10, Gayton-road, photo-zinc etchers, referring to the necessity of an early extension of the electric lighting plant required in their business, unless the Vestry were prepared to supply them.

Acton.—Mr. William Terriss, of Bedford-park, has written to the Local Board asking if there was any probability of the electric light being installed in Acton, as he and many other residents in Bedford-park would be glad to use the light. The Works Committee reported that they had instructed the clerk to reply to Mr. Terriss's letter, but no information was vouchsafed by the committee as to the nature of the clerk's reply. The Chairman said it would be well to keep Mr. Terriss's letter. The Board had now several applications for the electric light. At a later stage of the meeting the chairman observed that several firms were now making tentative offers for the purchase of the Board's electric lighting order. The Board decided to give the competing firms a month in which to prepare their tenders.

Birmingham Tramways.—An extraordinary general meeting of the Birmingham Central Tramways Company, Limited, was held on Wednesday, when the following resolution was passed: "That the capital of the company be reduced from £500,000 (divided into 10,000 fully paid-up 5 per cent. guaranteed shares of £10 each, and 40,000 ordinary shares of £10 each, of which 38,000 are fully paid up, and 1,200 have not been issued or agreed to be issued) to £300,000, divided into 10,000 fully paid-up 5 per cent. guaranteed shares of £10 each. and 38,800 fully paid-up ordinary shares of £5 each, and 1,200 unissued ordinary shares of £5 each; and that such reduction be effected by cancelling capital which has been lost or is unrepresented by available assets to the extent of £5 per share upon each of the said 38,800 ordinary shares which have been issued and are now outstanding, and by reducing the nominal amount of such 38,800 ordinary shares and of the said 1,200 unissued ordinary shares from £10 to £5 per share."

Brighton.—At a meeting of the Lighting Committee of the Town Council it was resolved to place a brass tablet on the electric lamp-pillar at the bottom of Regency-square, at an estimated cost of £3. 10s, bearing an inscription commemorating the inauguration ceremony of lighting the front by electricity performed by the Mayoress (Miss Ewart) on September 16, 1893. The confirmation of the proceedings having been moved, Alderman Hawkes expressed the opinion that the names of the Mayor and Mayoress and the members of the committee should be placed on the tablet. The Mayor said there would be no room on the tablet for the names. Besides, only one name need be put upon it, that of the Mayoress. Alderman Reeves thought it would be only doing what was customary to put the names on the tablet. Alderman Lowther pointed out the difficulty of putting a lot of names on the tablet, and Councillor Berry, in reply, said he thought it was quite sufficient to record that the Mayoress switched on the light.

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The amendment on being put was lost, and the proceedings were passed.

Whitehaven.—Mr. Jonathan Cant, who is seeking re-election on the Town Council, in the course of an address to the ratepayers has stated that he was an opponent of the attempt of the gas company to monopolise the lighting of the town, and a supporter of the adoption of electric light, which was likely to be a very great success. From figures submitted at the trustee meeting it appeared that for the first year there had been a profit of £143. The present supply of electricity was fully taken up, and they required to have two more sets of engines and dynamos. A further statement of the probable result after those had been erected, showed that the profit would then be £232 Besides that, at the end of the 20 years for which they had borrowed their money for the works, the whole of the present debt on electric lighting account would be repaid, and the present plant would belong to the town, and be absolutely free, so that they would then probably be able to have electricity very much cheaper than they had at the present time, or, if not, their profit must necessarily be much greater than it was now.

Stafford.—The Electric Lighting Committee recommended to the Town Council the acceptance of Messrs. Siemens Bros. and Co.'s tender for £1,290 for supplying conductors on the three-wire system. They also recommended that the electric department of the Corporation should keep a staff of their own for wiring just as the gas department did for pipe-laying. It was also thought best to excavate the trenches for the conductors by the Corporation's servants. The tender of Messrs. W. G. Bagnall and Co., Limited, for £75 for overflow main and exhaust pipe for engines was recommended for acceptance. Alderman W. H. Peach moved the adoption of the report. The tenders for conductors had been referred to Dr. Hopkinson, and he recommended the acceptance of Messrs. Siemens Bros.', and should have done so if it had not been the lowest. He had had experience of Messrs. Siemens's work at Whitehaven, and they had always given perfect satisfaction. Dr. Hopkinson strongly recommended the acceptance of the tender. The various works at the electric lighting station were progressing satisfactorily. Mr. G. J. Flamank seconded the adoption of the report, which was carried.

Luton.—The Highways and Lighting Committee reported to the Town Council last week that the town clerk had brought up the resolution passed by the Town Council at their meeting on the 18th ult. requesting the committee to bring up a report upon the probable cost of obtaining a provisional order for the supply of electricity for public and private purposes in the borough and as to the desirability or otherwise of applying to the Board of Trade for such order. After consideration of the question it was resolved and ordered that the town clerk prepare a series of queries upon the subject-matter and forward the same to boroughs where electricity is used. At an adjourned meeting on October 1, the town clerk reported that in compliance with instructions he had prepared and forwarded to 51 town clerks a series of questions as to electric lighting, that he had received 44 replies, and that he had such queries and answers and caused the same to be printed. It was resolved that in consequence of the voluminous nature of the document so prepared, and owing to the impossibility of duly considering the same, a special meeting of the committee be held on Friday, the 12th inst., to consider the whole question, and prepare and submit a report thereon to the Town Council at their meeting on the 16th inst.

Bournemouth.—The Electric Lighting Committee of the Town Council reported last week that they had received a letter from the secretary of the electric supply company offering reduced terms for the electric lighting of the Winter Garden, and also a letter from Messrs. Roger Dawson, Limited. The committee recommended that the town clerk reply that the Council are not prepared to accept the terms proposed, but would be willing to enter into an agreement for 5½ years, as from September 29, on being allowed a discount of 40 per cent. on the current price for the time being, instead of 15 per cent. as at present. A letter had been received from the Local Government Board asking for a copy of the approval of the Board of Trade to the system proposed to be adopted, and as to the advisability of providing an additional small engine The committee recommended (1) that the surveyor prepare a statement of the system proposed, and that the town clerk apply for the sanction of the Board of Trade to the same; (2) that the town clerk, on the receipt of such approval, forward a copy of it to the Local Government Board; and (3) that the town clerk reply to the other portion of the above letter that the Council had considered the point raised by the Board, and did not think it advisable or necessary to provide another engine. These reports were adopted.

Bradford.—On Tuesday, at a meeting of the Town Council, the minutes of the Sanitary Committee, the adoption of which was moved by Mr. L. Walker, the chairman, and seconded by Mr. M. O'Flynn, stated that at a meeting held on September 18 the committee inspected the electric light installation recently provided at the Hammerton-street destructor works. Mr. Hezekiah Lister asked when the "mountain" at the Southfield-lane destructor was to be removed. Had an arrangement been made with respect to the removal of the nuisance caused by this great heap of refuse? If not, he hoped that steps would speedily be taken to remove it. Mr. J. S. Toothill said he would be glad to know something more about the electric lighting installation at the Hammerton-street destructor. Mr. Walker, in reply to Mr. Lister, said that they had already begun to lead the "clinkers" away from the Southfield-lane destructor, and no more "clinkers" would be put on the hill. With respect to the electric light at the Hammerton-street destructor, the installation was not costing more than £100. The work, it was expected, would be completed this week. The gas bill for the destructor was £57 per annum, and the committee hoped that in a year or two they would be able to pay the whole of the expense of the electric plant out of the saving effected by using the electric light instead of gas. The minutes were adopted.

Folkestone.—When the Town Council met last week, Councillor Thompson drew attention to the electric wire being placed over the public highway Sandgate-road and West Cliff Gardens. He said it was absolutely necessary that they should know their position in reference to the matter. If a private individual could do what was being done now, it must prejudice in future the Corporation in introducing electric light, and still more would it prejudice their powers to part with their provisional order, should they ever obtain one, to a private company. It was not only the fact of overhead wires, but they had also had their pavements taken up for the purpose of laying down electric wires, and he thought they would all agree that they ought to take some action in order to ascertain what powers they did possess, and what their real position in the matter was, and what the Board of Trade would do under the circumstances. None of them would object to the parish church being supplied with electric light in itself, but it was necessary for them to ascertain what their real position was. He moved that the town clerk be directed to report to the Board of Trade the fact that a private individual was supplying electric light by means of overhead wires, and that the Board of Trade be requested to take the necessary steps under the Electric Lighting Act of 1888. Councillor Pursey seconded the motion, which was adopted.

Newport (Mon.).—Mr. F. Phillips at a meeting of the Corporation, referring to a clause of the Works Committee which left the question of the number of electric lights and the kind of fittings for the Town Hall and other public buildings to a sub-committee, spoke of the need of putting practical men, such as Alderman Huzzey, on the sub-committee. He did not think men who had not had that experience were able to deal with the matter, and moved that the matter should be reconsidered. Mr. Wilkinson (filling up the pause): Well, sir, for the sake of discussion, I will second it. Alderman Moses said the duties of the sub-committee involved merely a question of taste in fittings. He, of course, yielded to others more endowed on matters of taste, but he did not think practical men were necessary in such a matter. Besides, to increase the sub-committee would increase the expense. Mr. F. Phillips: I do not object to Alderman Moses. Mr. Greenland: I suppose my friend objects to me. As far as I understand, it is a matter of taste of certain brass and iron pendants; but I do not feel that the question of taste is insurmountable as far as I am concerned. Mr. T. Jones thought the mover of the amendment altogether misconstrued the duties of the committee. It was merely to go to the manufacturers and select goods. Mr. Goldsworthy supported the report, and Mr. Parnall pointed out that the sub-committee would have the aid of the electrical engineer, who was thoroughly abreast of the latest types of goods. Afterwards the report was adopted.

Hereford.—The Gasworks Committee reported to the Town Council last week that they had received notice of the intention of the Great Western Electric Light and Power Company to apply for a provisional order to supply electricity within the district. They therefore recommended that it was desirable the Corporation should obtain a provisional order, and that the Council take steps as they might deem necessary to obtain the order. The Mayor moved that the report be adopted. With regard to the provisional order for electric lighting, the committee had thought it prudent to make application for such an order in self-defence. He might say that the credit of making the proposal might certainly be given to the town clerk, who called attention to the matter, and the committee then very properly adopted his recommendation. Mr. Williams seconded. The Deputy-Mayor said he should like to know a little more about the provisional order they were to embark upon. It was an Act of Parliament in a small way that they were going in for. He should like to know the position of things, what time they must move, what was to be done, and what expense they were to be put to in obtaining a provisional order; and, when obtained, whether the Council would be obliged to go on with the work, or whether the powers would lapse if they did not do so? This was a matter which ought to receive some consideration. He thought it had better be referred to a committee, so that the subject might be considered in all its bearings. After further discussion the subject was referred to the Finance Committee for consideration.

Larne.—A number of complaints with regard to the unsatisfactory state of the lighting of the town was made by several of the members at a meeting of the Town Commissioners. Mr. Foster complained of the state of the lighting arrangements in the town at present. In the neighbourhood of the Roddens—a portion of the town where there were many gentlemen's residences—the lamps were very frequently out, and one evening recently not only that portion of the town, but Mount-pleasant and Fair-hill, were in darkness. Mr. Picken also complained of the badly-lighted state of the Curran. Mr. M'Cay stated that the residents of the Bank-road had just cause to complain of the unsatisfactory state of the light in that district. Mr. Fullerton entered into an elaborate explanation in defence of the electric company, which, he said, was doing its best to meet the wishes of all concerned, and had, he thought, given every satisfaction of late. With regard to complaints of lamps going out, he thought people should exercise a little forbearance, as accidents rendered it necessary that the light should be out occasionally. He added that Bailie Crawford, of Glasgow, who was recently on a visit to Larne,

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expressed the opinion to him that it was the best-lit country town he had ever been in. Mr. Foster took exception to the fact that 100-c.p. lamps had been erected at the open, where the Board were paying for 1,200 c.p., and he understood that for this 100 c.p. it was proposed to charge them £9, while the price in the schedule for a 500-c.p. lamp was £7. 10s. This discussion, which lasted almost an hour, was finally ruled by the chairman out of order.

Southport.—In moving the minutes of the Gas and Electricity Committee at Tuesday's meeting of the Town Council, Alderman Robson referred to the resolution passed by the committee—"that the price of gas for all purposes other than lighting be reduced 6d. per thousand cubic feet, provided the gas is supplied through a separate meter"—and expressed the opinion that it would be unwise to adopt such a plan. If they granted these advantages to those who consumed gas, they would have to do the same in respect to the electric light consumers. Moreover, he contended that all ratepayers who consumed gas should be treated alike. With respect to the recommendation of the committee that the tender of the Fowler-Waring Cables Company, Limited, to supply 1,200 yards of high-tension cable for Scarisbrick New-road at £57 per mile be accepted, he said that it meant an entire change in the system of electrical distribution—a change which had been strongly condemned by their electrical engineer. Councillor Hesford said this step was taken under the exigencies of circumstances, and on the advice of their electrician. The work of constructing their electricity supply works was so far advanced that by November 9 they would be able to turn the electric current into the mains. It was proposed on that occasion to illuminate the Town Hall and the Cambridge Hall, and the trees and gardens in front, with incandescent lamps. Alderman Fisher said the main object of the committee in passing the resolution with regard to the reduction of the price of gas was to keep the works constantly going in summer as well as in winter. After an unusually lengthy discussion, the minutes were passed.

Canterbury.—The Electric Lighting Committee of the Town Council reported as follows: A letter from Messrs. Mowll and Mowll, of August 20, as to the price of the electric light and the power of same was read, and it was resolved that the Brush Company be asked to send down their engineer to inspect the city streets and to consult with the committee as to the position and number of electric lamps which it is desirable to have erected. A sub-committee, consisting of Alderman Mount, Councillors Warren and Mourilyan, were requested to meet the engineer. Councillor Dean said he saw the sub-committee was to meet the engineer to the Brush Company, and he asked had the Council decided that they were going to give the company the lighting? The Mayor said no. The engineer was only coming down for purposes of information. The Town Clerk, explaining, said the sub-committee were going round with the engineer practically in order that the company might "make out their case" as to the desirability of the electric lighting. An appointment was made, but shortly before the time fixed the engineer telegraphed to say he could not come at the arranged time. The Surveyor stated that he had had a letter from Messrs. Mowll and Mowll to the effect that the engineer would come down next week and would let them know the day. Alderman Cross said it would be very desirable that the inspection should take place after dark. Alderman Mason said he really hardly knew what the engineer was going to do. The surveyor already had a plan showing the places where it was thought desirable these standards should be placed, and what the Council really wanted to know was how many ordinary gas lamps these electric lighting lamps would replace, and the difference of the cost, in order that the Council might then consider whether it would be worth while to enter into a contract for the public lighting or not. The matter then dropped, and the report was confirmed.

The Electric Tramway to Kingstown and Dalkey.—The work of constructing the electric tramway between Haddington-road, Blackrock, Kingstown, and Dalkey will shortly be entered on by the Dublin Southern Tramways Company, who own the undertaking. The line is virtually owned by the Imperial Tramways Company, Limited, and at their recent meeting in Bristol some interesting facts in connection with the coming electric project were disclosed. The company's system will be reconstructed as double lines in connection with working the traffic by electric traction in place of animal power. The Thomson-Houston system is the one which the company submitted to the authorities when they were obtaining their Act, and the British company sent their engineer and traffic experts to Dublin to gauge the position for themselves, and from what they saw they formed a high opinion of the earning capacity of the line when worked by electricity. The present outlay on the laying of the double line, rearranging their Ball's Bridge depôt as a power station, and equipping the line with electric power and motor cars is estimated at about £70,000. Towards this outlay it is proposed that the Imperial Company shall raise by debentures £10,000 in cash, the remainder being mainly subscribed by the Thomson-Houston Company, while the permanent-way contractor, who shares their views as to the future success of the lines, will take up the necessary balance. The company's present gross receipts in Dublin are about £11,000 a year earned with a 15-minute service, which with horses is necessarily slow, but when the electric installation is made there will be a five minutes' service, and with an electric tramway worked at quick speed, the directors calculate that they will be able to cope with the very large traffic which is to be obtained in the district throughout the summer, as well as the influx of traffic on the numerous occasions of exhibitions, shows, and public entertainments at the Royal Dublin Society's grounds, which are direct on the line. The Thomson-Houston Company's experts are satisfied that the traffic will be so very materially increased, while the percentage of expenditure will be reduced on the present and increased traffic to 55 per cent., that there will be ample profit to pay the preferential charges on the new capital and leave a substantial dividend on the ordinary capital, all of which is owned by the Imperial Company. Dublin will shortly be placed in the position of a pioneer of electric traction for public streets and thoroughfares in Ireland, though in this matter Portrush has on a small scale the advantage.

Burton.—The Gas and Electric Lighting Committee reported to the Town Council that the mean illuminating power of the gas in standard candles had been 18·40. There was need for extending the area of the supply of the electric light, and the committee recommended that Mr. Ramsden, manager, should issue circulars to the residents of Ashby-road to ascertain how many would be willing to have the light if conveyed thither. The committee further asked for power to take the best professional advice as to the safest means to prevent further contamination of water in the neighbourhood of the gasworks. Alderman Lowe proposed the adoption of the report, and stated that at present the electric light was not a paying concern. If, therefore, they could extend its use by the laying of fresh cables, the committee thought it would be advisable to do so; hence, the recommendation to apply to the residents on Ashby-road. Councillor Graham, in seconding the motion, referred to the contamination of the water near the gasworks, and suggested that the Council should erect pumps which would over-balance those used by the brewers, and so prevent water which had passed by the gasworks being brought back again, as was the case at present. Alderman Evershed, while admitting that the brewers had been the innocent cause of scarcity of water among ordinary householders, warned the Council to think seriously over the matter before they embarked on a huge system of pumps as suggested. Councillor Morris remarked that the committee were almost unanimously in favour of something being done in the direction indicated by Councillor Graham. Alderman Lowe replied that the committee would not enter into a scheme of pumping which would entail a large or unnecessary expense, but they thought they ought to have advice as to the best way to put an end to the claims made against them for the contamination of the water supply. The proposition was then carried.

Cardiff.—During the consideration of the minutes of the Lighting and Electrical Committee at Monday's meeting of the Cardiff County Council, the Mayor (Mr. W J. Trounce) said he should like to know whether the information contained in the Press was accurate or not. There was no doubt that the electric lighting should have been completed months ago, and there was no reason for deferring it to this late period. Many of their shopkeepers had been waiting for it, but the application forms had not yet been distributed. He thought it was full time that the light should be instituted, as they were now losing large sums of money in the way of interest. Mr. C. Waring: How many applications have been made to have the electric light put in on private premises at Cardiff? Alderman Jacobs: About three. Mr. Waring: Don't you think that the Lighting Committee should institute a canvass of some sort? Many tradesmen would like to have it, but they don't know anything about it. The Mayor said there was great apathy on the part of the private consumers. Mr. Waring remarked that to make the electric lighting pay it would be necessary to have from 4,000 to 5,000 consumers. Up to the present they had only about 40, he understood. The Mayor said he was told that the application forms were not printed a few days ago. Mr. Waring proposed that a representative of the Corporation be appointed to canvass amongst the tradespeople of Cardiff. Mr. Good asked on what authority Alderman Thomas Rees had recently stated that the electric lighting would not be ready for six months. The Mayor: I understand it will be ready in the course of a week. Alderman Thomas Rees: My remark was only a play upon words—a figure of speech. Mr. Vaughan, chairman of the Lighting Committee, said there was no one more disappointed than he and the members of the committee at the delay—he thought it had been unnecessary. First, there was the question of the strike, and the contract could not be carried out in time. Then, after the engines and dynamos had been put up they found that certain pipes of various dimensions were to be got, and it was contended by the engineers that these things could not have been fixed until the condenser, boiler, and engines had been erected. With regard to the canvassing, he did not think any members of the committee would consent to act as canvassers. They had issued pamphlets giving all particulars, yet they had only three applicants for the light. The people were, therefore, not waiting for them, but the Corporation were waiting for the people. No doubt, when they got their public buildings lighted, there would be an increase in the number of applicants. Alderman Richard Cory suggested that if they could not find a clerk of their own to canvass the town, they might employ someone on commission. The discussion then dropped.

Woking.—The question of the electric light and its reliability has during the past few days considerably exercised the minds of most of the tradesmen of the Woking Station district, to whose houses and places of business it is laid on. On one or two occasions there have been trifling interruptions in the supply of electricity, but a rather more serious difficulty occurred lately, when for a considerable time the light was not available, owing, it is believed, to a slight disarrangement of an engine at the works. The failure of the supply occurred soon after six, when most of the business places had commenced to light up, and it was quite half-past seven before the current was turned on again. Naturally,

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considerable inconvenience was caused to many of the shopkeepers, though some who, like Messrs. Wenham, have gas in front of their business premises were not so much affected. The defect at the works was, of course, remedied with the utmost possible despatch, and the current again turned on. A number of the tradesmen of the district felt that the question of the reliability of the light was an important one, and it was decided to hold a meeting of those interested to see what could be done to secure an uninterrupted supply during the winter months. The meeting was held at the assembly-room of the Liberal Club, when Mr. R. Gloster presided, and amongst those also present were Messrs. S. C. Knight, Wenham, Geddes, Ivens, A. G. Clinton, Finch, T. Gloster, Lovett, Gunning, Saul, Underhill, and De Neuville. The Chairman commented on the irregularities in the supply, and pointed out that consumers had gone to the expense of purchasing fittings, and it would be a matter of some expense if they had to change their mode of lighting. Mr. Knight said unless the supply was more satisfactory he should certainly consider the advisability of lighting his premises by other means. Mr. Mayne, who was present, gave an explanation of the circumstances by which the interruption to the light was caused, and mentioned that the supplying of the street lamps would not interfere with the supply to private consumers. The company were purchasing a new engine, and even before that arrived he felt sure they would be able to satisfy all the demands made upon them. He thought he could safely promise them a good supply in the future. It was then decided that those present should consider the question of calling another meeting if thought desirable. It will be seen by the statement made by Mr. Mayne that the company are doing their utmost to secure a perfect service, and it is to be hoped that in this they will be successful. The work of erecting the standards to carry the lamps for lighting the streets is being pushed forward, and it is expected that in a short time the installation will be complete, and the streets of Woking, at any rate of the Station district, properly lighted—a reform which will be most welcome to everyone living in the neighbourhood.

PROVISIONAL PATENTS, 1894.

October 1.

18542. **Improvements in facsimile telegraphs.** Harry William Charles Cox and Richard Joseph Crowley, 51, Cricketfield-road, London.

18559. **An improvement in electric conductors.** Albert Walter Gamage, 126, Holborn, London.

October 2.

18661. **An improved frame or holder for detachable electric fuses.** The Acme and Immisch Electric Works, Limited, and Ernest Francis Moy, 433, Strand, London.

18662. **An improvement in switches for electric circuits.** The Acme and Immisch Electric Works, Limited, and Ernest Francis Moy, 433, Strand, London.

18673. **Improvements in electric mechanism for winding and synchronising clocks.** Henri Fréderic Mouquin, 53, Chancery-lane, London. (Complete specification.)

October 3.

18696. **Improvements in instantaneous, quick-break, double-pole switches.** Frank Henry Starling, the Gresham Electrical Works, Nottingham.

18743. **An improvement in collectors for overhead electric conductors.** Arthur Henry Bagnold, 28, Southampton-buildings, Chancery-lane, London.

18753. **Improvements relating to the transmission of telegraphic signals and to apparatus therefor.** John Mabry McMahan, 11, Southampton-buildings, Chancery-lane, London.

18754. **Improvements relating to the transmission of telegraphic signals and to apparatus therefor.** John Mabry McMahan, 11, Southampton-buildings, Chancery-lane, London.

18755. **Improvements in and relating to apparatus for intermittently closing and interrupting electric circuits.** John Mabry McMahan, 11, Southampton-buildings, Chancery-lane, London.

18757. **An improved insulation for either high or low tension cables and joints in same particularly.** William Parrott, Albert Essinger, and Thomas Harden, 26, Thavies-inn, Holborn, London.

18767. **Improvements in automatic switches for transformers or other electrical appliances.** Darwin Bates, Thomas Harden, and Oliver Leopold Peard, 70, Chancery-lane, London.

October 4.

18809. **Improvements in or connected with secondary or electric storage batteries.** Frank King, 47, Lincoln's-inn-fields, London.

18814. **Improvements in electric batteries.** Basile Alexandrovich Balasny, 6, Bream's-buildings, Chancery-lane, London.

18854. **New or improved instrument for use in ascertaining the description of leads or conductors required to suit conditions of electrical systems.** Charles William Godson Little, 47, Lincoln's-inn-fields, London.

October 5.

18860. **Improvements in the automatic connection of conductors conveying alternating currents of electricity.** George Kirby Chambers, 10, Richmond-villas, Seven Sisters-road, London.

18910. **Improvements in and relating to vessels for electrolytical purposes.** Peter Jensen, 77, Chancery-lane, London. (Hans Cappelen and Diderik Capelin, Norway.) (Complete specification.)

18925. **Improved means of attaching electric lampholders to oil lamps.** Frederick Charles Bryan Robinson, 55, Chancery-lane, London.

18933. **Improvements in apparatus for making and breaking electric circuits.** Haydn Thies Harrison, 46, Lincoln's-inn-fields, London.

October 6.

18996. **Improvements in or relating to brush and commutator mechanism for dynamos.** Alexander Ramsay, 6, Lord-street, Liverpool.

18999. **Improvements in electric fuses for mines and like purposes.** William Phillips Thompson, 6, Lord-street, Liverpool. (La Société M. Gaupillat and Co., France.)

SPECIFICATIONS PUBLISHED.

1893.

17172. **Covers for junction-boxes for electrical distribution, etc.** Baynes.

19809. **Carbons for electrodes, etc.** Castner.

23309. **Continuous-current dynamos.** Hutin and Leblanc.

1894.

7145. **Electro-deposition of zinc, etc.** Cowper-Coles and Walker.

10044. **Luminous electric changeable writing.** Theodoli.

13794. **Electric conduits.** Eisenhuth and others.

14607. **Electric cable traction apparatus.** Lamb.

14642. **Electrical battery.** Feeny. (Dubero and another.)

15276. **Diaphragms for electrolytic purposes.** Kiliani and others.

15321. **Telephone cords.** Schrimpff and Riffelmacher.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	5	5½-5⅝
Bournemouth Electric Company	—	—
Brighton and Hove Company Original	100	208-213
—— "A" Ordinary	—	160-165
Brush Company, Ordinary	2	2⅞-3
—— Nom. Cum., 6 per cent. Pref.	2	2⅞-2⅞
—— 4½ Debenture Stock	100	110-113
Charing Cross and Strand	5	4¾-5¼
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	13-14
—— 6 per cent. Cumulative Pref.	10	14¾-15
—— 5 per cent. Debenture Stock	115	131-133
City and South London Railway, Consolidated Ordinary	100	36-38
—— Debenture Stock	100	121-123
—— 5 per cent. Pref. Shares	10	13-14
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	94-99
Electric Construction, Limited	2	⅜-½
—— 6 per cent. Debentures	—	87-92
—— 7 per cent. Cumulative Pref.	2	1½-2½
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1⅜-1⅝
Elmore's French Company	2	3/16-5/16
Elmore's Wire Company	2	1⅜-1⅝
Fowler-Waring Cables	5	¼-1⅛
W. T. Henley's Telegraph Works, Ordinary	10	8-9
House-to-House Company, Ordinary	5	1-1¼
—— 7 per cent. Preference	5	5¼-5½
India Rubber and Gutta Percha Works	10	24-25
—— 4½ per cent. Debentures	100	102-104
International Okonite, Ordinary	—	—
Kensington and Knightsbridge	5	4¾-5¼
—— 6 per cent. Pref.	—	6¼-6½
Liverpool Electric Supply, Ordinary	5	6¾-7
—— Pref.	—	—
Liverpool Overhead Railway	10	7¾-8¼
—— Pref.	10	13-13½
—— 4 per cent. Mortgage Debentures of £100	100	111-113
London Electric	5	⅞-1⅛
Metropolitan Electric Supply	10	9¼-10
—— 5 per cent. Reg. Debentures, 1-10,000 in Bonds of £10, £20, and £40	—	—
National Telephone, Ordinary	5	4⅞ 5⅛
—— 6 per cent. Cum. First Pref.	10	15-15½
—— 6 per cent. Cum. Second Pref.	10	14-15
—— 5 per cent. Nom. Cum. Third Pref	5	5⅛ 5⅜
—— 4½ per cent. Deb. Stock	—	109-112
Notting Hill Company	10	5¼-6¼
Oriental and Electric Company, £1 shares	1	1-1⅛
—— £5 Shares	—	7-7⅛
—— £4½ shares	—	5¾ 6¼
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7½-7¾
—— 7 per cent. Pref.	5	8¾-9
Swan United	—	—
Telegraph Construction and Maintenance	12	41-43
—— 5 per cent. Bonds	100	105-108
Westminster Electric Supply, Ordinary	5	6¾-7¼
Yorkshire House-to-House	4½	4⅛-4⅜

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NOTES.

Electric Lighting in Brazil.—There is some talk of lighting Alagoas with electricity.

Neuhausen Aluminium Works.—The output of these works is now three tons per day.

New London Exhibition.—Next year an exhibition, entitled "The Light and Heat Exhibition," is to be held at Woodhouse Park, W.

Danish Telephony.—Negotiations are in progress between the Danish and German Governments to establish telephonic communication between Copenhagen and Berlin *vid* Odense, Kolding, and Hamburg.

Electrolytic Processes in South Africa.—The Meyer and Charlton Company is about to follow the May Consolidated Company's example in adopting the Siemens-Halske electrolytic process of treating tailings.

The Indian Telegraph Department.—The ultimate sanctioned superior strength of the Telegraph Department is 86 men. There are now only 74, but three new assistants are to arrive from Cooper's Hill this month.

The House of Commons.—Electrical communication is to be established between the Chamber, the library, and the smoking-room, and the division bells will be extended to the Grand Committee-room in Westminster Hall.

Electric Lighting in Burmah.—There is a proposition, which may be carried out, to light the new Government House and other public institutions in Rangoon with the electric light, the dynamo and machinery being worked in the gaol.

The Kinetoscope.—The apparatus used in connection with the kinetoscope, which reproduces living action without sound, and of which a demonstration was given at 70, Oxford-street, W., on Wednesday evening, is driven by an electric motor.

Electric Launches.—The Spree-Havel Steamship Company intend, in connection with the Berlin Exhibition of 1896, to run twenty-two electric launches on the river. The accumulators to be used will be those of the Allgemeine Elektricitäts-Gesellschaft.

"Science Progress."—We have received the October number of this magazine, which is published by the Scientific Press, Limited, 428, Strand. It contains the first of a series of articles on continuous-current dynamos by Mr. C. C. Hawkins, M.A.

A Revival.—Although *La Lumière Electrique*, as mentioned a few weeks ago, has become defunct, a new journal bearing the title of *L'Eclairage Electrique* has made its appearance. This journal, published at the same address as *L'Electricien*, seems to be a resuscitation of *La Lumière Electrique*.

British Association Screw Threads.—A card concerning the British Association screw threads has been forwarded to us by Messrs. Davis and Timmins, Limited, of 28, Hatton-garden, E.C. The card, which gives the dimensions in millimetres and thousandths of an inch, will prove very handy.

Electric Lighting in Hungary.—Mr. Franz Pelikán, the electrical engineer to the Prague Municipality, has drawn up five different schemes for the electric lighting of the town, which will receive due consideration. The Wenzelplatz in the same town has been lighted electrically by means of 42 Krizik arc lamps.

Fire at Telegraph Works.—We regret to learn, from paragraphs published in yesterday's daily papers, that part of the premises of Henley's Telegraph Works, in Store-road, North Woolwich, was destroyed by fire on Wednesday evening. The cause of the fire is attributed to the boiling over of insulating compound.

Limelight versus Electric Light.—The electric light is to be substituted within two months for the limelight at the South London Music Hall. This is to be done to please the Theatres and Music Halls Committee of the London County Council, otherwise the renewal of the license would not have been recommended.

Transmission of Power in Italy.—A portion of the water power of the Lake of Amman, about three miles distant from Pordenone, is now being profitably utilised for the electrical transmission of power to a cotton mill at Pordenone. The electrical plant has been supplied by Messrs. Brown, Boveri, and Co., of Baden, Switzerland.

Electric Transmission in Spain.—A project has been drawn up by Major Julio Cervera for utilising the falls of the River Gabriel, in the province of Cuenca, for the electric transmission of power. Over 10,000 h.p. is available, and work has been commenced. It is proposed to transmit the current to Madrid, Valencia, and other places.

New German Company.—There has been formed in Germany the Gesellschaft für Elektrische Unternehmungen (Company for Electrical Undertakings), with a capital of £750,000. The concern has been founded by the Diskonto Gesellschaft, Dresdner Bank, Bank für Handel und Industrie, Ludw. Löwe and Co., S. Bleichröder, and Born and Busse.

Testing of Meters.—The London County Council announces that it is now in a position to test electric light meters. The tests will be made by competent electricians, and the amount of the fee for testing each meter will depend "upon its capacity and mode of construction." Communications on the subject are to be addressed to the Engineer-in-charge, London County Council Testing Station, 42, Cranbourne-street, W.C.

Telephony in Germany.—The postal authorities are going to establish telephonic communication between Striegau, Schweidnitz, and Breslau. The line between Gotha and Friederichroda will be carried out next spring. Work is to be commenced at once in establishing telephonic communication between Frankenthal and the network of the Palatinate. Telephonic communication has been established between Berlin and Wolgast.

New Catalogue.—We have received from Mr. William Rickard, Ashbourne-road Mills, Derby, a wholesale catalogue and price-list of his manufactures, including British standard wire-gauge wire, plain silk and cotton-covered wires, guttapercha-covered line wires, paraffined line wires, twin line wires, flexible bell cords, fancy handle cords, telephone terminal cords with metal tags, braided double flexible cords, electric light leads, and electric light cables.

Athletics.—The City Electric Lighting Athletic and Football Club, who have just started their first football season, played the return match between the two departments, Worcester Wharf and Wool Quay, on Saturday last on the Hackney Marsh ground. The first match resulted in a win for the Worcester men by ten goals to three. A much closer and better game ensued on Saturday, but in the end the Worcester men again proved victorious, scoring three goals to their opponents' one.

At it Again.—Good old *Kuhlow's German Trade Review!* We have received the issue of October 10, which in all contains five items relating to the electrical industry of Germany. Four of these are lifted from our issue of 28th ult. and one from our issue of 14th ult., and all without

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any recognition of the source. Even if our contemporary does not care to acknowledge where its information is obtained from, the least it could do would be to scissor the matter a little more promptly.

The Indo-Chinese Telegraph Line.—The connection between the India and Chinese telegraph systems will be made from Nampoung to Momein, the distance between these two places being between 60 and 70 miles only. The alignment will thus be along the valley of the Taeping River, which is the caravan route for trade between Burmah and Yunan. The posts and wire for the whole of the new line will be sent from India to Bhamo and thence onward to Nampoung, where work will be begun by the Indian telegraph officers.

"Life of Edison."—Messrs. Chatto will, on the 25th inst., publish "The Life and Inventions of Thomas Alva Edison," a large-paged, finely-illustrated volume. The authors are Antonia Dickson and W. K. L. Dickson, who, as they explain in a short preface, have been intimately associated with Edison during the past 13 years. As a result of this, they have had every assistance put at their disposal for the preparation of his "Life." Indeed, there can be little doubt that some parts of the work will be more or less autobiography. Among the 200 pictures there are several portraits of Edison and his family, and one of his residence, Glenmont, New Jersey.

Breaking-up of Streets.—It appears from a report presented to the Vestry of St. Martin-in-the-Fields that the superficial area of pavements disturbed in that district during the year 1893-94 by electric supply companies was considerable. For instance, the London Electric Supply Corporation opened up 311⅓ superficial yards of York footway, and 60 yards of asphalte foot and carriage way, granite carriageway and wood paving. The Metropolitan Electric Supply Company disturbed 75⅓ superficial yards of York footway and 25 yards of other forms of pavement. The Electricity Supply Corporation opened 416 superficial yards of York footway and 66 yards of other pavement.

Electrical Accessories.—In a new price-list just issued to the trade, Messrs. O. Berend and Co. illustrate a variety of electrical accessories. Commencing with different kinds of branch switches, the list passes on to main switches for both high and low pressures. Next come the "V. H." multiple-contact accumulator switches, which by the insertion of a suitable spiral wire resistance prevent injury to the cells arising from short-circuiting. Another type of switch for regulating purposes is on the Burger system. Cut-outs for low and heavy currents then receive attention, together with safety fuses, wall sockets, resistance frames, arc lamp resistances, lightning protectors, etc.

Exhibition at Amsterdam.—An international exhibition comprehensively illustrating hotel arrangements and accommodation for travellers generally, as well as means of transport by sea and land, has been decided upon by the city of Amsterdam, and will be opened there in the summer of next year. The buildings are to be erected on the land situated at the back of the State Museum on the site occupied by the universal exhibition of 1883, and they will cover an area of 160,000 square metres. The necessary funds both for carrying out and guaranteeing the undertaking have already been provided, the plans of the various exhibition buildings are being prepared, and their construction will be shortly taken in hand.

"Daylight" Incandescent Lamps.—A price-list of the "Daylight" incandescent lamps, placed on the market by Messrs. O. Berend and Co., of 61, Fore-street, E.C., has reached us from this company. The filament of this type of lamp comprises a chemically pure carbon wire which is exceptionally elastic and harder than glass. The lamps are exhausted to a specially high vacuum. This fact, combined with the properties possessed by the filament, ensures the lamps a long life, a well-maintained candle-power, and less blackening of the globes. The lamps recommended are the economic "Daylight" lamps, having an efficiency of from 2 to 2½ watts per candle-power. A speciality is made of lamps for theatrical, surgical, and other purposes.

Electric Traction in Germany.—Yet another scheme has been put before the Berlin Municipality for an electric tramway by a Mr. H. Grauel. It is partially of the switchback order. In Hamburg the authorities have before them a scheme for a high-level electric railway prepared by Mr. Eustace Langen, of Cologne. Mr. Osthoff, of Berlin, has laid before the Municipality of Flensburg an electric tramway project, but the authorities have decided to do nothing in the matter until they have had some experience of the working of the local central electric light station. The managers of the Frankfort-Eschersheim local railway propose to substitute the electric trolley system for steam on their line early next year. Messrs. Schuckert and Co. are going to build an electric tramway from Wiesbaden to Sonnenberg—a considerable distance—and a company has been formed, with a capital of £10,000, to carry out the undertaking.

French Cable Companies.—The Exchange Telegraph Company's Paris correspondent, referring to the question of the fusion of the two French cable companies, states that it is by no means certain that the scheme can be carried out as projected by the financiers, who are anxious to get rid of a heavy parcel of shares and bonds of the Société Française des Telegraphes Sous-Marins, which the public has hitherto refused to take up. They had hoped to obtain a subsidy from the French Government, but independent shareholders of the P. Q. Company have strongly protested against the confiscation of their assets for the sole benefit of the clique. When the matter was mooted in Council the other day, it was decided to refer it to a special telegraph committee, and it is to be hoped that this committee will look carefully into the question before giving a favourable opinion, which, in fact, they could not do if they dealt with it impartially.

"The Engineering Magazine."—With its October issue this magazine inaugurates a departure towards which it has moved since it was started. It has already for some time published a technical index to current literature, but this idea has now been developed, and one portion of the magazine will henceforth be devoted to giving "expert reviews of the most important publications of the month, in every field of applied science; to supply a complete index to all the leading articles published in the scientific and industrial journals of all the English-speaking peoples; and, finally, through the Clipping Bureau, to furnish the original and full text of each and every publication so reviewed or catalogued. That is to say, as a review it does for industrial literature precisely what the *Review of Reviews* does so admirably for the political and literary world; as an index it is to the technical expert just what Poole's index to periodical literature has long been to the literary worker."

Paris Central Electrical Laboratory.—Since referring several weeks ago to the Laboratoire Central d'Electricité, which is located at 12 and 14, Rue de Stael, Paris, we have received a circular concerning the object and regulations of the laboratory. As we then dealt fully with the matter, it will only be necessary to

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mention a few of the charges made for testing and standardising instruments. For the tests in the first category, entitling commercial instruments to a certificate, the following charges are made: direct-current ammeters of from 0 to 100 amperes, 5f.; from 100 to 500 amperes, 10f.; and from 500 to 100 amperes, 20f. Direct-current voltmeters reading from 0 to 150 volts, 5f.; from 150 to 500 volts, 10f.; and from 500 to 100 volts, 20f. Alternating-current ammeters and voltmeters of from 100 to 1,000 amperes, or of 150 to 1,000 volts, 20f. Standardising a meter, 40f. The circular then gives the charges for testing cables, insulators, lamps, resistances, batteries, and dynamos.

Metallic Electrolysis.—Perhaps one of the most valuable papers, from a therapeutical and practical value, read recently before the American Therapeutical Association, was the one by Dr. Wm. J. Morton, of New York, on "Metallic Electrolysis," "Cataphoresis," etc., with illustrated cases—such as trachoma, tinitus-aurium, vascular tumours, cysts, etc. The paper in its first part, according to the New York *Electrical Review*, dealt with a historical review of some of the subject-matter. In fact, the groundwork was gone through so thoroughly that nothing was left wanting either scientifically or otherwise. His physiological experiment on cat muscular fibre are highly to be praised for its originality, and has thus gone far to prove the fact that metallic electrolysis is most valuable. He examined cat's muscle under the microscope while electric diffusion was being performed. By the aid of the microscope he watched the diffusion of the copper. In removing these deposited minute particles and testing them, they were found to give the reaction for copper.

Patent Agent Logislation.—The Select Committee on the Patent Agents Bill report that they have not been successful in their efforts to induce the general body of patent agents to agree upon the terms of a Bill that would be acceptable to them all. They have, therefore, been left to deal with the matters before them without such assistance. The most important feature in their report is its emphatic assertion of the inexpediency of allowing the exclusive right of communicating with the Patent Office to fall into the hands of any body of men, "or to create a monopoly in respect thereof." While considering it desirable that there should be a roll of duly-qualified patent agents, they express the opinion that there should be no regulation to prevent solicitors or other professional men from transacting business at the Patent Office, or to compel an inventor to employ any particular class of agent. The committee admit that it would be of public advantage to give to patent agents an improved professional standing and organisation; but, on the other hand, they declare that they "do not consider that the Chartered Institute of Patent Agents, as at present constituted, sufficiently represents the general body of the practitioners at the Patent Office."

The Proposed German Atlantic Cable.—There is naturally a good deal of excitement and anxiety among the proprietors in the Anglo-American Telegraph Company, says the *Morning*, in consequence of the scheme for a German Atlantic cable, with a Government guarantee of about £70,000 per annum. But as that project will have as its basis the exclusive right to land at the Azores and other points, a difficulty is quite likely to arise from the side of the United States Government, who may make it a condition of the new cable being landed on their territory that American citizens shall also have the right to land cables at the Azores and in Portugal. It will be interesting to watch how this difficulty will work out, for we have reason to believe that it is a real stumbling block in the way of the carrying out of the project. The concession has been taken up by the Eastern Telegraph Company, and as the same gentlemen figure on the boards of that and of the companies whose business is threatened by the competitive scheme, it is to be presumed that when they have got everything in shape they will have the grace not to seek to retain their seats on the whole of them, including the Trust companies, which have an enormous stake in the existing cable companies, and whose affairs they also administer.

Electro-Harmonic Society.—The next smoking concert will be held on Friday, the 26th inst., at the St. James's Hall Restaurant (Banquet-room), Regent-street, W., at eight o'clock. The musical directors are Mr. T. E. Gatehouse and Mr. Alfred E. Izard. The following is the programme—Part I.: madrigal, "What, Ho!" (Beale), the London Glee Singers; song, "False or True" (Allitsen), Mr. Robert Fisher; pianoforte solo, "La Campanella" (F. Liszt), Mr. Alfred E. Izard; song, "Hush, Dear Heart" (Behrend), Mr. Charles Chilley; recitation, "The Building of St. Sophia" (Baring Gould), Mr. J. K. Boddy; violin solo, "Romance in F" (Beethoven), Mr. T. E. Gatehouse; song, "The Tempest" (Ed. St. Quentin), Mr. R. E. Miles; burlesque lecture, "The Decease of C. Robin, Esq." (Leigh), Mr. C. E. Nott. Part II.: violin and piano, Andantino and Allegro, from "Sonata in B Flat" (Mozart), Mr. T. E. Gatehouse and Mr. Alfred Izard; song, "Edward Gray" (Sullivan), Mr. Alfred Pinnington; song, "Fairer Than Morning" (A. Cecil), Mr. R. E. Miles; recitation, "The Three Parsons" (Overton), Mr. J. K. Boddy; violin solo, Andante and Rondo, from the "Seventh Concerto"), (De Bériot), Mr. T. E. Gatehouse; old song, "Tom Bowling" (Dibdin), Mr. Charles Chilley; humorous song, "The Learned Leviathan" (Paulton), Mr. C. E. Nott.

Liverpool Engineering Society.—The opening meeting of the twenty-first session of this society will be held on the evening of Wednesday, the 24th inst., at eight o'clock, when the president-elect, Prof H. S. Hele-Shaw, Wh.Sc., M.I.C.E., will deliver his inaugural address. For the succeeding meetings the following is the proposed scheme of papers to be delivered—viz., November 7—Mr. W. Rowland, Wh.Sc., "Recent Improvements in Locomotive Design"; November 21—discussion on ditto; December 5—Mr. S. Dunkerley, M.Sc., "The Whirling and Vibration of Shafts"; December 19—Prof. Oliver J. Lodge, D.Sc., LL.D., F.R.S., "The Second Law of Thermo-Dynamics"; January 9—Mr. John A. Brodie, Wh.Sc., A.M.I.C.E., "Tramway Traction"; January 23—Mr. W. Worby Beaumont, M.I.C.E., "The Theory and Action of some Automatically-Balanced Machinery"; February 6—Mr. H. H. West, M.I.C.E., "The Stability of Ships"; February 20—discussion on ditto; March 6—Mr. D. B. Morison, M.I.M.E, "Experiments in Connection with Evaporation"; March 20—Mr. F. G. Baily, M.A., and Dr. C. A. Kohn, Ph.D., B.Sc., "A Scheme for the Distribution of Energy in Towns"; April 3—Mr. J. Reney Smith, Wh.Sc., "Engineering Work and Operations at Perim Island"; April 24—Mr. Arthur Musker, "Artificial Paving Slabs"; and May 1—annual general meeting—discussion upon miscellaneous communications.

Horse Racing by Electric Light.—The racecourse at Maspeth, Long Island, belonging to the Newtown Jockey Club, has been lighted by electricity, and is the second American course where the electric light has been introduced, the first being that at East St. Louis. The novelty is reported to have proved a complete success.

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The jockeys say that there is plenty of light, and that they feel perfectly comfortable in running the race. There has been no accident, no interference, and no swerving of any account, and, what is more, both the public and the club are pleased with the arrangement, which has been carried out by Messrs. Curtis and Dean, of New York. The Maspeth racecourse is half a mile long, and closed in by a high fence of white board. The track is lighted at night by clusters of incandescent lamps suspended over the middle of the course, the light being thrown down by reflectors. The horses as they run round are followed by powerful search-lights. Arc and incandescent lamps light up the grounds and grand stand. The electric plant includes two boilers, two 115-h.p. engines, and two Edison 100-kilowatt generators. There are 200 clusters of four 32-c.p. lamps each over the track, 100 32-c.p. lamps distributed about the entrances, betting ring, offices, etc., 50 16-c.p. lamps, 28 arc lamps, and three 6,000-c.p. search-lights. During the race the load is 1,050 amperes at 135 volts. The track is wired in three sections, and these sections in turn are wired so that, if one machine were to break down, alternate clusters of lamps would burn, so that the chances of the course being thrown into total darkness are very remote. Tests taken one morning after 12 hours of soaking rain showed a variation between the most distant lamps and those nearest to the station of less than three volts.

Electric Ballet.—On Monday there was provided at the Oxford Music Hall a sort of ballet which was described as "The Carnaval Electrique." This is understood to have been a great success at Blackpool, from which place it has been transferred to London. It is evident that when Lancashire trippers go to enjoy themselves they are not very exacting in the matter of entertainment, for the ballet in question is not striking from the point of originality in any way. The programme gives the names of the designer and maker of the dresses, the manufacturer of the wigs, the composer of the music, the arranger of the ballet, and the producer, but though stress is laid on the fact of the electrical features, no information is vouchsafed as to who has carried out the electrical arrangements, though it is mentioned that the "electric effects" have been "originated by Mr. William Holland." The ballet for the longest part of its course has nothing suggestive of electricity about it, but just at the end the stage is darkened, the ballet enter with festoons in front of them and conductors behind them, the festoons containing white, red, and green incandescent lamps, and similar festoons are also suspended underneath the sky-border. First of all, the white circuit is switched on and turned off; then the red is dealt with similarly; and finally the green, winding up with all three together. It will be seen that this is merely a development of the display given on the roof of Pears's soap warehouse, close in the neighbourhood, every evening. A young lady also gives a sort of serpentine dance, the underside of her dress being sprinkled over with white incandescent lamps, plum-pudding fashion. Her movements are, however, hampered by the fact that she is anchored by her cable. A special "pome' has been written in praise of the electric light.

The City and Guilds of London Institute.—The report on the work of the examination department of the City and Guilds of London Institute for the session 1893-94 states that during the session the number of classes registered was 853—701 in technology and 152 in manual training. The total number of students in attendance was 25,718. In the previous session the number of registered classes was 734, and the attendance of students was 24,374. At the examinations held in 1894 the total number of candidates examined was 11,631, or 1,377 in excess of the number examined in the previous year. The examinations in technology were held in 344 centres in the United Kingdom, and also in New South Wales, New Zealand, and Bombay. The number of home candidates was 9,814 out of a total of 9,907. The number of London candidates was 1,360, so that the number from centres outside the metropolitan area was 8,547, which, compared with 7,520 in the previous years, shows that the withdrawal of grants on results has had no appreciable effect in retarding the normal increase in the number of candidates. The percentage of failures has fallen from 46·4 to 44·6, but this result is in no way due to any lowering of the standard. A noticeable feature of the work of the session is the institution of preparatory classes in electric lighting and typography, an arrangement which has been attended with very satisfactory results and a demand for its extension. The classes in manual training are intended exclusively for teachers in public elementary schools, and the number of teacher-students in attendance was 3,015. At examinations held at the close of the session, 1,816 candidates presented themselves, of whom 1,256 satisfied the examiners. The training given in these classes is intended to qualify certificated teachers to give instruction in wood and metal work. In the new programme, the syllabuses of instruction and the lists of works of reference have been carefully revised, and, in response to applications, arrangements have been made for an examination in bookbinding.

The Havre Electric Tramways.—A few weeks ago we referred to the official opening to traffic of the electric tramways in Havre. A noteworthy feature in this connection is that all the lines in the town have been simultaneously converted from horse haulage to electric propulsion, a fact which has never previously been exemplified in any European country. The Compagnie Générale Française des Tramways some time ago entrusted the Thomson-Houston Company to supply the rolling-stock, and asked the Société l'Energie Electrique, of Havre, the local electric lighting company, to furnish current for the working of the tramways. The tramway system in Havre comprises three main lines. The first, which starts from the jetty and ends at Graville, is about 3½ miles of double line; the second beginning at the Rond-point, Rue de Normandie, terminates at Sainte-Adresse, the length being three miles; and the third connects the main quays and the basins. A fourth line, now in course of construction, will be carried along the Boulevard Maritime. At present the total length of single line worked is 14·88 miles. The rails are of the Humbert type, weighing 27 kilogrammes per metre, and laid on metallic sleepers. The gradients reach 4 per cent., and the smallest curves have a radius of 18 metres. The overhead conductor is a hard copper wire 8·25mm. in diameter, suspended in the usual manner in the centre of the track at a height of 6·50 metres from the ground—that is to say, partly from the cross-arms of steel standards, and partly from the fronts of houses. The steel standards have been brought into requisition for the lighting of the main thoroughfares, and for this purpose arc lamps to the number of 85 have been fitted in carriers on the top of the standards. The tramway service is dealt with by 40 cars, each having accommodation for 50 passengers. The electrical equipment of the cars depends upon the lines upon which they are operated For instance, 24 cars are fitted with only one motor, and 16 with two motors, of a normal power of 25 h.p. The supply of current for the working of the cars is obtained from the central station of the Société l'Energie Electrique

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in the centre of the town. Here four alternators, rope driven, have for some time furnished current for private purposes. Now three four-pole Thomson-Houston dynamos, giving current at 500 volts at a speed of 425 revolutions, have been installed for dealing with the tramway system. The substitution of electric for horse traction has already brought about an increased traffic, and at the same time the tramway company have reduced the fares.

Two-Wire Distribution at 200 Volts.—In the now defunct *Lumière Electrique*, M. G. Claude discussed a few months ago the difficulty of obtaining in a three-wire system of distribution a sufficient regularity of voltage, and mentioned the interest there would be in suppressing purely and simply the intermediate wire. M. Claude now takes up the subject once more in the columns of *L'Eclairage Electrique*, with special reference to a letter received by him from M. P. Vitte, the electrical engineer to the Compagnie du Gaz de Lyon, who furnish both a supply of gas and electric light. To quote from the letter in question, M. Vitte says: "Why not dispense with the middle wire so as to distribute directly at 200 volts, and feed the lamps arranged in groups of two in series. I add that those lamps that cannot be conveniently grouped in twos and must remain isolated, whether the subscriber desires only one lamp, or the particular application necessitates one lamp and not two working simultaneously, whether for any other cause we could employ 200-volt lamps a little more fragile than the others, but certainly realisable at the present for intensities of 16 and even 10 candles. Many lamps of five candles at 110 volts are made. It is only necessary to place two of the corresponding filaments in series, with a few precautions, to have 10 candles at 220 volts. In one word, the necessity of having in some cases recourse to isolated 200-volt lamps more fragile and a trifle more costly, cannot constitute an argument against distribution at 220 volts by means of two conductors, given the great advantages of this method of distribution and the possibility of reducing to a very small fraction the number of these isolated lamps. A station constructed for 200 volts and two conductors would certainly have fewer troubles than is generally supposed." With regard to this quotation, M. Claude states that nothing better can be said. In his article already referred to, he did not insist upon the possibility of directly branching lamps on 200 volts, because, as mentioned by M. Vitte, if 200-volt lamps are realisable, they are not so practical at the moment as 100-volt lamps. But as he, M. Claude, had only in view, in devoting himself to distribution at 200 volts on a two-wire system, the possibility of obtaining in a practical manner the forcing of the lamps to 2·5 watts per candle, he thereby eliminated even those systems of lamps which would not be able to bear such an action, and he had wrongly extended this elimination to all cases. M. Vitte, however, reminded him rightly that the case of 200-volt lamps would only be the exception, but that their existence would always give the possibility of offering satisfaction to a subscriber who, against his own interests, would like to have recourse to the system of isolated lamps. M. Claude considers that this is another argument in favour of the method of distribution indicated, and he tenders his thanks to M. Vitte for having afforded him the opportunity. M. Claude, however, regrets one thing—that the distributing system of the Lyons station comprises two wires only, otherwise the experimental verification of these views on part of a circuit of a three-wire distributing system would have no doubt long since been an accomplished fact.

The Submarine Detector.—It is now a little over a year since the Russian monitor "Rusalka" foundered with all hands in a storm in the Gulf of Finland. Steps have since been taken by the Russian Government to discover the precise locality of the ill-fated vessel, with the view of raising her, an expedition having been organised for that purpose. This expedition consisted of a flotilla of several vessels equipped with divers and all necessary apparatus, including one of Captain M'Evoy's submarine detectors, which was made in London for the expedition. It has recently been ascertained that the spot where the "Rusalka" went down is a reef in the locality of the Wäster Tokan. The reef is submerged, and it is supposed that the "Rusalka" grounded there, and subsequently slipped off into the surrounding deep water. Her precise position has been localised in 30 fathoms of water by means of the submarine detector, a description of which, says the *Times*, may prove interesting. This apparatus is based on the principle of Prof. Hughes's induction balance, and it consists simply of an electrical arrangement contained in a small mahogany box, which is carried on board the searching vessel, and a sinker, which is trailed along the bottom. The sinker also contains an electrical arrangement, and is connected with that in the box by a light electrical cable of any required length. The apparatus includes a small battery and an automatic contact breaker, which opens and closes the battery circuit at short intervals. The battery circuit includes two primary coils, one in the box and the other in the sinker. Each primary coil has its secondary coil, and both the primaries and secondaries are respectively connected up by conductors, which are enclosed in the suspending cable. In the searching vessel there is a telephone, which is included in the secondary circuit. Before being used the apparatus is adjusted so that under ordinary circumstances little or no sound is heard in the telephone, notwithstanding the pulsations of the primary current. The reason of this is that the induction in one secondary coil is, by adjustment, made to neutralise the induction in the other secondary coil. When, however, the sinker approaches a mass of steel, iron, or any other metal the adjustment is deranged, and sounds become audible in the telephone, while they are reduced in intensity as the sinker recedes from the metallic object. Three hundred feet of electrical cable were employed with the detector in searching for the "Rusalka," and the depths searched varied from 15 to 50 fathoms. The search was continued for several weeks, and the exact position of the foundered vessel was at length placed beyond all question, as every time the searching steamer passed over a given spot the electric indicator of the detector sounded loudly, thus affording evidence that a large mass of metal was submerged below. After the vessel had been located the divers descended and examined her. Although most appropriate for the purpose of searching for wrecks of iron ships, the submarine detector was not primarily designed by Captain M'Evoy with that sole view. His main object was to provide a means of indicating the approach of iron ships to anchored torpedoes, as well as of searching for stray torpedoes, lost anchors and chains, telegraph cables, and the like. In the first-named case, the induction produced near the torpedo is neutralised by another induction on shore, the torpedo and the shore station being connected by a cable. The approach of a mass of metal, such as an enemy's ironclad, to the torpedo disturbs the balance, and causes the sounds to become audible in the telephone. The torpedo may then be fired electrically by means of the cable connection, the invention thus presenting itself as an important adjunct of coast defence.

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MECHANICAL TRACTION FOR TRAMWAYS.

(Continued from page 327.)

Electric tramcars are provided with either one or two motors, according to the grades to be encountered and general character of the traffic. When it is advisable that the whole weight of car should be employed for better adhesion either at starting or ascending a grade, the usual method is to have two motors, one on each axle, rather than couple the axles together. This arrangement is of course more expensive, and it increases the dead-weight and general cost, but at the same time offers more security and ease, or power of regulation, by employing one or both motors, in accordance with the requirements, at any instant. On the Marseilles tramway, equipped three years ago, two motors are fitted to each car; the magnetic fields of both are coupled in series, whilst the armatures are in parallel. Regulation is effected by means of a variable resistance in the circuit; whilst high speeds are given on the level by shunting the field magnets, so as to weaken the fields.

In the Thomson-Houston system the two motors are coupled in series when starting, and may be connected in parallel for ordinary speeds, or one of them cut out of circuit when the resistance to be overcome is small. Five different connections are thus obtainable:

1. Two motors in series, with a variable resistance in circuit. (Position at starting.)
2. One motor cut out.
3. Both motors in circuit, the field of one being shunted.
4. Both motors in parallel.
5. Fields of both motors shunted.

These are found sufficient to serve for all practical purposes, but on long grades both motors are sometimes short-circuited on one another with a resistance inserted. This arrangement constitutes an electric brake of great power and steady action. By reversing the armature or field-magnet current, the car may be stopped on the steepest grade and started again up hill.

A system based on that of Sprague is used in France by the Fives-Lille Company, the regulation being effected with great independence of working in the two motors. The field-magnet winding includes three separate coils which may be joined in series or in parallel, or two in parallel with the third in series, or cut out of circuit altogether, thereby giving a great variety of possible field arrangements. The two armatures are coupled in parallel except at starting: and a rheostat or variable resistance is only employed at starting or on long descending grades when the motors act as generators of current.

The motors are arranged on the cars in such a way as to be protected as much as possible from dust and mud: usually each armature is enclosed in a cast-iron frame or box forming a portion of the magnetic circuit and protecting the working parts, thereby considerably reducing the working expenses and cost of repairs. The Thomson-Houston "waterproof" motor is cited as an instance of this: the magnets are double polar with either two coils or a single one. Carbon brushes set 90deg. apart are used, in order to run either way. The Sprague motors made by the Fives-Lille Company are designed without a break in the magnetic circuit: the interior working parts are rendered accessible from the side instead of by removing a top cover. The considerable speed of electric motors renders necessary some intermediate device for connecting their spindles with the car axles. Sprocket wheels and chains were at first employed to some considerable extent, but do not seem to have given unalloyed satisfaction: and toothed gears now obtain the preference. At first, high-speed motors, each with a double set of gear, became general; but owing to their great absorption of power and heavy trouble due to wearing out and constant renewals, single pairs of gear wheels are now used, the motor speed being reduced accordingly. This entails a greater weight in the motors and a lower working efficiency, but still ensures better results taking everything into account. The motor speed with single-reduction gear seldom runs above 500 to 550 revolutions a minute for an output of 15 h.p. to 20 h.p.

The motor frame in this arrangement is fastened at one end to the underframe of the car by means of springs, whilst the other end is carried by the driven axle. The gear wheels rotate in a bath of oil contained in the iron casing.

Since even a single pair of toothed wheels may give trouble through breakage, motors are sometimes designed of such slow speed as to be coupled directly to the car axles. In these "gearless motors," as they are called, the armature is usually not mounted on the car axle itself, but upon a hollow spindle, through which the car axle passes, and which is attached to the wheels by means of very powerful springs. The field-magnet system is carried from bearings on the hollow spindle. In this method, the losses due to gearing, etc., are avoided altogether, but, on the other hand, the motor efficiency is extremely small at the slow speeds necessitated by coupling them direct to the car axles; the motor weight is also much increased. It seems therefore a matter of some difficulty to attempt a decision with regard to one method being more efficient or advisable on the whole than another.

In dealing with the question of efficiency in general on electrically-worked tramways the author appears hardly to be abreast of the times, for although the somewhat unfavourable results at which he arrives are such as were to be found in the early days of electric working, we are able now by the help of storage battery stations and better speed regulation to secure a more even working load and a higher average efficiency.

M. de Marchena, in entering upon figures, states that the fuel consumption seldom falls below 3½lb. per electrical horse-power at the generator terminals, even under the most favourable conditions, while it is usually much above this rate. Loss on the line he takes to be about 10 per cent. with practically perfect insulation. These estimates would, however, appear to be far too high when results on the Liverpool, South Staffordshire, and other lines are examined. Motors, of course, cannot possibly attain a high efficiency, owing to the conditions under which they work. As a rule, their design is based rather on qualities of strength, lightness, ease of repair, and everyday working rather than high theoretical efficiency. At full load their output is taken at from 70 to 75 per cent. of the input, as compared with a 90 per cent. efficiency of dynamos under favourable circumstances. Here, again, the figures would seem to be by no means excessive, but, of course, more modern instances would show greater improvement.

Trials made at Milan upon a short length of line gave a final result of 50 per cent. efficiency between the electrical horse-power at the central station and the mechanical horse-power at the car axle, not inclusive, therefore, of the generating plant; only 10 cars, however, were in use, and either great loss of current must have taken place along the line, or the motors were of an inefficient type, or else the average traffic requirements were quite abnormal.

Results are also given of tests made by the Fives-Lille Company on some eight-kilowatt motors operating cars of a weight equal to seven or eight tons on the line, with an average capacity for 30 passengers. With two such motors, on a car seating 28 persons, the results were as follows:

Motor field connections.	Speed kilom. per hour.	Current in amps.	Grade per cent.	H.P.	Efficiency per cent.
			Up. Down.		
Three in series	12·2	8	·75	2·7	50
	9·7	16	·61	6	55
	7·5	24	2·15	8	49
Two in parallel, third in series with them ...	12·6	10	·5	3·7	54
	10·7	20	1·26	8·6	63
	8·6	30	3·6	12·6	62
Three in parallel	18·3	10	·75	4	61·5
	13·5	20	1·03	10	74
	12·2	30	2·96	15·9	78
	11·5	40	4·85	20·2	76
	9·1	60	8·48	27·9	68
	8·8	70	10·5	31	65

In these trials, the speed reduction was as 1 to 5; working pressure, 500 volts.

Similar tests were made with cars of the same size and weight, but each fitted with a single motor. The following table gives the results obtained in this way also:

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Field motor connections.	Grade per cent.	Speed kilom. per hour.	Current in amps.	H.P.	Efficiency per cent.
	Up. Down.				
Three in series	1·07	12·2	4	1·35	50
	·29	9·7	8	3	55
	·58	7·5	12	4	49
Two in parallel, third in series with them ...	·93	12 6	5	1·85	54
	·07	10·7	10	4·3	63
	1·25	8·6	15	6·3	62
Three in parallel	1·075	18·3	5	2	61·5
	·06	13·5	10	5	74
	1·05	12·2	15	8	78
	2·13	11·5	20	10·1	76
	4·2	9·1	30	14	68
	5·37	8·8	35	15·5	65

The average efficiency according to these results works out to about 60 to 65 per cent., without counting the losses due to starting or slowing down in actual work. Reckoning the losses on line, in the motors, and the generating plant at the fixed station, the total efficiency is estimated by the author to be about 40 per cent., reaching to 50 per cent. under the most favourable conditions. As already stated, this was undoubtedly the case in the early days of electric traction, but it may be, and is, much improved upon at the present time.

The author points out as a counterbalancing advantage the fact that such a system of electric traction allows the dead-weight to be considerably less than with steam locomotives or similar appliances. The dead-weight of the electrical apparatus does not, he says, exceed, say, 150lb. per passenger capacity, and the whole weight of the electric car equipped for work is not more than double this.

He estimates also that the total fuel consumption in the power-house is about 7lb. to 9lb. per horse-power developed on the car axles, which is said to be equivalent to about ·5lb. per ton kilometre, or 5lb. per car kilometre—that is, in English measure ·8lb. per ton-mile or 8lb. per car mile. That this estimate seems too high, with well-designed plant, seems evident from the fact that a good compound locomotive only requires about ·06lb. of coal per ton-mile.

(To be continued.)

ELECTRIC TRACTION IN LONDON.

More than one inquisitive individual has wanted to know why it is that the Central London Electric Railway should run from Liverpool-street *viâ* the Mansion House and Oxford-street in order apparently to terminate in the *terra incognita* of Shepherd's Bush—a place that has the sound of country life in its title, but not very much of rural beauty in its actual surrounding. Answers to this question are many, and some are obvious. It might, for instance, be said that a railway is bound to stop somewhere: the Great Northern, *e.g.*, ends in a ploughed field near Doncaster, though connections with the North-Eastern enable the East Coast traffic to pass over the dividing line without the knowledge of travellers.

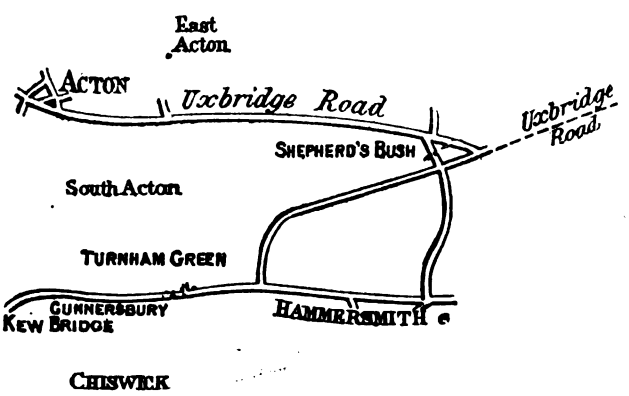
The Central London might, again, be said to end at Shepherd's Bush because there are two roads leading thence, under either of which the subway could extend with equal justice and possibility of good traffic. But whether intentional or not, the most important reason for making the western terminus of this line just beyond Uxbridge-road Station might fairly be considered to consist of the fact that from this point westwards there radiates a *surface line* or system of *tramways*. No one willingly travels underground if he can help it; and it was either a wise step or a happy coincidence that led the Central London engineers to end this line at the point where the tramways begin their suburban course. Passengers may then travel by the electric underground in a reasonable atmosphere for a long distance under crowded areas and streets where surface lines are impossible owing to dense traffic; then, at the journey's end, they come up to the daylight and complete their ride in the open air on the tramways. If this isn't the real reason why the Central London stops at Shepherd's Bush, then it might very well be so.

This locality may be, as above stated, a *terra incognita* to the average City man who lives south or east; but it need not be thereby considered a far-distant desert place. So far from that, it has a thriving population, more local industries than many other quarters of London, and serves as a market for Acton, Ealing, and the adjacent suburbs.

Ealing, as the readers of this journal will know, has just made itself rightly prominent for a well-designed installation of electric lighting both for private and public purposes; it is not a far cry to Acton, and the local authority of the latter district has now a splendid chance of distinguishing itself in such fashion as to rival, if not surpass, the neighbouring district. A rumour is current to the effect that the new interest which has lately taken over the West Metropolitan Tramway Company's system throughout this part of London proposes to double the lines—that is, to practically reconstruct them—along the Uxbridge-road from Shepherd's Bush to Acton. We feel that the opportunity—if the statement be well founded—is a most excellent one for the local authorities to oppose this project tooth and nail *unless the tramway company undertake to adopt electric traction* upon this line, and apply to Parliament at the same time for all necessary powers. The roadway is amply large enough along its entire length for the use of ornamental iron poles along the centre, upon which the trolley wires may be carried from brackets in the usual manner, whilst the local authorities would then be enabled to use the same poles for arc lamps by which to illuminate the roadway.

The traffic along a road of this kind is absolutely certain to increase rather than diminish, so that the comparatively slow speed, not only at starting but in running also, which is typical of ordinary horse traction, would soon prove an inconvenience to frontagers, passengers, and users of the road in general. A good and reliable form of mechanical traction may therefore be regarded as absolutely essential for this line; and taking the absence of grades into account, as well as the nearness of the Central London Electric Railway generating station, we can say with perfect safety that nothing could be found more suitable than the "trolley" system of overhead wires.

They should indeed make it a condition that the tramway company so arrange the line that this may be effected: it would mean a considerable saving to the ratepayers, accompanied by a great gain in attractiveness and value of the whole district. There would then be literally an electric road—above ground and below—the entire length of the way from Acton to Liverpool-street, so that for rapidity and ease of transit the inhabitants along the route would be the most happily situated of almost any in London. Already, we understand, some provisional steps have been taken to urge definite action upon the local authorities, and we trust that they will prove sufficiently wideawake to the chance now offered to show their appreciation of the advantages obtainable from electric light and power.



In the annexed diagram is shown an outline map of the principal roads in the district: that upon which electric traction thus has an opportunity of being installed is the continuation of the Uxbridge-road westwards from Shepherd's Bush to Acton. The line shown by dashes represents the Central London Railway terminating at this point.

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HOW TO MAKE A DYNAMO EXCITE ITSELF.*

BY GEORGE T. HANCHETT.

Of all the minor difficulties which arise in electrical engineering there is none so annoying as the refusal of a machine to excite itself, or, as it is technically termed, "build." It often happens when the stockholders and parties interested have assembled to see the new machine start, and it invariably occurs if the district manager has been so injudicious as to invite gentlemen to whom he hopes to sell a machine, or has arranged to have the daughter of the president of the company throw the switch for the first time. In view of these facts the writer has collected various data on making a dynamo build, and adding some of his own ideas, has embodied the result in the following article, which he hopes may prove useful.

Series Machines.

A series dynamo will refuse to excite from any one of the following causes: (*a*) open circuit, a poor contact; (*b*) short-circuit, field magnets or armature; (*c*) bobbins so put on as to be opposed to each other; (*d*) incorrect connections; (*e*) insufficient residual magnetism. Inasmuch as it is more or less trouble to test out and correct these difficulties, it is wise to examine the symptoms carefully and make a thoughtful decision as to the nature of the trouble before applying the test and remedy.

(*a*) *Insufficient Contact and Open Circuit.*—This difficulty has often proved very elusive. It is to be carefully noted that a magneto bell is not a decisive test in such a case as this.

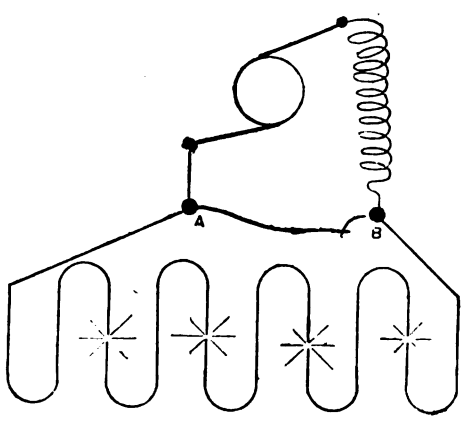

Fig. 1.

The initial magnetism of a new machine is apt to be very low, and the resulting voltage correspondingly so, perhaps, one-half a volt, or even lower. A magneto bell will ring quite briskly in circuit with a contact through which an E.M.F. of one-half a volt would be unable to establish a current sufficient to start the machine. Therefore be absolutely sure of the contacts by carefully inspecting them all. A loose screw or nut or a little lacquer under a contact may be responsible. This is a common difficulty with platers and machines of low voltage, but it sometimes occurs even on arc machines rated at 2,000 to 3,000 volts. Having made sure that the internal circuit is as it should be, obtain a good external circuit by short-circuiting the machine. This must be done very cautiously. It is wise to have the regular load in circuit, and establish the short-circuit, as shown in Fig. 1. A good method is to place a short piece of scrap wire in one binding post, and then with a suitable piece of insulating wire make contact between the other binding post and the short piece of wire. Should the machine build it will be at once evident by the sparking of the brushes. The short-circuit should then be removed and broken first where the two wires touch. The resulting arc will only burn the wire, and the binding posts of the machine will be uninjured. It is to be remembered that when a series machine is induced to build in this manner that it builds with a rush. It is, therefore, absolutely necessary to be able to instantly remove the short-circuit on the appearance of sparks at the commutator. Oftentimes a mere flying touch of the two wires is sufficient, and this should always be tried at first before a firm short-circuit is made.

* The *Electrical World* (New York).

(*b*) *Short-Circuited Field Magnets or Armature.*—It is evident that either of these difficulties deprive the field coils of any energy that may be generated, and so prevent the machine from building. Some series dynamos have a resistance in multiple with the field coils, and thus divert a portion of the current therefrom. When making a refractory series machine build, all resistances and controlling devices connected in this manner should be temporarily cut out by opening the derived circuit. Some series machines have a switch which short-circuits the field or armature. Be sure this is open. This seems a useless caution, but the writer has known of cases where it was not done, and considerable valuable time wasted looking for the difficulty elsewhere. Look for the simple things first.

(*c*) *Bobbins or Windings in Opposition.*—This defect rarely occurs unless the machine is assembled, and the bobbins connected when installed. To a man acquainted with the machine such a defect should be obvious at once. It may be discovered also by disconnecting and separately exciting each bobbin with a few cells of battery or other source of current. The resulting poles may be detected with a pocket compass. This will give sufficient information about the direction of the windings to properly connect them.

(*d*) *Incorrect Connections.*—It often happens that the loose cables and smaller parts of a dynamo are boxed separately. When the machine is installed, if these cables are put on by an inexperienced man they are almost sure to be put on incorrectly. A sketch of the connection should be, and is in most cases, sent with the machine, but even with this aid the inexperienced man is liable to go astray. Therefore look carefully to the connections of the machine.

(*e*) *Insufficient Residual Magnetism.*—This is usually the first cause to which the refusal to excite is ascribed, but it is scarcely ever necessary to excite temporarily from an outside source. A series machine heavily short-circuited will build on a very weak residual magnetism. If, however, it is absolutely necessary to excite the field separately to obtain an initial magnetism, the exciting current should be kept on for some time. It will also be well to pound the pole-pieces quite heavily with a copper hammer while the magnetising process is going on. This tends to more thoroughly saturate the magnets.

Shunt Machines.

A shunt machine will refuse to self-excite from any one of the following causes: (*a*) a short-circuit or a heavy load; (*b*) an open shunt circuit; (*c*) bobbins or windings in opposition; (*d*) incorrect connections; (*e*) insufficient residual magnetism.

(*a*) *A Short-Circuit or a Heavy Load.*—A shunt machine will not build under these conditions, for the reason that a very small fraction of the current generated goes to excite the machine. When the machine starts this initial current is very feeble, and if so small percentage of this already weak current is used in excitation, the chances are that it will not be sufficient to start the dynamo. Therefore in such a case see that the main circuit is open in order that the current generated may assist in building the voltage.

(*b*) *An Open Shunt Circuit.*—It is obvious that if the shunt circuit is open the machine will not build. Such a defect may often be located in the rheostat when a burned-out coil or a poorly-made connection may be the cause of the difficulty. It may often be detected by short-circuiting the rheostat. Sometimes the defect exists on the connections of the machine itself. Often the fault is in the rheostat wires running to the switchboard. The insulation of a wire will sometimes hold the two ends of a broken wire together so as to defy anything but the most careful scrutiny. Nothing but rigid inspection and testing of the entire shunt circuit will locate the difficulty.

(*c*) and (*d*) These have been discussed under series machines, and the same remarks apply.

(*e*) *Insufficient Residual Magnetism.*—In this case the expedient of short-circuiting the machine will only make matters worse. If it is possible to obtain a powerful outside source of current, the fields may be separately excited and the pole-pieces hammered as described under series machines. If such a current is not available, the

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following device may be used with advantage: In Fig. 2 let B represent a few cells of Leclanché or Grenet battery. Three or four will answer. Let D represent the dynamo and F the shunt field. C is a knife plunge contact and X a fixed point. W is a weight tending to turn the switch, S, on its pivot, A, and make contact at C. It is prevented from doing this by a piece of 10-ampere fuse, X Y, which supports the switch. The battery is connected, as shown, in such a way that its E.M.F. will assist whatever feeble E.M.F. the dynamo may have. The dynamo starts and the combined E.M.F.'s send sufficient current into the field to build the machine. The voltage of the machine rises and the current in the shunt increases. The 10-ampere fuse being under tension fails at about eight amperes. The weight instantly closes the broken shunt circuit, and the batteries are thus automatically cut out before they are damaged by excessive current. A machine with eight amperes in its shunt circuit can continue to build without difficulty. At the time of cutting out the batteries their E.M.F. will be a very small fraction of the total, and the resultant current will be very little reduced thereby. It is important that the switch be just barely held open by the fuse wire so that the shunt circuit may be closed before the field magnets have time to discharge. The parts of the device are so simple that it is possible to construct it or its equivalent with almost any material at hand.

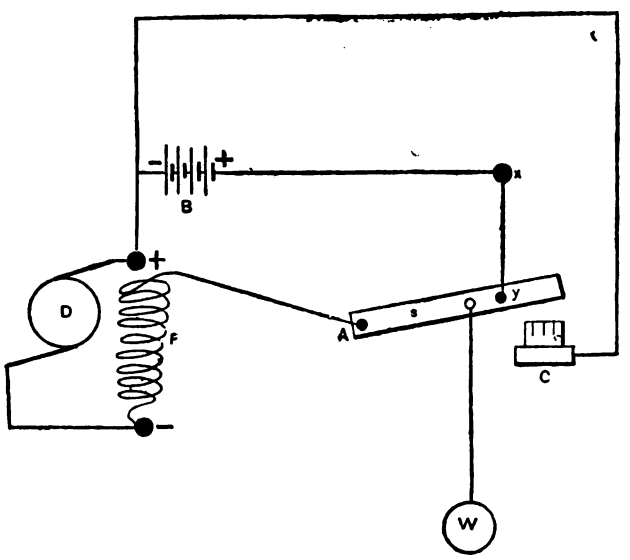

FIG. 2.

Some shunt machines require less than eight amperes for excitation. In such a case after the machine is built, the fuse wires, X Y, may be cut with a pair of pliers, and the batteries thus cut out and saved from further waste. It is not always known just how much current the shunt circuit of a machine requires, but a momentary current of eight amperes will not injure the ordinary battery. This method may also be used on compound and series machines, but it is hardly ever necessary. The writer has in the course of his experience encountered several cases where the men in charge did not give the machine time to build. Shunt and compound machines build very slowly, and especially so when first installed. In some rather exceptional cases it will take five or six minutes to bring the machine to voltage. A man in a hurry and somewhat excited in his desire to have things working properly is liable to try the machine correctly connected, and on its failing to give at once voltage sufficient to light the pilot lamps he decides that his connections are incorrect, and, shutting down, proceeds to change them, and thus incurs a long series of failures which a little patience might have avoided.

COMPOUND MACHINES.

These partake of the difficulties of both series and shunt machines, but they also have some that are peculiarly their own. A compound machine will refuse to build when: (*a*) the shunt circuit is open; (*b*) the brushes are heavily short-circuited; (*c*) bobbins are wound in opposition; (*d*) incorrect connections; (*e*) insufficient residual magnetism.

(*a*) *An Open Shunt Circuit.*—The machine may in this case build if a piece of light (No. 18 or 20) B. & S. copper wire be placed across the terminals. This will burn out, but still the machine will not come up to its rated voltage. This shows that the series coil is all right, but that the shunt circuit is open. Find and close this open place, and then make a quick short-circuit of the dynamo, as explained under series machines. In this case, however, it is not well to have the load thrown on. In case the series coil is so connected that it "builds down" the dynamo, this method will only tend to destroy what little residual magnetism there is. If, therefore, the machine refuses to build under this treatment, cross the series terminals and try again. If the dynamo still refuses to build with its field coils, all assisting each other and producing the correct polarity, look for faults (*b*) and (*e*) and apply the corresponding remedies.

(*b*) A heavy short-circuit at the brushes. This should be readily discovered and easily removed.

(*c*) This has been discussed under series machines.

(*d*) This also has been discussed under series machines, but, in addition, it is well to note that a compound machine has numerous studs and binding posts, and the difficulty is still more liable to occur.

(*e*) *Insufficient Residual Magnetism.*—This must be overcome in several ways. The magnets may be remagnetised through the shunt coils by an independent circuit, or the battery method explained on shunt machines may be used. Another very good method is to disconnect the series coils altogether, and separately excite them by a few cells of battery in such a way as to help the shunt coil. A storage battery is admirable for this purpose.

It sometimes happens that the machine will build properly, but that its series coils tend to reverse the polarity of the dynamo. This may be detected when the machine is loaded by short-circuiting the series coils. If the voltage rises in doing this the coils are in opposition, and the terminals of the series coils must be reversed. If the shunt is so connected as to "build down" the dynamo, the machine will refuse to excite till the terminals of the shunt coils are interchanged. In closing, it is well to note that it is perfectly possible to connect a field coil in such a way that it will tend to produce a polarity opposed to the magnetisation to which it owes its current. If all the coils of a machine be thus connected, it will refuse to build till the terminals of these coils are reversed. This is not confined to compound dynamos, but applies to shunt and series dynamos also.

THE PERFECTION OF THE ELECTRIC RAILWAY MOTOR.*

BY LINCOLN NISSLEY.

A study of the history of the electric railway motor shows us that, from the beginning up to a few years ago, there has been a great tendency toward complicated, fanciful, and impracticable designs, including outlandish forms of field magnets and unnecessary number of field cores and coils. In most cases also the mechanical construction has been very bad; the shaft being too small, the bearings being weakly supported, and the general workmanship poor and not up to standard. It has long been my opinion that the proper way to design a good railway motor is to consider very carefully and systematically each part, first by itself and then with reference to other parts, and thus collect and build up the elements which are best.

Let us now take up the various parts of the electric motor, and consider each as a simple problem in designing. The size of the frame should be such that it can readily be placed upon any standard truck. The machine should be completely shut in so as to make it thoroughly iron-clad. A good substantial iron-clad frame does more than anything else to give great stability and strength to the whole machine, and is highly desirable in a railway motor. The bearings should be directly and rigidly mounted in this frame, a simple fact that has often been disregarded,

* Abstract of a paper read before the Pennsylvania Street Railway Convention, Reading, September 5, 1894.

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and all parts should be interchangeable. The armature and car axle should be in perfect alignment, and consequently perfect meshing of the gears is obtained, which experience has proved to be of vast importance. The gearings should be mounted closely to the frame, so as to eliminate buckling and tendency to loosen parts. The field magnets should be bipolar. The field should also be of the single magnetic circuit, rather than the consequent pole type, because the former is more economical in wire and current required, lessening the cost of renewals and repairs. A single circuit requires only 70 per cent. of the weight of wire, and 70 per cent. of the energy of magnetisation that is required by a double magnetic circuit. The field cores should, of course, be perfectly insulated; this can be accomplished with certainty by winding them on a solid spool of material which is firm and waterproof and highly insulating. The armature should be of the ring type, so that the winding does not slip out of place or pile out at the ends when running at high speed, a fact which will be appreciated by those who are operating cross country and suburban lines. The armature should have teeth or projections upon it in order to secure and protect the wires from mechanical injury, to reduce the reluctance of the magnetic circuit and the weight of wire and energy of current required to magnetise it. The perfect insulation of the armature core is of the utmost importance. The best material and the most complete covering should be used, and the greatest possible care should be exercised to avoid short-circuits, grounds, or broken wires. The efficiency should, of course, be as high as possible, and is made a maximum by reducing all elements of loss as far as possible. These losses are current to magnetise field, loss due to armature resistance, friction, resistance of air, and eddy currents. It has always seemed to me that if a machine can be run for several hours under full load without any part becoming overheated, the efficiency of that machine must be high. This fact is more absolute than any efficiency test can possibly be.

In looking over the past eight years of practice in the designing and perfection of the electric railway motor we have much to commend and considerable to condemn. The boldness of the achievements, the problems that have been solved, the rapidity of development, seem almost beyond comprehension. That the electric railway motor in less than eight years should reach the high state of perfection, economy, and efficiency that it has, as compared with the long years of development of the steam-engine, is remarkable. In the perfect railway motor we have something entirely different from what we have in the steam-engine. We have no reciprocating parts, but continuous rotary motion. The strains are all tangential, and this aids greatly in running and maintenance. The railway motor of yesterday is not what the railway motor of to-day or a few years hence will be. Yesterday we were struggling with difficulties connected with the commutator and brushes, which have been the great bugbear of all types of motors. Commutators and brushes require more care outside of gearing connecting motors to axle than anything else we have to deal with. They have always been the weakest spot in the electric railway motor. The question arises, can these difficulties be overcome? I think they can, and have been to a great extent already overcome by several of our large manufacturers.

In connection with the motion, we are labouring under very serious difficulties in regard to proper control and regulation. In the control of the railway motor we cannot do exactly as we do in the locomotive—adjust our point of cut-off so as to secure the best results with a given load. We have to govern our motors by varying the resistance in the circuit, which means loss necessarily, because the resistance has to be overcome to some extent by the current passing through it or by reducing the intensity of the field magnet, which also means loss; if this is true, then it seems to me that it is unfortunate, but is it necessary? I do not think so. The ideal railway motor for the propulsion of our cars would be a motor running at a continuous and uniform speed, and with a variable gearing, giving the motor the advantage of power when the car was first started. You all know that when our motorman wants to change the speed of his motor he moves a switch or controller handle around, which adjusts the current flowing through the motor. Now, as a matter of fact, the motor should adjust the current itself, and not the man, and the speed of the motor should remain absolutely constant, while for regulation between the motor and the gear on the driving wheels you should depend on varying the mechanical advantages entirely.

It should be borne in mind that it is less than three years since the first single-reduction motor was commercially introduced. The work was done under the most unfavourable circumstances. Compared with similar motors of to-day they were indeed crude and very costly. They answered the purpose, however, and it is generally admitted that they have been a financial success as compared with the use of former construction. The single-reduction motors have since been in continual operation, and those of recent manufacture, embodying the latest improvements, are a great advance in the onward march toward perfection. That there are still annoying circumstances in connection with the mechanism no one who is charged with the practical operation will for a moment deny, but inasmuch as they are universally proving a financial success, it may be taken for granted that electrical and mechanical improvements will be gradually introduced until they become as nearly perfect as anything of the kind can be. The question is not whether a motor is perfected, but whether it is enough of a success to warrant the improvements which will lead to perfection. Its advantages are not yet thoroughly appreciated, but they will be. Its future is assured; with this outlook will come better construction, better engineering, better mechanics, and the solving of the larger problems, which will place the perfected railway motor on a cheaper, better, and more successful basis.

ELECTRIC CABLES AND GAS-PIPES.

A legal case that has extended over two years has recently been decided by the Tribunal Civil de la Seine. As long ago as March 2, 1891, an explosion of gas occurred in the Larue Restaurant, Rue Royal, Paris, and this gave rise to an action between the Compagnie Parisienne du Gaz and the Compagnie Parisienne de l'Air Comprimé et de l'Electricité, the latter being generally known in this country as the Popp Company. From the report of the experts nominated to ascertain the cause of the accident, and to apportion the responsibility, it appears the conclusion arrived at was that the Popp Company had not sufficiently insulated its cables from the lead gas-pipes of the gas company and which were laid in close proximity to each other in the case in question. On the other hand, it was shown that the employés of the gas company had not kept a proper record of the warnings given to them, which, if attended to, would have allowed of the fault being remedied. From this it was urged that the responsibility for the accident, which resulted in injury to various persons, was divided between the two companies.

According to the judgment of the Court, it appeared from the experts' report that the original cause of the explosion was due to an escape of gas caused by a gas-pipe having been perforated. The gas entering a manhole of the Popp Company in the Rue Royale, passed through the service pipe carrying a branch cable for the electric lighting of the Larue Restaurant, into the cellar of the restaurant, where it became ignited at a light placed near the door of the cellar. It was found that the two holes through which the gas escaped from the gas-pipe had been caused by an electrical phenomenon, which had fused the gas pipe at two points where the cables had come into contact with the gas-pipe in the manhole. The enclosure of the gas-pipe in the manhole in proximity to cables carrying high-pressure current, the suspension of the cables without fixing them to the side of the manhole, and the negligence shown by not closing one end of the iron pipe carrying the service conductors into the cellar, and the fact of having in case of an escape of gas no outlet other than through the service pipe into the cellar, are

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characterised as a serious mistake. The manhole was constructed by the Popp Company without any intimation being given to the gas company.

On the other hand, on the morning of March 2, 1891, the gas company's workmen were informed of a smell resembling gas having been noticed in the cellar of the Larue Restaurant. On their arrival on the spot at 2 p.m. no escape could be discovered; at 9 p.m. they were again informed of an escape of gas, but judged it useless to return at once. The Court held therefore that the company had failed in its duty, for carrying on a dangerous business they were bound to proceed at once to subscribers' houses on being informed of an abnormal fact. The inaction of the gas company, which, after the warning in the morning should have awakened their attention, was much to be regretted, as if the workmen had arrived about 9.30 p.m., or 10 p.m. at latest, they might have been able to prevent the explosive mixture from entering the cellar. The Court finally condemned the Popp Company in damages to the extent of 75 per cent. of the total amount, the gas company being mulcted to the tune of 25 per cent.

ELECTRIC POWER IN ENGINEERING WORKS.

The following is the presidential address delivered by Alderman Thomas Richardson, B.A., J.P., at the first meeting, held on Tuesday, of the present session of the North-East Coast Institution of Engineers and Shipbuilders:

Closely associated as I have been all my life with an engineering works started more than half a century ago, and increasing in size with the growth of the trade of the district until it has become one of the largest marine engine works on the North-East Coast, I have had by tradition and experience continually before me the difficulty of always keeping up to date with machinery and meeting the demands of labour, and great as this task often has been in the past, I can recall no time so discouraging and difficult as the present. We have had to contend with bad trade, with disputes between capital and labour, but I remember no period when we have had pressure from both troubles to contend with at the same time, making the successful carrying on of industrial concerns an impossibility.

Those of you who are directly associated with the engineering and shipbuilding industries will readily appreciate that the subject of economical production is one to which more than usual prominence has lately been given by the recent almost complete stoppage of work on this coast by one of those disastrous disputes between capital and labour which are now so frequent. It is not my province, as president of an institution such as ours, to dilate on the inevitable result of such disputes, but rather to seek for a counteracting element, in order to do our part in postponing the day when the industries with which we are connected will, instead of being in the proud position they were a few years ago, be crushed into comparative insignificance, if an end is not put to these suicidal conflicts.

Another factor which is year by year becoming more prominent is the competition of foreign countries, and the unfortunate doctrine which is so often sensationally made use of as to our superior capacity as handicraftsmen is by no means so true now as formerly. The extended and universal adoption of machinery has been the chief cause of this levelling up, and particularly is this the case in the engineering industry, where the scope for the application of machinery is practically unlimited.

It is not enough, however, to apply machinery, but to develop it, as the one remedy for survival is continuous evolution, although the unconscious fascination which is often associated with old tools and old methods often renders the evolution dangerously intermittent. It is apparently this fascination, combined with an unselfish desire to satisfy the cravings of the shipowner for propelling machinery requiring the least possible consumption of coal, which is responsible for the fact that whilst we build engines and boilers consuming 1½lb. of coal per indicated horse-power per hour, we drive the machinery in our workshops at an expenditure of fuel four to six times greater in amount. This is, of course, attributable to the use of a number of high-pressure non-condensing engines distributed over a large area, and supplied with steam through long lengths of piping from a central group of boilers. This, then, is a field in which economies are to be obtained, and one of the best solutions appears to be the application of electrical driving.

In the able address of Prof. Kennedy before the Institution of Mechanical Engineers this subject was very fully dealt with, and at the late meeting of the Iron and Steel Institute at Brussels a very interesting and instructive paper was given by Mr. Selby Bigge, which conclusively showed the importance and possibilities of the system. At the risk of rendering this address narrow, and more in the form of a paper rather than general, I propose to give some illustrations of the application of electrical driving, both in this country and abroad, hoping that a *résumé* of what has actually been accomplished may promote a discussion which will thoroughly ventilate the question and be fruitful in beneficial results. With the late disastrous record of the shipbuilding and engineering industries as an example, it is highly improbable that any capitalist will start a new shipyard amongst us, so that we may be sufficiently selfish to consider the application of electrical driving to existing works only. The first question to consider, therefore, is that having boilers grouped in one place from which steam is led to engines distributed over a large area, what economy can be expected from substituting those engines with electric motors supplied with power from a central station, and will the results justify the expenditure? We are all thoroughly aware that condensation does occur in steam in steam-pipes, and that the present engines are uneconomical; but a broad view is generally taken of the matter, and little has been done to ascertain what the results really are. It is for this reason that the experiments and developments made by Mr. Panton, of Messrs. Dorman, Long, and Co., of Middlesbrough, in conjunction with Mr. Selby Bigge, are of the greatest value, and particularly so as they have resulted in complete success. The original steam-driven machinery comprised punching, shearing, and bending machines, cold saws, etc., all of which were distributed over a large area and driven by six engines capable of indicating the following powers—viz, 27, 14, 14, 14, 16, and 9. These engines were disconnected and replaced by motors of 10½, 3½, 5, 3½, 3½, and 3½ horse-power respectively, the driving gear consisting of a belt from the motor direct to the flywheel of the machine. The most noticeable case is that where a large bending machine formerly driven by an engine having a cylinder 10in. diameter with a stroke of 12in. is now efficiently worked by a 3½-h.p. electric motor. The current for these motors is generated by a 50-h.p. Pieper dynamo driven by an ordinary horizontal engine, the steam being obtained from two Lancashire boilers which were already in use in connection with the steam driving of another portion of the works. Formerly the six engines in question were supplied with steam by two boilers, which are now dismantled, with the result of a net saving of 30 tons of coal per week and the entire labour in connection—stoking and upkeep.

Another striking advantage is that the speed of the motors being practically constant under all loads within their capacity, the machines driven by them are always running at the desired speed, and are therefore in a condition for producing the greatest possible amount of work. In reviewing this plant we have the advantage of ascertaining the approximate loss resulting from condensation in a long range of steam-pipes, and the working of small high-pressure engines under conditions usually found in ironworks and shipyards. It will be apparent, however, that the generation of power at one centre admits of an economy beyond this—viz., the use of a modern high-pressure triple-expansion condensing engine with a consumption of 12lb. to 14lb. of steam per indicated horse-power per hour, instead of a consumption of from 40lb. to 60lb., as frequently is the case at present. It is evident that the loss in such a case as that of Messrs. Dorman, Long, and Co. may be termed a maximum, on account of the machines working in the open air, and the steam-pipes led underground, but the results from ordinary cases of shop machinery are often sufficiently startling to warrant more attention being given to them than they usually receive. For purposes of comparison we will consider the results obtained from two works of about equal driving power, one having an electric installation and the other steam.

One of the most complete installations of electrical driving in the world as applied to large industrial establishments is that of the National Arms Factory at Liège, Belgium. These works were built in the year 1889, and are of very large extent, employing 2,000 hands, the daily output of finished rifles being 250. Some idea of the system adopted, and the value of machinery for economical and rapid production, may be formed when it is considered that there are about 58 parts in a complete rifle and bayonet, involving in their production about 750 operations; yet so great has been the development of machine tools used in this manufacture, that of the 750 total operations only 6 per cent. are performed by hand labour. Another feature is that a large percentage of the machines are automatic, and advantage is taken of this by placing several in the charge of one operative. The whole of the machinery is driven by electric motors receiving their current from one central dynamo coupled direct to a Corliss condensing compound engine having two cylinders and indicating 500 h.p. at 70 revolutions per minute, with a boiler pressure of 90lb. The auxiliary feed and condensing water is supplied by a pump driven by a 10-h.p. motor, receiving its current from the main generating dynamo, and placed on the canal bank 2,840ft. distant and 117ft. below the level of the engine. The water, after being used in the con-

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TABLE I.

Engine.	I.H.P.		Length of steam-pipe, in feet.	Water trapped, in pounds per hour.	Weight of steam.				
					Calculated from diagram.		20 per cent. for cylinder condensation.		Pounds per I.H.P. per hour, including water trapped.
	Loaded.	Light.			Pounds per hour.	Pounds per I.H.P. per hour.	Pounds per hour.	Pounds per I.H.P. per hour.	
No. 1	48	17·2	680	270	2,227	46·2	2,672	55·6	61
,, 2	93·9	23·4	695	260	2,502	26·6	3,002	31·9	34·7*
,, 3	44	20·2	833	190	2,365	53·7	2,838	64·5	68·9
,, 4	28·9	15	969	130	1,562	54	1,874	64·9	69·3
,, 5	56·2	20	511	110	1,890	33·6	2,268	40·4	42·2
,, 6	75·7	22·8	971	27	2,580	34·1	3,096	40·9	41·4†
,, 7	9·3	6·5	1,210	125	445	46·4	534	55·6	68·8
,, 8	15·6	7·8	1,068	75	700	45	840	53·8	58·5

* I.H.P. with the dynamos not at work = 38·3. † The small amount of water trapped here is due to the trap being placed very near to that of No. 5 engine.

denser, is discharged into a tank placed 40ft. high, from which it passes through finely-perforated pipes in the form of spray into an open reservoir on the ground level, and by this means is reduced in temperature so as to be again available for condensing purposes. The generating dynamo is placed between the high-pressure and low-pressure engines, and the armature being on the main shaft, acts as a flywheel. The armature, which is 16ft. in diameter, was constructed in place. The electromagnets are 20 in number, and there are 40 pairs of brushes, 20 on each side. The capacity of the dynamo is 3,000 amperes at 125 volts, and the makers guaranteed an efficiency of 90 per cent. The current from this powerful generator is distributed to about 31 motors, ranging from 3 h.p. to 50 h.p., placed in different sections of the works. The machines used in the manufacture of rifles are necessarily of light design, consequently the motors are arranged to drive line shafting only, and although the total length of main shafting exceeds 4,000ft., and the total length of belting is about 11 miles, there are no indirect main drives, a motor driving one line of shafting only, the object in view always being the reduction of loss by friction. Each motor is provided with an ammeter, and those in charge know the amount of power required to drive the machines when being worked to their desired capacity—any increase of that power at once indicates that there is a waste in friction, whilst any decrease indicates that the machines are not doing sufficient work; and when it is remembered that the revolutions of the motor are practically constant under all loads within their capacity, it is impossible to imagine an arrangement which so exactly fulfils the requirements of maximum economical production.

Compare this with the wasteful arrangements so common in shipyards and engine works, where engines, often already fully loaded, have to drive still another new tool, and the "make-the-best-of-it" policy of giving just a little later cut-off is adopted. The result generally is that the mean revolutions of the main shaft are not only decreased by any variation in load, but are, in addition, highly sensitive to the variations of steam pressure. This is, however, a diversion, and referring again to the Liège factory, there is also a 300-h.p. Willans engine, coupled direct to a dynamo, which generates the current necessary for recent extensions.

It has been found by careful experiment that the consumption of steam in the Corliss engine is about 14lb. per indicated horse-power per hour, whilst the losses are 10 per cent. in engine friction, 10 per cent. in the dynamo, 2 per cent. in lines, and 15 per cent. in motors, or a total efficiency of 63 per cent. at the motor driving pulleys of the indicated power of the generating engine. The whole of the electric installation was made and fitted by the International Electrical Company, of Liège, from the designs and under the direct superintendence of Mr. H. Pieper, the managing director and electrician-in-chief of the company, and we have an ample testimony of the efficiency of the entire plant in the fact that, although the works have been running over three years and a half, there has not been one single stoppage of the main dynamo during working hours, and no accidents of any kind whatever.

Particulars such as these are always of general interest, but any radical change made in existing works involve a very considerable outlay, and extreme care is necessary to be certain that such a change would be commercially successful. It is therefore essential in the first instance to ascertain what are the conditions existing at present; so we will take as an example an average old-established marine engine works, of which there are many in this district, the majority of them having been added to year by year to meet the demands of trade, and where extensions have generally been the result of a compromise between what was desired and what existing conditions would allow.

The works in question are steam driven, the boilers being arranged in one group, and supply steam at 60lb. pressure to 31 engines in different parts of the works. Eight of these are used for driving the machinery in the various sections of the works, and 23 are auxiliaries in connection with cranes, hydraulic pumps, and the like. The driving engines are of various powers and of designs which may be taken as representing a fair average of those used for the same purpose in similar works (Table I.).

No. 1 is a beam engine 50 years old, and is used for driving about 50 lathes, planing, slotting, and drilling machines of various sizes. With an average daily working load the indicated horse-power is 48 whilst running the shafting only, and with the machines all standing it is 17. Steam is supplied through 680ft. of piping, and the water discharged from an automatic steam-trap close to the engine stop-valve amounts to 270lb. per hour. The weight of steam used by the engine, and as measured from the diagrams at the average daily load—viz., 48—is 2,227lb. per hour, to which should be added 20 per cent. for moisture in suspension, thus making a total, including the water condensed in the steam-pipe, of 61lb. per indicated horse-power per hour. No. 2 engine is a modern two-cylinder horizontal, with variable expansion gear worked by the governor. The machines driven consist of two dynamos for works lighting, as well as a large number of average-sized tools. It will be seen from the table that the average working load when driving the dynamos is 93·8 h.p., but driving during the day the average horse-power is reduced to 38. Nos. 3 and 4 are single-cylinder inverted engines, and afford a good example of the wasteful effects of overloading. Nos. 5 and 6 are old-fashioned horizontal engines, in which the governor works an ordinary throttle valve, and both have been in use for about 30 years. Nos. 7 and 8 are small inverted-cylinder vertical engines running at 150 revolutions. The wasteful effect of this system of driving is shown by the consumption of steam, which averages 50·9lb. per indicated horse-power per hour, and to this has to be added the condensation in the steam-pipes, which is 7 per cent., bringing the total up to about 55lb. per indicated horse-power per hour, and even this is by no means exaggerated, as it is probable that the condensation in the pipes exceeds that indicated by the traps.

In comparing the two systems at this stage, and allowing 10 per cent. for engine friction in each case, and a total electric loss of 27 per cent. for dynamo conductors and motors, we require 45lb. of steam per effective horse-power at the main driving pulley of the steam installation against about 20lb. for the electric. Taking the total at 500 effective horse-power (which allows 125 average for the 23 auxiliaries) in each case, and an evaporation of 8lb. of water per pound of coal, the consumption of coal would be 36 tons per day for the steam and about 13 tons for the electric. In the steam installation under consideration the water is obtained from the waterworks main at considerable cost, whereas under similar conditions with a condensing engines the cost would be much less.

Another feature of value is the reduction of labour, which for stoking alone would be about one-half, whilst still further reduction could be made in the engine driving and greasing staff, as whilst steam-engines require constant attention, the motors could be practically left to themselves except for starting and stopping, as should anything go wrong with any motor it would be immediately detected in the central station engine-room by the indicator corresponding to the particular motor at fault. It will be evident that we have dealt with the greatest source of economy by the concentration in one highly efficient plant for the generation of power for the whole of the main driving of the machinery of the works. It will be interesting, however, to consider the relation between the power at the main driving pulleys and that absorbed by the machinery in doing actual work. Referring again to the driving engines, 1 to 8 (Table II.), it will be seen that the loss in driving the shafting,

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belts, pulleys, etc., range from 25 to 70 per cent., or an average for the six engines of 43 per cent. These experiments have been confirmed by some made by Mr. Westgarth, and referred to by him at a meeting of the Cleveland Institution of Engineers. Mr. Westgarth found that in an engine and boiler works he experimented on that of the total power developed by the steam-engine 59 per cent. was absorbed by the shafting and gearing, and in one of the workshops where two long lines of shafting were used for driving a comparatively small number of machines the power absorbed was 75·6 per cent. of the total. In another workshop where the shafting was well laid and rope gearing used for the main drives the percentage was 42. The average of the whole experiments is therefore about 50 per cent. Consequently it appears that half the mean power would be saved if all the machines could be driven by independent motors instead of by line shafting. This in an existing engine works is, of course, impossible; but there are many instances where long drives may be divided with great advantage, whilst the independent driving of large tools would be another very desirable feature.

TABLE II.

Engine.	Length of shafting, in feet.	No. of pulleys.	Length of belts, in feet.	I.H.P.		Loss per cent.
				Loaded.	Light.	
No. 1	370	153	4,292	48	17·2	35·8
,, 2	782	113	2,263	93·9	23·4	25
,, 3	515	283	3,582	44	20·2	46·2
,, 4	571	335	4,831	28·9	15	52
,, 5	691	79	1,401	55·2	20	35·6
,, 6	381	22	464	75·7	22·8	30
,, 7	117	49	1,210	9·3	6·5	69·9
,, 8	242	70	1,429	15·6	7·8	50

An example of what may be termed ideal electrical driving is that of the Bedson Wire Company, of Middlesbrough, where the installation is the most perfect and complete that has as yet been attempted in this country. Every process connected with the manufacture of wire is carried out by means of electricity, the wire drawing, galvanising, spinning, and barb fencing machines, overhead and locomotive cranes, hydraulic pumps, induced-draught fans, lathes, centrifugal pumps, are all independently driven by electric motors. Owing to the entire absence of shafting and belting, the construction of the building is very light, and the convenience of the whole plant is most noticeable. The current is generated by a 600-h.p. dynamo driven direct by a three-crank triple-condensing engine with boiler of 160lb. pressure. A special tunnel, 350 yards in length, has been constructed for the conveyance of the conductors, and branches are taken from these to the 50 motors, which vary from 5 h.p. to 40 h.p. each. The lighting of the works is most complete, the greater part being carried out on the inverted arc principle, which is so perfect that there is an entire absence of shadows. The original plans for driving these works electrically were prepared by Mr. Selby Bigge, who appears to have given considerable attention to the question of electric driving. Before definitely deciding to put down such a novel plant several experiments were necessary, for which purpose special machines were designed by Mr. Bedson, the managing director of the Bedson Wire Company. These experiments were made at Liège by Mr. H. Pieper, and were so successful that after an exhaustive series of tests the directors of the company decided to adopt the electrical installation in its entirety.

A novel feature in connection with the boilers at Messrs. Bedson's works is the application of Messrs. Ellis and Eaves's well-known system of induced draught. This is the second application of the system to land boilers, the first having been made at the Atlas Works, Sheffield, originally arranged with Lancashire boilers. These have gradually been replaced by 10 single-ended boilers of the marine type, the advantages claimed being as follows: (1) considerable economy compared with the Lancashire boilers with Galloway tubes; (2) considerable reduction in space occupied; (3) absence of smoke; (4) greater elasticity of power.

In ordinary work, by maintaining a vacuum of 3in. at the fan, the combustion is at the rate of about 35lb. per square foot of grate surface, and one single-ended boiler can readily evaporate as much steam as three Lancashire boilers 27ft. by 7ft., with ordinary chimney draught. Where the demand for steam varies in a works, the system is a great inconvenience, and this is especially the case for electric light installations. It is evident that with this system of draught, or with any other efficient system, the assumed consumption of 13 tons per day could be still further reduced.

From the comparison which I have made we may fairly conclude that the saving gained by the substitution of electrical driving in an old-established works would be considerable. Whether this saving would justify the outlay in all cases would have to be settled by those who have their capital invested in works suitable for its adoption. I may say, however, with reference to the firm of which I am a member, that for some time we have had the matter under consideration, and the various investigations and experiments made by Mr. D. B. Morison, and of which are those enumerated in this address, have so convinced us of the commercial possibilities of the system that we have now on order a small plant prior to further developments hereafter.

I have endeavoured to confine myself in my remarks to a plain statement of what has been accomplished by making use of electrical power to drive machinery, and have not gone into any of the possibilities the future may reveal. We have known the science of engineering to advance at times, as it were, by leaps and bounds, and from the rapid strides that this comparatively new energy has made within the last few years, we may have reasonable expectation of still further development in this direction.

In the address which I have given to you this evening, I feel that I have but inadequately fulfilled the task imposed when you conferred upon me the honour of electing me president of this valuable and widely-known institution, but hope that my remarks will be productive of help in the work before us. That the suggestion of the possibility of further expenditure of capital is unpalatable to many members of this institution I can well believe, seeing what dark clouds are hanging over us, but let us hope that, as in past times, the clouds will have a silver lining and shortly disperse, giving place to the pleasant sunshine of renewed commercial prosperity of which both capital and labour will receive their just and fair proportion.

TURVEY'S TESTING SET.

In the annexed illustrations is shown the testing set introduced by Mr. W. Turvey, of 101, Campden Hill-road, Notting Hill-gate, W. The resistance-box, represented in Fig. 1, has been devised to meet the demand for an accurate and economical resistance box. Every attention has been given to all essential points, and at the same time all unnecessarily expensive parts have been eliminated. The blocks and plugs are carefully fixed and fitted, and are made from specially hard brass to withstand wear, and the plugs are fitted with milled ebonite handles, and are mounted on a dull finished ebonite slab, which is plainly engraved with the values and conections. The coils are of platinoid wire wound on brass bobbins, and are most accurately adjusted to the marked values in Board of Trade units at 17deg. C. There are four pairs of proportional coils and 16 resistance coils; the total resistance being 11,110 ohms, thus enabling resistances from ·001 to 10 megohms to be measured. The outer case is of polished mahogany, lined with baize and fitted with lock and handle. All the tests, etc., described in the various test handbooks can be readily performed by means of this instrument.

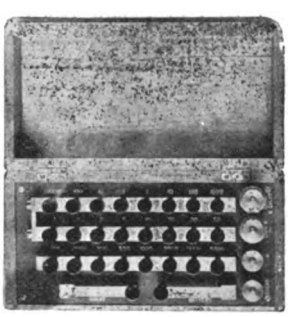

FIG. 1.

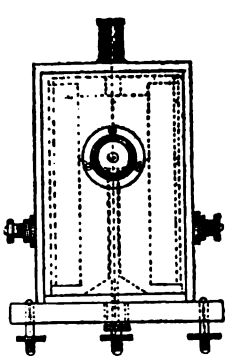

FIG. 2.

The galvanometer, which is shown in Fig. 2, has been specially designed for use with the resistance-box mentioned, but it can also be employed for any purpose for which a highly sensitive and dead-beat galvanometer is required. It is of the permanent magnet type, with powerful magnets. The coil has a resistance of about 250 ohms, or more or less as required, and it is fitted in an aluminium tube, and suspended by means of a phosphor-bronze strip, which can be easily replaced should it ever be necessary, and one coil can be exchanged for another in a few seconds. The mirror is a concave one of one metre focus, and is rigidly attached to the coil in such a manner that the silvered surface is exactly in line with the axis of suspension, and when not in use the coil can be clamped by simply turning a milled head, thus relieving the suspension of all strain. The terminals are both insulated from the case, and the instrument is exceptionally steady and well made. To these instruments Mr. Turvey has given the name of the "Electrical Engineer" resistance-box and galvanometer.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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ARE WE QUITE SATISFIED?

Dr. Kemna, when addressing the Municipal Engineers at Antwerp, paid a high compliment to English engineers. He said: "English engineers have specially shown a spirit of daring enterprise and a well-marked practical turn of mind." As a rule, engineering practice has been very successful, but there have been some well-known failures, and a good deal of "try another tack" to get over this or that difficulty has gone on before, in some instances, success could be recorded. It may be that the "spirit of daring enterprise" has in some matters electrical led our engineers along doubtful paths, and many of us are not even now quite satisfied with existing tendencies. To come to the practical point. Is there not a too great spirit of daring enterprise, not to say an extreme rashness of spirit, in permitting many central stations to depend so entirely upon everything going right? Of course it is difficult to suggest that any particular part of the apparatus, be it boiler, engine, dynamo, or distribution plant, should go wrong. You cannot put your finger upon *the* weak point, otherwise it would soon be less weak; but weak points must necessarily exist, and should be looked for. The contrary, however, is the practice, and too often disaster more or less acute follows the breakdown of a weak spot. There is hardly a man in many stations but fully understands the risk of a breakdown at any moment. Yet too many engineers, eager to do something, advise a more or less temporary installation, which must and does run at great risk of breakdown. These breakdowns come periodically, and do considerable damage to the industry. Everyone who knows anything of the matter sees the foolishness of such action, but those who know little or nothing of electrical work imagine that such breakdowns are inevitable. Hence the reason why men in authority so often taunt us with "being in our infancy." Is not this delusion fostered by the daring spirit we have emphasised? Carefully consider some of the smaller, yea, even some of the larger stations, and the fact must strike the most casual observer that success depends upon everything going right. There has been no thought of a possibility for one small link to fail. All the eggs are in one basket, and these eggs are usually placed there by engineers who arrogate to themselves all the knowledge of the universe and relegate to others an equal amount of ignorance. Although at the risk of being misunderstood, we must again call attention to one phase of English practice which tends to perpetuate this evil—it is the non-employment of a competent engineer. In a somewhat sarcastic way we referred the other week to weak specifications, and specifications whose only object seemed to be to aim at the compulsory adoption of this or that patented apparatus. While some specifications err in this direction, others err in allowing the contracting parties all manner of license. This kind of specification shows that the consulting engineer is, as a rule, incompetent, and relies upon the contractor to get him out of his difficulty. This rule, however, is not universally true, for

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we know of undoubtedly competent men who rely too much upon the contractors, but then the contractors know that they know their business, and that anything cheap and nasty, unreliable, and inefficient would be immediately condemned. It is different with the incompetent man: the contractor can and often does take an advantage which detracts from the value of the installation.

RULES FOR WORKMEN.

Almost every electrician-in-charge frames rules and regulations for the men employed upon the installation. These rules are not always as comprehensive as they might be, and though fatal accidents have been few in number, a good many men have received shocks they would rather have avoided. In a good many of these cases the shock has been received through a direct infraction of rules, some through carelessness, and some because there existed no rule to direct attention to the danger. Mr. J. Ayer, of St. Louis, has drawn up a fairly complete set of rules to be followed by the employés of the Municipal Electric Lighting and Power Company, of that city. These we give elsewhere, as although they may require many subtractions, as well as many additions, to make them cover the practice in this country, they do form such a set of rules as ought to be in the hands of every employé of every central station in this country. We purpose hearing the criticisms of chief electricians upon these rules, and then issuing the amended rules in pamphlet form so that they may be placed in the hands of workmen. A large proportion of the circuits in America are overhead, and these we imagine are more dangerous to the workmen than the underground mains more prevalent in this country. The large number of central stations so rapidly coming into use will find employment for many workmen, and these have to be educated by the chief electricians—a task requiring for a time very constant supervision. It will therefore assist them if they are able to obtain an exhaustive set of rules, and we trust the nucleus we give in this issue will lead to what they require.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

CLASHING ADDRESSES.

SIR,—As it has come to my knowledge that a Mr. V. Newport, styling himself electrical engineer, of Messrs. Newport and Holder, is issuing business cards bearing my address—viz., 23, Sherwood-street, Piccadilly-circus, London, W.—without my permission or authority, will you kindly insert this note in your next issue, so that if it catches the eye of Mr. Newport, he can alter his cards. I am sorry to trouble you, but I do not know Mr. Newport's private or business address.—Yours, etc.,

October 16, 1894. GEORGE WILSON.

Telephony in Hungary.—The local authorities of Jász-Berény intend to establish telephonic communication between the various towns and villages of the district, the chief central station being situated in Szoheck.

CITY AND GUILDS OF LONDON INSTITUTE.

LECTURE VI.—THE CONSTRUCTION AND ACTION OF ELECTRIC BELLS, THE ARRANGEMENT OF BATTERY CELLS, AND OF CIRCUITS FOR BELLS.

(Specially contributed.)

I have arranged a bell circuit on the board, and you see it contains four different pieces of apparatus. These are the battery, B (Fig. 1); a push, P; a bell, C; and the connecting wire, W. In many bell circuits another piece of apparatus—the indicator, I (Fig. 2)—is used.

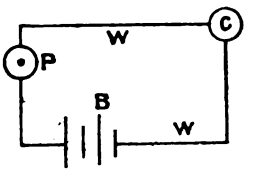

FIG. 1.

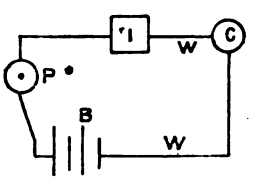

FIG. 2.

Let us begin our investigation with an examination of the battery. We must look upon a battery in electrical work somewhat as we look upon a pump in hydraulic work—namely, a piece of apparatus to enable us to maintain a difference of pressure in a circuit and thus to obtain a current of electricity. We can examine the various parts of one of the cells, several of which are connected together to form the battery. Here is a cell similar to those in the battery.

Leclanche Cell.—This consists of an outer containing vessel of glass, Fig. 3, inside of which is a small cylinder

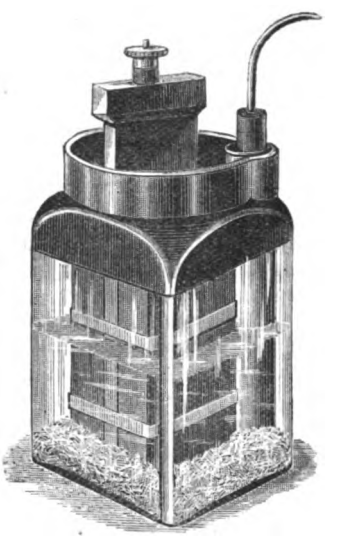

FIG. 3.

of zinc, Zn, and a porous pot fitted with a strip of carbon, C, surrounded by peroxide of manganese and coke. This mixture is tightly packed round the carbon strip, and kept in by a layer of melted pitch at the top. The liquid you see is a solution of sal-ammoniac in water.

Polarisation.—Before examining further into this form of cell, we will examine a still simpler one. Here

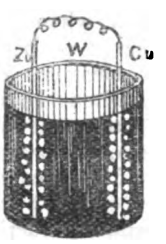

FIG. 4.

I have an ordinary glass jar, Fig. 4, containing a strip of zinc, a strip of copper, and a little dilute sulphuric acid. I throw the image on the screen, and connect the

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strip of zinc to the strip of copper by this wire. Immediately the connection is made you see the liquid, as it were, especially around the Cu strip, starts into bubbling life. Thousands of bubbles are formed. These grow in size, and escape from contact with the metal, going up through the liquid, and burst at the top. With suitable apparatus we could collect the gas which forms these bubbles, and should find that it was hydrogen. The investigation of this phenomenon, however, is not just now my purpose, but I want to point out that these gases evolved upon the surface of the plates interfere with the normal working of the cell. If the plates in the original clean condition would maintain a definite difference of pressure, or E.M.F., the Cu, when covered with the gas bubbles, will not maintain so great a difference of pressure.

The combined actions may be likened to two opposing forces. The resultant of two opposing forces is their difference. Thus, if two forces act—one, say, of 100lb. in one direction, and one of 50lb. in the opposite direction, the resultant is as if only one force of $100 - 50 = 50$lb. was acting in the direction of the greatest force.

Well, the action of the Zn and Cu is to push up an E.M.F. in one direction, and the hydrogen film, being opposed in the cell to the zinc plate, gives rise to a counter E.M.F.; so that when the cell is polarised the acting E.M.F. is the difference between these two opposing tendencies, and is smaller than it would be could the plates be kept perfectly clean.

This phenomena of the action of the gases which collect on the plates is called *polarisation*.

The experiment with the two metals and the one fluid in the glass shows you the action of polarisation, and I may tell you that similar polarisation takes place with the Leclanché cell. This renders such a battery unsuitable for constant work, but when the work is light and intermittent as in bell work, the battery has a chance to recover itself. We shall see directly how this defect through polarisation has been overcome in other designs of battery. At present, however, we will examine the battery we have here a little closer.

Energy.—If I pump water to a height I have to expend energy in so doing, for work is done, and whenever work is done energy is expended. When I personally raise and lower the pump handle muscular energy is consumed, and this muscular energy is maintained by the changes which take place in the food consumed. We may look upon the food as being chemically consumed in the body. Just the same if the pump is worked by a steam-engine—the energy can be traced back to the consumption of coal in the boiler furnace. Again, if it is electrical energy that is used, and has to be maintained, we must look for the chemical consumption of something. In most batteries the energy is obtained by the chemical consumption of zinc. It is so in this Leclanché battery. If I weighed the zinc rods when first put into the battery, and weighed them again and again after use, I should find the weight gradually decreasing in proportion to the work I called upon the batteries to perform. It does not take long to see visible signs of their being eaten away. The source, then, of our electrical energy in this circuit is to be found in the chemical consumption of zinc in the cells. Chemists symbolise zinc, copper, and carbon thus: Zn for zinc, Cu for copper, C for carbon, and in our diagrams we may well use these symbols.

Maintaining Pressure.—To return to our Leclanché cell: you may assume that when the combination of zinc, sal-ammoniac, and carbon is properly made, there is thus obtained a difference of electrical pressure, or an E.M.F. This E.M.F. is greatest when the cell is doing no work—when it is upon *open circuit*—that is, when there is no external conductor connection between the zinc and carbon, or when the resistance of that connection is infinite. If we connect the zinc and carbon by means of a conductor that has very little resistance, practically no resistance, the plates are said to be *short-circuited*, so that

open circuit means practically infinite external resistance,

and

short circuit means practically no external resistance.

When we have a reservoir of water, so long as the water has no channel by which to flow away the head is constant, but directly we open a channel or channels the water runs away, and the head of water is lowered. If we want to keep the head of water constant at its highest point with the channels open, we must have a pump or some means of obtaining that head; and so we have to expend energy obtained from somewhere to maintain this difference of pressure.

When the electric cell is properly made, then the E.M.F. is like the head of water—constant and a maximum. Use the cell, and we must maintain the E.M.F., and we do this in the Leclanché cell by burning the zinc. Thus, you see, the burning of the zinc is necessary to maintain the difference of pressure, or E.M.F.

Further, if I employ a steam-engine to keep up a head of water, that steam-engine will not enable me to get an infinite difference of level or a head of water infinitely high. A given steam-engine only allows me to get a given head. If I want a higher head, I can use a second engine to help the first, and if the height obtained is still insufficient I can use a third or a fourth. You will see at once that the height is increased only if the engines help each other.

Just the same with my electrical apparatus. One cell will only allow me to get a certain pressure, but I can supplement this by using a second, a third, a fourth cell, and so on till I get a sufficient pressure.

Mr. Kempe, in his pocket-book, gives the following table as the E.M.F.'s of various cells:

Name.	Volts (approximate).
Grove	1·96
Bunsen	1·96
Fuller bichromate	2·14
Leclanché	1·60
Daniell	1·07

In order to obtain a greater E.M.F., I have to arrange the cells so as to help one another to raise the E.M.F. Cells so arranged are said to be in series. Here are four cells, Fig. 5, making a battery so arranged. You see the first zinc

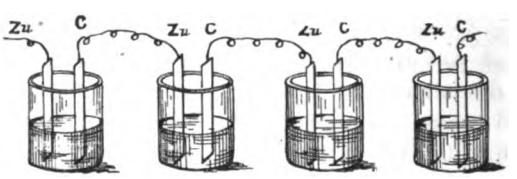

FIG. 5.

on this side is left free to connect to the external circuit, then the first carbon is joined to the second zinc, the second carbon to the third zinc, the third carbon to the fourth zinc, and the fourth carbon is left free to join to the external circuit.

The pressure is assumed to act in all cells from the metal consumed towards the other metal, and in this instance we look upon carbon as a metal. Hence in the battery shown the pressure acts from the first zinc to first carbon, and so on; the current, when any, also flows in the same direction.

If E represents the E.M.F. of one cell, then 4 E represents the E.M.F. of these four cells, and n E represents the E.M.F. of n cells similarly connected.

Recalling Ohm's law,

$$C = \frac{E}{R},$$

where R indicates total resistance, we may for the moment modify this formula, and let R represent total external resistance, and r total internal resistance, and so write

$$C = \frac{E}{R + r}.$$

If, however, r represents the resistance of one cell, then the resistance of n such cells in series is represented by $n\,r$, and we can write the formula

$$C = \frac{n\,E}{R + n\,r}.$$

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Using cells in series, then, adds to the internal resistance. Usually we require all possible E for use in the external circuit, and so desire the internal resistance to be as small as possible, so that as little E.M.F. as possible may be used in overcoming this internal resistance. This necessity for keeping the internal resistance low may modify the arrangement for cells, and there is still another cause which may modify the arrangement. Once more consider the reservoir of water. To maintain the head of water, the pumps have to supply as much water as the channels carry away. Now, a particular pump or set of pumps may be able to keep up a required head if the quantity to be supplied is below a given limit. If the quantity required is above that limit, then another pump, or more pumps, will be required to assist in obtaining the quantity; and these additional pumps must be so arranged as to give that quantity at the given head or pressure.

Ohm's formula becomes, when there is no external resistance,

$$C = \frac{E}{r};$$

and if there are n cells in series with no external resistance it is

$$C = \frac{nE}{nr}.$$

From this we see that adding cells in series when there is no external resistance does not advance us with current, for

$$C = \frac{E}{r} \text{ is equivalent to } C = \frac{nE}{nr}.$$

What I have previously said about resistance is applicable to internal resistance as well as external resistance. We may take the sectional area of the internal resistance as equal to the sectional area of the opposed strips of metal. Thus, in Fig. 4, we may suppose the Zn and Cu strips to be similar in all respects as to size, and take the surface area of one of the opposing faces of the metals as the sectional area of the liquid resistance between them. If we double this sectional area, we halve the resistance just as with a piece of copper conductor. Hence, increasing the opposed surfaces of the strips decreases the internal resistance. So, also, does bringing the strips closer together, for that diminishes the length of the resistance. It is not always convenient to increase the size of the opposing strips, but we can obtain the same result by joining the similar strips in two or more similar cells.

	1	2	3	4	
Cu	——	——	——	——	Cu
	1	2	3	4	
Zn	——	——	——	——	Zn

Suppose the lines represent respectively the Cu and the Zn opposed in four similar cells. Each cell has a resistance, r. If now I join the four copper strips to each other, Fig. 6, and the four zinc strips by good conductors having

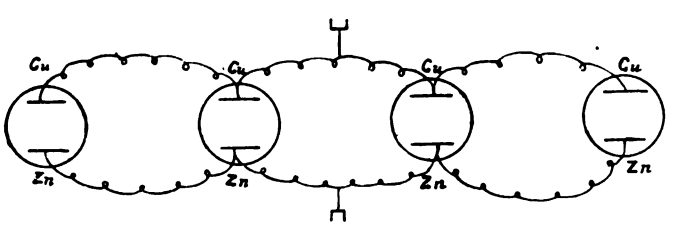

FIG. 6.

a negligible resistance, then the combined cells act as one large cell, giving the E.M.F. of one cell, but having one-fourth the resistance of one cell, or a resistance $= \frac{r}{4}$.

Cells joined up in this fashion are said to be in parallel.

Joining cells in series increases the E.M.F.

Joining cells in parallel diminishes the internal resistances of the combination.

It is easy to combine these ways of joining up, or to arrange the cells in *multiple series*.

THE CHLORIDE ELECTRICAL STORAGE BATTERY.*

The Franklin Institute of the State of Pennsylvania for the Promotion of the Mechanic Arts, acting through its Committee on Science and the Arts, investigating the chloride electrical storage battery, finds as follows:

The sub-committee appointed to conduct this investigation has had this battery under careful consideration for a number of months, and has investigated the several features which are claimed to give it merit. During the larger portion of the time a number of cells have been in possession of the committee, and have been placed upon a regular working circuit under the control of one of the committee's members, where they have been subjected to exactly the same usage as a number of other storage cells of other makers and of the same size, so that opportunity was thus given to obtain the results of the performance of the chloride storage battery in regular use, which is ultimately the final test by which the utility of all inventions and improvements must be measured.

The results of this examination have led to the opinion that this battery embodies certain features of construction which prove it, both theoretically and as verified by use, to be a distinct improvement over hitherto known forms of storage batteries. In order to fully appreciate these features of improvement, it will be necessary to recapitulate, briefly, a few well-known facts regarding storage batteries in general.

In all lead storage batteries, one of the objects desired is to obtain a large lead surface for small mass, as the capacity and discharge rates are strictly proportional to the amount of surface involved. This necessary maximum of surface has hitherto been obtained in one or two ways. The earlier way was to slowly eat out the lead plates by electrolysis until they had attained the requisite spongy condition, an affair of some time and expense. The later way—and the one which is generally practised—is to cast a frame of lead, with raised right-angled ribs on each side, thus forming little depressed squares, or to punch a lead plate full of holes, which squares or holes are then filled with a pasty mixture of red oxide of lead in positive plates, and with litharge in negatives.

For several reasons cells made in this way have always given more or less trouble in service. In the first place, after continued use or during heavy discharges a greater or less amount of mechanical disintegration of the positive plates would often take place, small fragments of lead and lead oxide dropping down between the positives and negatives, short-circuiting them and often causing further and more serious break-up, buckling, and sulphating. Even when these particles are prevented from falling, their mechanical looseness causes poor contact with their supporting lead frame, thus entailing increased internal resistance and heating with diminished output. This disintegration appears to be due largely to the fact that the lead oxide paste placed in the holes is a mechanical rather than a chemical mixture, and hence that in changing from PbO_2 to $PbSO_4$ during the action of the cell, the molecules being only related to one another in a fortuitous manner, are easily broken up and thrust apart in the change of volume attending the chemical action. This, of course, seriously limits the life of a battery and its utility for public service.

In the chloride battery, it is claimed, and the committee's investigations go to confirm the correctness of the claim, that the method of construction is such that this disintegration is far less liable to occur. This mode of construction is as follows:

Instead of cementing lead oxide paste into or against a lead framing in order to obtain the necessary active material, the latter is obtained by a strictly chemical process. Lead chloride is taken, mixed with a given proportion of zinc chloride, and this mixture is then fused and cast in small squares in suitable moulds. When thus cast, the product is of whitish colour and vitreous character, being quite brittle.

For the negative plates, these blocks are about ⅛in.

* Being the report of the Committee on Science and the Arts on the invention of Clement Payen. Issued from the Franklin Institute, Philadelphia, March 29, 1894.

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square and $\frac{5}{16}$in. thick, and are cast in groups of four, these groups being united by portions having, say, $\frac{3}{32}$in. to $\frac{1}{8}$in. thickness. For positives, the fused mass is cast in separate lozenges, each lozenge having a bevelled V-shaped periphery. These cut squares or lozenges are then placed in a suitable mould, and a molten mixture of lead and antimony, in proper proportions, is cast about them under high pressure, thus fixing them securely in a firm lead framing of somewhat more than the usual density. (The feature of casting under pressure is an improvement in manufacture, due to Mr. H. Lloyd, who is connected with the American makers, and the process is protected by patents granted to him). The connecting sheets of the squares making up a group, and the V-shaped bevel of the lozenge, serve to make their solidity of fixation exceedingly good.

The frameworks containing the chloride castings are then placed in a dilute solution of zinc chloride, together with plates of zinc, the frames and zinc plates being alternated with one another and in metallic contact. This combination is the equivalent of a primary battery "dead short-circuited." The chemical reactions which occur result in the removal of the zinc chloride and the chlorine of the lead, and there remains finally the dense framing containing squares or lozenges of spongy lead, which plates are then "formed" in practically the usual manner.

If a section of the spongy lead thus made be examined, it is found that the metal is in a crystalline condition, and that the crystals are all uniformly arranged with their longer axes perpendicular to the surface of the plate. This provides interstices, so that the changes of volume occurring in the chemical reactions of electrolysis may take place without exerting lateral pressure upon the crystals, or otherwise crowding them into a condition of break-up. These crystals are not, of course, mechanically and irregularly bound together, but are related to one another according to the laws of molecular formation, and are consequently much more strongly bound together than if they had been mechanically combined.

Furthermore, this crystalline structure presents the maximum obtainable surface for the given mass, an infinite number of inter-crystallic channels passing all through the material and the entire plate being of the same thoroughly spongy consistency, except in those small portions where the continuous lead framing is encountered.

The effect of this extreme porosity and surface area is to give the battery a maximum capacity for a given weight and size of cell, an item of great importance when considered with reference to the demands of traction. Very heavy discharges also can be taken from this battery, owing to the interstices between the crystals permitting changes of volume to occur without mechanical violence to the structure.

While the method of construction just described seems to accomplish its anti-disintegrating function perfectly, it has been thought best by the manufacturers, in order that there shall be no doubt about the matter, to introduce between the plates a thin sheet of acid-proof fabric, so that any small particles which might fall away could not make metallic contact with two adjacent plates and thus short-circuit the cell. The fabric chosen for this purpose is woven asbestos cloth. It might be thought that the introduction of this asbestos would considerably increase the internal resistance of the cell, but the fact is otherwise, the resistance of the cell being not appreciably higher than that of other lead cells.

This is undoubtedly due to the fact that the larger part of the resistance of most lead cells is that caused by poor contact between the lead framing and the paste placed in it. In the chloride battery this contact is exceptionally good, owing to the pastilles of chloride being so firmly bound by the framing cast under pressure as to compensate for any resistance due to the asbestos.

These batteries are, and have been for several years, operating successfully and in very large numbers in the city of Paris as a source of current for lighting purpose. A large plant has been in operation in this city in the building of the Provident Life and Trust Company for a year past, and a very large one has been installed at the station of the Germantown Electric Light Company, where it is said to have given, thus far, entire satisfaction.

The manufacture of this battery is protected by a large number of patents of the United States and of foreign countries. The essential features of the process of manufacture, however, are covered by the patents granted to Mr. Clement Payen.

Believing that this battery is a noteworthy and meritorious improvement upon many other forms of lead battery, tending to greater durability, greater capacity without increase of weight, and making possible heavier discharges without injury, the institute, therefore, recommends the award of the John Scott legacy premium and medal to Clement Payen, the inventor.

ELECTRIC TRAMWAYS AND TELEPHONE WIRES.

The question as to what is the best method of protecting telephone lines from injury by the working of electric tramways is again discussed in the *Elektrotechnische Zeitschrift*, Dr. V. Wietlisbach, of Berne, taking up the subject in that journal of October 11. The writer reminds us that the disturbances caused in telephone operation by electric tramways are both electrical and mechanical. The first mentioned are noticeable by noises in the telephones and the difficulty of understanding conversation, and the second by the two networks coming into accidental contact, resulting in the fusion of wires and possible damage from fire.

The electrical disturbances are set up in the first place by the strong current passing along the rails to earth, entering the telephone appliances *vid* the earth wires of the telephone system; and secondly, by electro-dynamo induction of the parallel carried lines. Another effect of the current passing along the rails is the electrolytic action on gas and water pipes. This difficulty has been overcome in Switzerland by the arrangement of a copper wire 7mm. to 8mm. thick (of the same strength as the contact wire) near the track. This wire is connected to the rails at intervals of at most 100 metres, and with the generator at the power station. Experience has shown that by the use of this wire the so-called roaming, or "vagabondising," as Dr. Wietlisbach puts it, currents are completely removed, at least from telephone wires. For instance, notwithstanding the fact that in Zurich a large number of telephone stations, with their "earths" generally connected to the water-pipes, is situated in the immediate neighbourhood of the electric tramway, no noise is heard in the telephones. As is known, this noise causes interruption in those towns where there is no return wire, but where the rails are provided with earth-wires. By the use of the return wire, the electrolytic action of the current on the iron and lead pipes laid in the ground is to a large extent removed.

It is not so easy to overcome the effects of induction as that of a current distributed along the rails to earth. Experiments made by the author with the Zurich tramways and telephones showed that a noise arose with a parallel arrangement in the same street for a distance of 500 metres of both conductors separated by a distance of 10 metres, the disturbance rendering the comprehension of conversation difficult.

As a result of his experiments, Dr. Wietlisbach comes to the following conclusions: (1) that the parallel arrangement of single telephone wires only for a length of 100 metres in the same street as an electric tramway is excluded; (2) that with the loop system the parallel method is practicable for about five kilometres, although all wires along the route must be looped; (3) that long lines, especially those connected with other long lines, are best carried another way; (4) that crossing is not injurious if not too often repeated, and if it is effected in a suitable vertical distance from the contact wire. The author finally discusses the subject from the mechanical point of view.

Electric Lighting in France.—The local gas company at Angers, which has a monopoly for gas lighting until 1929, is being asked to introduce the electric light into the town. The railway station at Niort has been installed with the electric light.

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MONOCYCLIC ALTERNATING SYSTEM FOR SIMULTANEOUS LIGHT AND POWER WORK.

The issue to hand yesterday of the New York *Electrical Review* for October 10 contains a long article dealing with a monocyclic alternating system for simultaneous supply of light and power introduced by the General Electrical Company, of that city. This method has been devised for the distribution of alternating currents for lighting with incidental power, and our contemporary considers that this system is the most recent and most promising innovation in the electrical power transmission field. To it has been given the name monocyclic, and it constitutes a complete central-station lighting and power system. We quote the following from our contemporary:

The system takes the place of the well-known high-frequency system in central-station work, operating transformer systems, and distributing networks in the same manner, with the additional advantage of being able to supply the current to motors by means of a balance wire, which is carried only to places where the motors are to be used. The principal advantages attained by the monocyclic system are the following: It can operate incandescent and arc lamps and motors in parallel from the same generator, and even from the same transformer; it solves the problem of the operation of alternating-current motors which has for so long proved the *bête noire* of the electricians—the motors employed being not only equal but claimed to be superior to continuous-current motors in their constancy of speed, great simplicity, and absolute reliability, commutators, collector rings, brushes, or moving wires, being entirely absent. They can be started at full load with normal current. By the flexibility of voltage incident to the use of the transformer it is able to operate low-tension networks on the Edison three-wire system in the same way as the continuous-current lighting system, and even with the use of the same overhead or underground mains. It affords a better balance and entails less expenditure of copper by replacing the heavy low-tension feeders with high-tension primaries of much less cross-section feeding into the mains by transformers.

It offers the same simplicity as the ordinary alternating-current system, and differs from it only in its ability to operate high-grade motors by means of the third wire, which is similar to the neutral wire of the Edison three-wire system. It allows perfect operation of the whole system of the generators in parallel, the whole lighting and power station being operated from three 'bus bars, only the third 'bus bar being provided for the supply of current to the motors. By the use of two transformers, three-phase, quarter-phase, or any other type of alternating motor may be supplied with current. The low frequency of 7,200 alternations per minute used with this system reduces the effects of line inductance, and is consequently favourable to transmission over long distances. The generators and motors are both slow speed, and for both generators and transformers are claimed an efficiency and regulation never before attained.

As above said, the lighting system is operated in the same way as in the old alternators by two wires and one transformer, which supplies a two-wire or Edison three-wire system from its secondary terminals. From the same mains, however, motors are operated, and in this case two transformers are used, connected between the main wires and the supplementary or power wire; in which, by the action of the motors, an intermediate but laterally displaced voltage is established and maintained. For this purpose the generator armature contains besides the main coil a small supplementary or teaser coil, which is connected with one end to the centre of the main coil, while the other end is led to the third collector ring. It is obvious that this third collector ring is used only for supplying motors, while the lighting current passes exclusively through the main collector rings, and that the third or power wire needs to be carried only to where motors are located, and, since it does not convey large currents, needs to have a small cross-section only.

The frequency for the monocyclic system has been fixed at 7,200 alternations, or 60 cycles per second. This frequency is better adapted to the general requirements of incandescent lighting than any other, since higher frequencies occasion inductive effects in conductors which more than outweigh the advantages gained in reduced transformer cost, while with lower frequencies the increased cost of transformers is a serious objection. For arc lights also this frequency is very desirable, since we cannot go much lower without having an unstable arc, and since increased frequency increases the humming which is caused by all alternating arcs. At 7,200 alternations this noise is inappreciable. Besides, this frequency gives a convenient number of poles in motors at moderate speeds, and is consequently well suited to power work, while at the same time it allows the operation of generators running at about one-half the speed of the old high-frequency alternators.

For very long-distance work occasionally a frequency of 33 cycles per second, or 4,000 alternations per minute, is used—33 cycles have been chosen in this case as being 10 per cent. higher than the lowest frequency at which incandescent lighting is still perfectly feasible. In general, however, 60 cycles per second, or 7,200 alternations per minute, are preferred as standard frequency.

The alternating-current generators have been designed with all the qualities requisite constantly in view. The reliability of the machine is increased by the care bestowed on the insulation, which renders the use of high voltages possible. The number of armature coils has been reduced, and these coils are machine wound, insulated, and afterwards slipped into the armature slots; thus they are easily replaceable. The generators are compounded for constant voltage under all loads, or over-compounded up to 15 per cent. to take care of the drop of voltage in the line.

The bearings are both self-aligning and self-oiling, running with scarcely a tremor and exceptionally cool. Most of the machines can be arranged for direct propulsion by high-pressure waterwheels, the large units lending themselves readily for direct coupling to turbines. All the generators have a commercial efficiency of at least 90 per cent., rising to 95 per cent. in the larger sizes.

The transformers employed in the monocyclic system are designed for frequencies between 33 and 60 cycles, and have as high an efficiency as the standard transformers. Thus they can be operated not only at the standard frequency of 60 cycles, but also in those cases where for long-distance work 33 cycles have been chosen. All these transformers are oil insulated.

Sub-station transformers have also been designed for power transmission work where the transformer units may be banked in groups of large output. These are more particularly suited for step-up and step-down work, and for all sub-station distribution. They are without oil insulation. They are thoroughly ventilated, and each bank is provided with one or more ventilating blowers passing a draught of cool air through them. The efficiency of these transformers is very high, notwithstanding the decreased frequency, owing to the care used in the selecting of the iron, and ranges from 96·5 to 98 per cent., and even higher in very large units.

All the low-frequency alternators are fitted for use as synchronous motors, and will run up to speed under light loads without the use of clutches or starting motors. They have as synchronous motors the same high efficiency as the generators, will run in absolute synchronism with the generators, and will stand very heavy overloads without falling out of synchronism. They also possess the valuable property of compensating for the loss of voltage by the self-induction of the line and for idle currents, by their action as condensers.

As our readers are aware, an induction motor is one with a closed-circuited armature having no connections with the supply circuit. Such a motor, however, can with a simple alternating current of the old type of machine not start of itself from rest under full load without excessive current. This difficulty has been overcome in the new monocyclic motor, which in its action is essentially identical with the best three-phase motors built. It has a closed-circuited armature wound with a small number of heavy copper bars

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of low resistance, and a starting rheostat is placed within the armature spider. At starting, the coil sliding along the shaft is kept out of contact with the switch used to short-circuit the resistance, but when the motor is approaching full speed the contact ring is moved along the armature shaft until the armature is short-circuited on itself. Thus a very large starting effort is obtained with the current limited to a reasonable amount by resistance.

In all the standard induction motors the starting resistance is adjusted so as to give a starting torque 50 per cent. in excess to the running torque at full load, and requiring, therefore, an excess of 50 per cent. of current over full-load current.

The field winding of the motor is very similar to that of the three-phase induction motor, with the difference, however, that only two of the three terminals are connected with each other and with the teaser coil of the generator by the intervention of transformers.

WORKMEN'S RULES

[The following are the rules and regulations adopted at St. Louis. We give them complete, and ask our readers to criticise, so as to be able to obtain a set of rules suitable for English central stations.—ED. *E. E.*]

INSTRUCTIONS AND CAUTIONS.

1. Do not handle any electric light apparatus while you are standing on the ground.

2. Never use both of your hands while handling dynamos, or anything pertaining to same, while said dynamos are being used.

3. Do not touch a water-pipe, iron post, or any stone, brick, or iron structure while in contact with a lamp, line, dynamo, or anything connected with the electric light apparatus at the same time, unless you are provided with rubber gloves and other insulating material, which the Municipal Electric Lighting and Power Company has declared to you to be necessary and sufficient to fully protect you from accident by the electric current.

4. When your business necessitates your going through the station, keep as far as possible from the machinery and belting, and do not meddle with anything unless you are ordered by the man in charge, and then only after receiving careful instructions.

5. No one is permitted to in any manner work on the switch-boards except when directed so to do by the man in charge of dynamo-room, and then only after receiving careful instructions.

6. Keep away from the lightning arresters and wires leading to them.

7. Linemen or others operating on lines must handle each and every wire at all times as if it were charged with the electric lighting current and grounded.

8. When obliged to pass over, or under, or by an electric wire, avoid touching it in any manner, and especially with any uncovered portion of your person. Damp or wet clothing makes chance contact with wire dangerous.

9. Tools used by linemen and others who have occasion to work on lamps or apparatus which may be charged with the current, must have handles well covered with rubber or other insulating material, and it shall be the duty of every lineman to look after his tools and see that they are in good condition for use, and especially as to the insulation of the handles.

10. If it is at any time necessary to stand on the ground or any surface not insulated from the ground while handling electric wires or apparatus, heavy gum boots or an insulated stool must be used; and under no circumstances allow yourself to make contact between two or more wires at the same time.

11. Lamp trimmers and others engaged in taking care of and trimming lamps must see that the switch on the board from which the lamp hangs is closed before they proceed to handle the lamp. Instruction laid down in Article 3 of these rules must be observed in connection with the work of handling the lamps.

12. In the event of anyone in any manner being caught on live wires, where it is possible to get to them, pull the one caught away by grasping any portion of his clothing or body protected by clothing. There would be no possible danger to the one rendering help, no matter where you might be standing. If the one caught should be on a pole or ladder, he could usually release himself by kicking himself loose from the supports, or drawing up his knees, thereby causing the body to fall. It is understood that employés will wear and use their safety belts when working above ground on poles or ladders, especially when handling wires.

13. Rubber gloves, rubber insulating materials for tools used by employés, and other protective articles will be found in the store-room. Employés have every access to these goods at all times through the storekeeper. They should examine their gloves and the insulation of their tool handles daily, and if they discover any defects therein, return the same to the storekeeper, and select themselves perfect tools in place thereof. No charge has been made or will be made for goods thus exchanged. Employés who have been provided with tools must return them on leaving the service of the company, or the cost of the tools will be charged against their account.

14. Any employé known to violate any of the above rules, or disobey any of the instructions or cautions, thus endangering his own life or the personal safety of others, will be immediately dismissed from the service, if complaint is made at the office.

GENERAL INSTRUCTIONS.

1. All employés are requested to report anything of interest to the company which they may learn, whether in their department or not, so that the best results may be obtained at all times in all departments.

2. All instructions which follow must be read and observed by all employés, wherever they may apply to any work they are required to do, whether designated for the government of the department they are in or not.

3. At the station, papers and books are supplied relating to the business, and you are urged to spend an hour or two using them when you can.

4. All necessary line tools that you are required to have will be furnished by the company on application to the storekeeper, except pliers, connectors, climbers, screwdrivers, belts, and other similar small tools. These tools all linemen must own. If desired, they can be purchased of the company, and on leaving they can be returned and the money will be refunded. All tools above mentioned issued by the storekeeper will be charged and deducted from your pay.

5. Do not use defective tools or appliances, whether yours or those of the company. If you have defective tools, ladders, or other appliances, you are hereby ordered not to work with them, and no foreman or others must be regarded who instructs you otherwise.

6. A written report of all accidents, whether to persons or property, wherein this company could possibly be interested, must be made on the accident blanks and forwarded to the office as soon as possible after the accident occurs.

LINE WORK.

When cutting wire, grip the line with the cutting jaws of the pliers and move up and down at right angles with the wire two or three times, so that you cut the insulation part of the way round on both sides; then hold your pliers firmly, bend the wire once or twice up and down with your left hand and the wire will break. Never try to break the wire by twisting your pliers, unless you first move the line out of the cutting jaws. There is no excuse for nicks in the cutting jaws of Stub's pliers, and careful linemen rarely have it happen.

7. In stripping the ends of wire to make a connection, always cut along the wire towards the end, in much the same manner as if whittling a stick. Never cut round the wire with the edge of the knife or pliers, except when cutting the wire.

8. In making joints, be careful never to let the cutting jaws or edge of your tools "score" the wire. If you do, don't cover it up, but make a new joint.

9. After a joint is made with not less than four turns each side of the connectors, dip or moisten with acid. If you are on the ground, dip the joint in melted solder and hold it there a few seconds to thoroughly heat the joint, then take it out. If well "tinned," dip it in water to remove any acid which may be on the ends of the wire near the insulation.

10. If where you cannot dip the joint, but have to use the ladle, pour the solder frequently over the joint until it leaves a thin, smooth coating on the wire. It is not properly done if the solder is in lumps or on in a thick layer.

11. If you are obliged to use a "blow pot," hold the joint in the flame until the solder will easily melt when held against the wire after the flame is removed. When this is accomplished, apply the solder with the flame and not before.

12. Solder is put on the joints to keep them from corroding, thereby ensuring good contact where the two wires come together, and is of no use if not well applied.

13. After the joint is well cleaned of acid after being soldered, paint it thoroughly with insulating compound, then cover with a layer of tape, which you will start on one side of the joint, against the insulation of the wire, but not over it. Have the first layer cover the joint and bare wire only. When this is done, paint it, then start back over the joint and tape until you have run over the line insulation about 2in., then wrap two more layers, painting each when done.

14. In wrapping tape, cover what you have half, or lap one-half. After four layers are on, paint the whole thoroughly.

15. Whenever you find a break in the insulation on the line anywhere, paint it first, then tape and paint it. Don't forget this.

16. In "tying in," never draw the tie wire so as to bend a kink in the line or cut through the insulation with the tie. A tie will properly hold the wire in place without drawing it so tight as to do either.

17. In using pulley blocks on the line, avoid the use of "come-alongs" when possible by taking a series of half-hitches, or making a "noose-wrap" with a small line on the wire to hook the block to. If you do use "come-alongs," see that you do not score, cut, or kink the wire, and always paint and tape broken insulation.

18. Groundmen are especially cautioned to watch the line in "paying out," and prevent "kinking." Should a short kink get pulled into the line, cut it out rather than take the risk of its breaking, though you should straighten it out.

19. Never use porcelain knobs where exposed to moisture or the

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weather, and never use them anywhere else if glass can possibly be used.

20. Porcelain knobs circuit-breaks may be used where necessary, providing not more than two lamps are on the loop. In making them, paint and insulate with tape the joints in connecting wire of loop.

21. In making house connections where wires enter building, be sure to have not less than 6in. clearance from cornices of walls. All wiring running over cornices or other building projections must be protected with rubber tubing, thoroughly taped and painted at the end. Never let a wire, however well protected, come in contact with any outside portion of the building.

22. In placing tubing on wire, carefully paint and tape at the upper end, leaving the lower end open, so that moisture could escape if it got in.

23. Always run wires in straight parallel lines, and make square turns where possible. Twelve inches between wires is the proper space for arc lighting circuits, where practicable.

24. Never fasten a cut-out box against the wall. Always place glass or porcelain knobs between the box and the wall.

25. Never fail to put in "drip loops" in line where entering building.

26. In all electrical work, remember where insulation is desired it can never be too good, or when contact is desired, you can never make it too good or strong.

27. In removing lamps ordered out, always close the loop at the line where it was originally cut in, and remove all dead wire. Never leave dead or unnecessary wire in circuit.

28. Always use iron pins on arms where wires turn a corner or leave the line.

29. Never screw an insulator on iron pin or bracket very tight, nor without first putting inside the glass a strip of paper folded twice or three times. This will prevent the glass being broken, as iron expands with heat nearly twice as rapidly as glass, and unless there is room enough, the difference in temperature between winter and summer would burst insulators in summer which were placed in winter.

30. In connecting line to lamps hung from suspension wire, put on safety loops by making a half-connection with a short flexible wire on each side of the insulators at the pole and on the lamp hood. Solder and tape same as other joints. Arrange the length of wires leading to lamp so the lamp will not shadow the roadway of either street.

31. No joints are to be permitted to be made and left without being soldered.

32. When working on an arc circuit, always keep it closed, unless you are able to have it tested O. K. during the day from the station at one o'clock, and from three to four, or as agreed with the chief inspector.

33. When placing guard wires on street crossings always use iron pins and glass insulators to attach both ends of guard wires to. Never tie on cross-arm on pole. In stormy weather, when they may be of use, they would be dangerous every way.

34. In working on lines all circuits must at all times be regarded as alive and grounded. With the hundreds of miles of wire throughout the city, some of which are carrying heavy current at all times, many using ground return, the line you are on may "come alive" at any time—be careful.

35. Always avoid temporary work. It is your orders at all times to do what you do thoroughly.

36. When working on poles, be careful to stand so, if you should slip or get a shock, you would fall on your belt rather than on the wires.

37. Avoiding leaning over or crowding through wires when possible, and do not put yourself in a position where you would fall on wires, should an accident occur.

38. Always in making connection on poles, work from below rather than above, when possible.

39. Examine cross-arms and see that they are sound and firmly fastened before trusting your weight on them.

40. Always report anything found defective, especially cross-arms or poles.

41. Be careful that all tools are securely fastened in your belt when working on pole or ladder, and, in handling wires and lines on poles, have a proper regard for the safety of those walking or driving below.

42. When working on poles, always use your safety belt, as well as other safety devices which you are requested to use. It takes but a little time to make yourself safe, and many weeks to mend a broken bone.

43. Never lay tools down when above the ground.

44. The company demand that you take the necessary time and precaution for your own protection and that of others at all times.

TRANSFORMER WORK.

45. In placing transformers and making connection for same, you will always leave the line connection where you branched off to be made after all other work is completed. The primary fuses at the transformer must be left out until the final line connection is complete.

46. In making connections to constant-potential (alternating or 500-volt) circuits, always finish one connection before breaking the insulation on the other line. Remember this: that you must have but one wire or joint bare at the same time when working on the lines.

47. After completing a transformer connection, and before closing line connection, carefully paint the entire outfit (except glass insulators) with insulating paint.

48. See that all wires leading out of transformers and out of fuse-boxes are well taped and painted where they leave the transformers, and all transformers must be placed so far from doors, balconies, windows, and other openings, and sufficiently high above ground and roof as to prevent accidental contact—in other words, out of reach.

49. All secondary wires from transformer to house should be as well insulated and protected from ground as if carrying high-pressure currents.

50. In plugging brick or stone buildings, paint the plugs with insulating compound before driving them.

51. All supports for transformers and fuse-boxes placed on buildings must be well painted with insulating paint.

INSPECTOR'S SPECIAL INSTRUCTIONS.

1 At all times when on duty your carts must be supplied with rubber gloves, boots, coat, and hat; also pliers, connectors, climbers, jack straps and vise, safety belt, hand axe, insulated stool, magneto, two or three brackets and glass, tape, carbons, line wire, jumpers, and hand-line.

2. Inspectors away from their carts, or those not provided with carts, are requested to have and to use their necessary safety devices and clothing where handling lamps or lines.

3. In working on lamps or lines, always regard the line as grounded and alive, whether it is or not. Observe this rule in hunting trouble on "dead" circuits. They may be "O. K'd" at any time by others and the current put on without a report from you. They may also cross up elsewhere with live circuits.

4. Report to their headquarters as soon as you can any trouble discovered on the lines of other companies, and report dangerous conditions existing to the City Lighting Department if you are in doubt as to the ownership.

5. Avoid interference with foreign wires where possible, but if you find the lines of other companies so situated as to be dangerous to the public, do what you think is right, and report to the owners and to this company by nearest telephone and make written report as well.

6. In the event of injury to persons or property by the wires or appliances of this or any other company, where the electric current could possibly be the cause, investigate fully and make full written report to this company only. If trouble was the result of cross or dead or broken wires, find out how the cross was made, how the wire was broken, to whom the wires belong, the names of witnesses and parties damaged in any way; in fact, report all you can find out and find out all you can.

7. Report by telephone, day or night, to the general manager any serious or unusual trouble as soon as practicable.

8. All repair work where material is used must be reported on a separate slip.

9. In putting on jumpers be careful that the loop of jumper does not lie on wire below, to make a cross possible if the insulation does not hold.

10. All inspectors when away from the plant are requested to report by telephone as often as practicable. All inspectors must report as often as once an hour during their entire watch, especially if on trouble.

11. Inspectors must report by telephone to plant any repair work to be done by linemen which has been occasioned by temporary work while on watch.

12. Mounted commercial inspectors must remain at the office when not out with their horses on regular duty.

13. All mounted inspectors must keep their carts as near their work as possible when out; at other times, at the station or office, and remain there themselves.

14. In addition to reporting by telephone when out, report to station at the time you go off duty, notifying the one in charge that you are off and that you will be off after that time.

15. Record on telephone sheet any call for extra service, and report same to office on properly signed blank form No 3.

16. No extra service will be furnished except by instructions from chief of dynamo department or the office.

17. In clearing trouble of any kind, where temporary work only can be done by you, make a full report on separate trouble slip, so that it can be properly repaired later. Unsoldered joints, broken insulation, bracket work on poles or similar troubles, as well as defective pins, cross-arms, poles, windlass-boxes, etc., should be reported separately.

18 Maps of alternating circuits, showing locations of branch cut-outs, must be carried by all inspectors.

19. Inspectors can find separate maps at station or office, which they can take with them if necessary.

20. All items of interest relating to the condition or operation of the plant in any manner you are requested to report.

21. Always be gentlemanly to customers and to the public.

22. Always wear your uniform and badges when on duty.

23. Always leave memorandum at station where you are gone.

INCANDESCENT WORK.

24. You must at all times be supplied with a complete supply of fuses. Exchange your wallet once a week or oftener, if necessary, for a full one.

25. In renewing fuses be sure that the binding post screws which hold the line wires are firmly set. Fuses are frequently blown by loose line connections.

26. When primary fuses are blown, examine transformer for short-circuit or leakage before replacing them.

27. When main-line secondary fuses have blown, test with the current for ground if circuit is being used; if not, test with magneto bells, first removing both fuses on main block and testing wires to lamps only.

28. In fusing primary circuits only, observe the following. Never fuse transformer with larger fuses than the following.

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10-light,		½	ampere.
20	,,	1	,,
25	,,	1	,,
40	,,	2	,,
50	,,	3	,,
100	,,	5	,,

Never fuse transformers until all the work is completed on the outside lines and you know the inside work is ready.

29. For fusing on secondary circuits only, be governed by the following:

For 50-volt lamps.

1 lamp,	use	1	ampere.		
3 lamps,	use	3	amperes.		
5 lamps,	use	5	amperes.		
6 to 8 lamps,	use	10	amperes.		
10 ,, 12	,,	,,	15	,,	
15 ,, 18	,,	,,	20	,,	
20 ,, 30	,,	,,	30	,,	
40 ,, 45	,,	,,	50	,,	
50 ,, 60	,,	,,	60	,,	
70 ,, 80	,,	,,	80	,,	
80 ,, 90	,,	,,	100	,,	

For 100-volt lamps.

1 to 2 lamps,	use	1	ampere.		
3 ,, 5	,,	,,	3	,,	
5 ,, 10	,,	,,	8	,,	
10 ,, 15	,,	,,	10	,,	
20 ,, 25	,,	,,	15	,,	
30 ,, 35	,,	,,	20	,,	
40 ,, 50	,,	,,	30	,,	
60 ,, 70	,,	,,	40	,,	
80 lamps,	use	50	amperes.		
100	,,	,,	60	,,	
120	,,	,,	80	,,	
150	,,	,,	100	,,	
200	,,	,,	130	,,	

30. In placing fuses on secondary circuits, always open the switch on the branch being fused, or turn the lamps "off" at sockets before replacing fuse.

31. When replacing fuses, always test for grounds or short-circuits on lines where fuses are blown.

32. Use your fused testing wire for all tests on secondaries if testing with current. When grounds are found, unless cleared by you, the branch grounded must be left cut out and the office notified.

33. If grounds or short-circuits develop on house wires, inform the owner and ascertain if he wants the company to correct the fault at his expense. Report to the office by telephone, if necessary, what trouble is found, and the owner's name, unless you locate and correct the fault. The usual report in writing will be necessary.

34. Always cut out entirely any faulty transformer and report by telephone at earliest moment in the daytime, so as to allow as much time as possible to change it.

FIRE RULES.

35. Record all fire alarms on telephone blank, and when location is discovered, examine the maps, so that you may be familiar with the locations of the circuits in the vicinity should a second alarm call you out.

36. When out, if you discover a serious fire, go at once and see if our lines are likely to be in the way.

37. In answering second alarms always report to the police captain and the fire chief on your arrival, and inform them where you will likely to be found about the fire.

38. If the supervisor of city lighting is on the ground, render him any assistance you can.

39. Don't neglect the company's interest at any time for that of others.

40. Save any property of the company in or near burning buildings only when you can do so without risk to yourselves.

41. Be of such service to the fire chief as you can, so far as it relates to your business.

42. Avoid cutting wires when possible, and arrange to renew the service as soon as possible if you do cut them.

A thorough knowledge of the circuits will enable you to do your work easier and in a more satisfactory manner to yourselves and the company than if you fail to acquire this. Study the maps.

DYNAMO DEPARTMENT.

1. The number of lamps on each circuit must be recorded on the circuit-board each day.

2. All new city lamps and circuit changes will be made on map-board and must be noted in this department.

3. All station employés are requested to study the circuit maps and become familiar with the locations of the different circuits.

4. On receipt of telephone or other message to cut out any circuit for the protection of life and property, do so promptly. On an arc circuit, always run the brushes up before pulling plugs on switchboard. On incandescent, by cutting in resistance at switchboard to kill the dynamo; then open the switch.

5. When a live circuit opens during a run, the dynamo must be cut out at once and left out until the trouble is located and O. K'd. by linemen or inspector.

6. Circuits ordered open must be marked on board with coloured chalk. All other circuits must be marked "O. K," with white chalk. This must be done only by those authorised so to do, and must be reported to man in charge in dynamo-room.

7. Never "try" a circuit with dynamo that opens during a run, until the trouble is located, no matter if it "rings" closed.

8. Never connect dynamo to a circuit on which men are at work, without instructions from the men to do so.

9. When an arc light or motor circuit is reported "O. K." after it has been open, build up current very slowly at dynamo by hand, and take about five minutes to put full current on, because it frequently happens that linemen will leave their work and start out on a circuit looking for trouble, without first notifying the station. By starting the circuit in this manner, should they be in a position where they might feel the current, they would likely have warning before current reached a dangerous intensity.

10. Never run two machines in series. Doing this will be sufficient cause for dismissal. No excuse will be accepted for disobedience of this rule.

11. Rubber mats and gloves must be used when working the switchboard. The same rule applies to work on dynamos when running.

12. An arc made by electricity can frequently be blown or whipped out with a towel, on continuous-current circuits, and should be extinguished in that manner if the connections which occasion the arc cannot be easily separated.

13. In the event of a short-circuit on alternating lines or switches in station, the current can be safely shut off by cutting in resistance on exciter at switchboard.

14. Water will not extinguish an electric arc or fire when produced only by the current.

15. Large canvas covers are available, which should be quickly spread over the dynamos if water is used to extinguish fire on the floor above.

16. Fire-buckets must be kept filled with both sand and water on each floor in machine building above engine-room. In many cases sand will prove more useful than water in extinguishing a fire. The hose on each floor must be kept connected and ready for use.

17. In using sand or water remember that a little well directed is better than quantities thrown wildly. Use no more of either than is absolutely necessary, as it is easy to do more damage with them than would be likely by fire.

18. Any faulty lamps, wires, belts, or anything else reported to this department must have immediate attention from the man in charge.

19. Always report to the general manager by telephone, at his office or residence, anything whatever which he should know. Do this promptly.

20. None but employés are permitted in the building without a pass. Men in charge are requested to respectfully enforce this rule.

21. Smoking is absolutely forbidden.

22. Always record all telephone messages.

23. Read all other rules, part of which apply particularly to this department, and a knowledge of them is required of you.

SHAFTING FLOOR.

1. Permit no one here except on business.

2. Do not approach the shaft between the pulleys while it is running, particularly that portion of the shaft where clutches are carried, except when it is necessary to examine the bearings. Then be careful that you have plenty of clearance between your body and the edge of the running pulley or clutch mechanism.

3. You must not wear loose or flapping clothing. Be careful that your sleeve does not hang down and that your jacket is worn buttoned.

4. Notify the dynamo tender in charge if a belt is flapping or jumping too much, or of any defects in the belts. Should a clutch slip, notify him, so that it may be thrown out if possible until it can be cared for.

5. Never clean shafting while it is running.

6. Examine daily your grease-cups and see that they are in working order, and be sure that all standing pulleys on running shafts are well lubricated. Before examining these, inform the dynamo tenders, so that they will not throw the clutch in while you are about the pulleys.

7. Keep your machinery clean and your floor free from dirt.

8. All towels, clean or dirty, must be kept in the cabinet provided for them.

9. The hose on this floor must always be connected ready for use in case of fire, and fire-buckets must be kept well filled.

10. In the event of fire avoid throwing water on belts. Use as little as possible on account of injury to belts and machinery below.

11. Report immediately to engineer on duty any machinery which appears defective or in any manner out of order; also make written report of same to chief engineer.

12. All engine belts must be "slacked off" when engine is stopped.

13. If dynamo belts are left tight, notify the man in charge of dynamo floor, or the engineer in charge.

14. If you notice any wires out of place or in trouble, report immediately to the man in charge of dynamos.

15. Do not handle any wires.

16. Smoking is absolutely forbidden.

17. Read all rules as well as those of your department.

ENGINE-ROOM.

1. No one, except employés whose business requires it, is permitted in this room without permission of the chief engineer, or a pass from the office; then only at their own risk.

2. No one must be permitted about the machinery whose business does not require it.

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3. All are cautioned to use the greatest care when about the engines to avoid accident. Loose or flapping clothing must not be worn, and jumpers or jackets must be worn buttoned.

4. Anything unusual must be reported to the chief engineer at once, or the engineer in charge.

5. In the boiler or engine room, or anywhere else, avoid contact in any manner with wires or lamps.

6. Faulty lamps or other electrical apparatus must be reported at once to the one in charge of dynamo floor.

7. Dynamos or wires on engine floor must not be handled by others than the engineer in charge or the man in charge of dynamo floor, and then only in the manner indicated in the rules for the dynamo department.

8. Should it be necessary, in case of accident, you can instantly stop the alternating current from any machine by throwing the small exciter belt, or by cutting or pulling loose one of the wires from the small exciter which is driven by the machine from which the current should stop. This can be done without danger.

ELECTRIC LIGHTING AT WORCESTER.

RULES FOR INSTALLATION WORK.

The Corporation of Worcester, for the guidance and information of consumers proposing to have their premises fitted for the electric light, have issued the following rules, which embody the principal requirements necessary to ensure safety. The Corporation do not take any responsibility with respect to any installations, nor will they be answerable for any damage which may arise from any defects in them. The Corporation strongly impress on intending consumers the great importance of having the work carried out by competent contractors. Inferior materials and workmanship are the cause of constant accidents and annoyance.

Service.—The Corporation will lay the service line from the main to the meter, and will charge the consumer for the whole thereof, with the exception of the portion of the service line extending from the main to a point 10ft. within the boundary of the consumer's premises, or to the meter, if it be situated within that distance. The portion excepted will be laid without charge to the consumer. The charges to consumers for service lines to supply 16-c.p. 60-watt lamps or their equivalent will be as follows:

	Per yard.
Not exceeding 15 lamps for a distance of 50 yards	3s. 6d.
Do. 15 do. 100 ,, ...	3s. 10d.
Exceeding 15 lamps and not exceeding 20 lamps for a distance of..... 50 yards	3s. 8d.
Do. 20 do. do. 100 ,, ...	4s. 6d.
Do. 20 do. 30 do. 50 ,, ...	4s.
Do. 20 do. 30 do. 100 ,, ...	4s. 8d.
Do. 30 do. 40 do. 50 ,, ...	4s. 6d.
Do. 30 do. 40 do. 100 ,, ...	5s. 4d.
Do. 40 do. 50 do. 50 ,, ...	5s. 3d.
Do. 40 do. 50 do. 100 ,, ...	6s. 10d.
Do. 50 do. 60 do. 50 ,, ...	5s. 8d.
Do. 50 do. 60 do. 100 ,, ...	7s. 4d.
Do. 60 do. 70 do. 50 ,, ...	5s. 8d.
Do. 60 do. 70 do. 100 ,, ...	7s. 4d.
Do. 70 do. 100 do. 50 ,, ...	6s. 10d.
Do. 70 do. 100 do. 100 ,, ...	8s.

The above prices only apply to ordinary cases. Special difficulties or anything which may occasion unusual or unexpected outlay will be charged for extra. The prices include both positive and negative conductors. The main fuse and double-pole switch will be supplied by the Corporation. They will be placed in position by them and sealed. Under no circumstances must the consumer or his contractor in any way interfere with the main fuse and switch, which remain the property of the Corporation. The Corporation reserve the right to settle the positions of the transformer (if any), meter, main fuse, and main switch.

Meter.—The meter and service switch, which will be supplied by and remain the property of the Corporation, will be let to the consumer on hire at the following rents:

For	15	16-c.p.	lamps or	their equivalent	4s. 6d.	per quarter.
,,	30	,,	,,	,,	5s.	,,
,,	60	,,	,,	,,	6s.	,,
,,	120	,,	,,	,,	7s.	,,
,,	180	,,	,,	,,	9s.	,,
,,	240	,,	,,	,,	11s.	,,
,,	300	,,	,,	,,	12s.	,,

General Rules.—The whole of the work in the installation must be of the highest class, and carried out in accordance with the rules of the fire insurance company in whose office the building is insured; or, if not insured, in accordance with the rules of the Institution of Electrical Engineers.

Conductors.—All conductors to be of pure copper, according to Matthiessen's standard of pure copper, and of such sectional area that the current in them shall not exceed 1,000 amperes per square inch, their area to be so proportioned to their length that the fall of pressure between the supply terminals and the farthest lamp shall not, at full load, exceed two volts. All conductors of larger sectional area than No. 14 S.W.G. should be stranded. No conductor to be used of less sectional area than No. 18 S.W.G., except in the case of flexible cords, which may be equal in section to No. 20 S.W.G. All copper wire must be tinned.

Insulation.—All conductors to be highly insulated and mechanically protected by means of tape and braid. Flexible cords to have a waterproof insulation. The insulation resistance of the conductors to be not less than 600 megohms per mile.

Casings.—All conductors to be placed in hard wood casings, except under special circumstances and with the approval of the authorised officer of the Corporation, the casing to be coated both inside and out with varnish or other waterproof composition when placed in damp situations. The covers of all wood casings to be screwed, and not nailed down. Metal staples must under no circumstances be used for fixing conductors; in special cases, however, metal saddles may be employed, subject to approval.

Fittings.—All fittings and electroliers must be insulated at the base. Fittings must be wired with flexible cord. The wiring of gas fittings is expressly prohibited, unless they are efficiently insulated from the gas-pipes, and duly approved.

Switches.—All switches, fuses, etc., to be of fireproof construction, and to have incombustible bases; all switches to have substantial rubbing surfaces, and to have "quick-break" action. No switch to control at one time more than 20 8-c.p. or 10 16-c.p. lamps, or one high candle-power lamp.

Fuses.—All branch circuits to be protected by two single-pole fuses; a single-pole fuse to be fixed at the origin of every flexible cord. All fuses to be of an approved type and easily accessible. Magnetic cut-outs are not to be used in any case, unless previously approved by the authorised officer of the Corporation.

Voltage.—The pressure will be 100 volts at the consumer's terminals, and the lamps installed must be of corresponding voltage.

Arc Lamps.—When it is intended to use arc lamps, the authorised officer of the Corporation must first be consulted in the matter, and the type of lamp, choking coil, etc., must be subject to his approval.

Testing.—The Corporation will not supply current to any installation (1) if there are any temporary wires or fittings; (2) if the whole of the work is not complete and all fittings fixed; (3) if when testing with the full pressure of 100 volts—the insulation resistance should be below the following standard, viz., 75 megohms divided by the number of lamps. Should the installation prove defective when tested by the authorised officer of the Corporation, a fee of 10s. 6d. must be paid before the second and before every subsequent test is made.

Alterations and Additions.—No alterations must be made, or any additional lamps installed, until a notice of seven days in writing has been given to the Corporation. Failure of such notice may render it necessary for the entire supply to be cut off.

Leakage.—In the event of the insulation resistance of an installation falling below 5,000 ohms, after a supply has been turned on, the whole of the installation will be cut off until the fault has been put right. Any expenses the Corporation are put to in finding such fault must be repaid by the consumer. The Corporation reserve the right to test any installation from time to time.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Hapton (Lancs.).—Tenders are invited for lighting with electric light the village of Hapton and so much of the township of Hapton as the lighting inspectors may think necessary. Full particulars may be had of the work required to be done by applying to Mr. Henry Cunliffe, chairman of the Lighting Inspectors, Post Office, Hapton, to whom tenders are to be delivered by 27th inst.

Sunderland.—The Corporation require tenders for wiring the Town Hall, including the supply and fixing of all cables, casings, switch and fuse boards, lamps, etc. Copy of specification, etc., may be obtained at the office of the borough electrical engineer on the deposit of £1. 1s. Further particulars are given in our advertisement columns. Tenders must be delivered at the office of Mr. Fras. M. Bowey, town clerk, not later than November 8.

Halifax.—Tenders are invited for the covering of the boilers and steam-pipes for the new electric light works, Foundry-street, Halifax (asbestos or fossil meal), for the Electric Lighting Committee. Particulars may be obtained on application at the Electrical Engineer's Office, Foundry-street. Tenders, endorsed "Tender for Pipe Covering," must be sent to Mr. Keighley Walton, town clerk, before 10 a.m. on 22nd inst. The tender of any person paying less than the minimum standard rate of wages, and who does not observe the hours and conditions of labour generally recognised in the district, will not be accepted.

London, E.C.—Tenders will be received until noon on Wednesday, 31st inst. (*a*) for supply of red fir telegraph poles, to be

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delivered in London, King's Lynn, or Sutton Bridge, and at Northumberland Dock (River Tyne), West Hartlepool, Hull, or Grimsby; and (*b*) for creosoting the poles with 10lb. or 12lb. of creosote to the cubic foot as may be directed. The poles to be felled between November 1, 1894, and February 28, 1895, and to be delivered during the following summer at the port at which the creosoting is to be performed. Butt sections from not less than three poles, to show the quality of timber offered, must precede or accompany the tender of any person who has not already supplied the Postmaster-General with poles. The Postmaster-General does not bind himself to accept the lowest or any tender. Forms of tender, containing all particulars, may be obtained on application to Chas. E. Stuart, controller of stores, Telegraph-street, E.C.

London, W.C.—Mr. John Annan, manager for Mr. Samuel Wheeler, "Official Receiver in Companies' Liquidation," acting as liquidator of J. W. Hobbs and Co., Limited, is prepared to receive tenders for the supply and erection on foundations, etc., provided by contractor in the hotel in course of completion on the Salisbury Estate, Victoria-embankment, of the following plant: (Section A) boiler-house plant—boilers and fittings, feed heaters, electric feed pump, injector, water-tank, steam, exhaust, feed, blow-off, and sundry pipes and valves, etc.; (B) engine-house plant—oil-tank, steam dynamos, oil filter, workshop fittings, ventilating fan, etc.; (C) switchboard, instruments, and meters. Tenderers are at liberty to tender for any section or sections, or for the whole of the sections, but not for part of a section. The ground plan of the buildings, and the specification, with terms and conditions of tender and contract, may be obtained at the offices of Mr. R. Hammond, the consulting engineer, Ormond House, Great Trinity-lane, London, E C, on payment of £2. 2s. Tenders to be addressed to Mr. J. Annan, 2, New-court, Carey-street, Lincoln's-inn, London, W.C., by 26th inst.

RESULTS OF TENDERS.

Cheltenham.—The tender has been accepted of Messrs. Humpidge, Holborow, and Co., Stroud, at £82, for the construction and erection of a seven-ton hand-power overhead travelling crane at the municipal electric light station.

Stafford.—For supplying conductors on the three-wire system for electric lighting, for the Town Council. Dr. Hopkinson, consulting electrician:—Siemens Bros. and Co., £1,290 (accepted) For overflow mains and exhaust pipes for engines: W. G. Bagnall and Co., £75 (accepted).

London, E.C.—The proprietors of the City Terminus Hotel, Cannon-street, E.C., have accepted the tender of Messrs. Robey and Co., of Lincoln, for the supply of a locomotive type boiler, together with a complete system of duplicate main steam-piping, etc., the whole to be supplied and erected to the specification and plans of their engineer, Mr. W. Durtnall, A.M.I.E.E.

London.—At Tuesday's meeting of the London County Council the Fire Brigade Committee reported as follows: "We reported on July 24 that, as the contract with Messrs. H. Binko and Co. for the maintenance of the electric bells belonging to the brigade would expire early in August, we propose to invite tenders for the maintenance for a further period, and that we had authorised the chief engineer to arrange for the work to be done by workmen directly employed by the Council, until the new contract should be entered into, and the Council approved our action. We have now to report that the cost incurred in maintaining the bells, including the substitution of new batteries for defective ones, and the execution of repairs to the wires and apparatus, has been about £95. Six firms were invited to submit alternative tenders for the maintenance of the bells for one or three years, but only five responded, their prices being as follows:

	For one year.	For three years.
A. W. Jackson	£325	£285 0 0
J. Sax and Co., Limited	325	303 6 8
Strode and Co.	330	330 0 0
J. D. Andrews and Co.	400	350 0 0
Nicholson and Lyle	1,050	1,000 0 0

The result of enquiries made by the solicitor with regard to the lowest tenderer appears satisfactory, and we recommend that the tender of Mr. A. W. Jackson to maintain for three years at the rate of £285 a year the electric bells belonging to the brigade be accepted." This was agreed to, with the proviso that the contract should be for one year only.

BUSINESS NOTES.

Alderley Edge.—A provisional order is to be applied for by the Local Board.

Reading.—An extension in the mains is being made by the local electric lighting company.

Bray.—The Town Commissioners have resolved to promote a Bill for electric lighting purposes.

Bolton.—The opening of the municipal central station has been postponed from the 24th to the 31st inst.

Mill-Lighting.—It is stated that the electric light is to be introduced into several Dundee jute mills.

Lowestoft.—Mr. F. H. Medhurst is to meet the Town Council to discuss the question of electric lighting.

Basingstoke.—The Town Council have referred Mr. Hammond's report to the Electric Lighting Committee.

Douglas (Isle of Man).—It is suggested that the local authority should introduce a supply of the electric light.

Keighley.—The Town Council have referred back to committee the question of applying for a provisional order.

Windsor.—Alderman Dyson has resigned his membership of the Electric Lighting Committee of the Town Council.

Sunderland.—The Town Hall Committee have made further arrangements for lighting the building by electricity.

St. Pancras.—The demand for current has reached such an extent that a second central station is now in course of erection.

Barrow.—The Town Council have declined to authorise the Selection Committee to consider the question of electric lighting.

Montrose.—The Town Council have agreed to support the application of the Scottish House-to-House Company for a provisional order.

Fareham.—The Local Board have received from the Board of Trade permission to take over the undertaking of the local electric lighting company.

Darlington.—The Town Council do not seem disposed to carry out their electric lighting powers until they are assured that there is a demand for the light.

Westminster Electric Supply Corporation.—This Company have called a meeting of shareholders for the purpose of increasing the capital from £300,000 to £400,000.

Middlesbrough.—The books in the free library having suffered from the use of gas on the premises, the building is to have the electric light installed by Messrs. Baker Bros.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending 14th inst. amounted to £906, as compared with £582 in the corresponding week of last year.

London, E.C.—The new Post Office building in St. Martin's-le-Grand is approaching completion. The whole of the building will be lighted by electricity, and there will be no gas fittings whatever.

Southwark.—The premises of Messrs. Burton, Baker, and Co., 110 and 112, Southwark-street, S.E, are being installed with the electric light by Messrs. W. J. Wolfe and Co., 11, Queen Victoria-street, E.C.

Coventry.—The Town Council have ordered that Mr. G. S. Ram be appointed clerk of works to superintend the engineering portion of the contract for the equipment of the electric lighting station at a salary of £4 a week.

Hove.—The Town Hall Committee have held a meeting for the purpose of testing the efficiency of the electric light at the Town Hall, and the result was regarded by the gentlemen present as entirely satisfactory.

Scarborough.—The annual report of the Scarborough Cliff Bridge Company, Limited, shows an increase in the expenditure of £493. This is partly accounted for by the installation of the electric light in the theatre.

Leeds.—The temporary electric lighting of the grounds and picture gallery at Temple Newsam during the visit of the Duke and Duchess of York was placed in the hands of Messrs. Maunsell Mercier and Co., of Manchester.

Llanberis Water and Gas Company, Limited.—This Company has been registered with a capital of £5,000 to establish and carry on works for the supply of water, gas, electricity, etc., to the parish of Llanberis, co. Carnarvon.

Farnworth.—The General Purposes Committee of the Local Board will shortly consider the question of convening a meeting of the Electric Lighting Committee for the purpose of discussing an application for a provisional order.

St. James's and Pall Mall Electric Light Company, Limited. This Company announces that the electric current sold during the quarter ended September 29 amounted in value to £6,935, as against £4,820 for the corresponding period of 1893.

Birmingham.—On Tuesday Colonel W. M. Ducat, R.E., an inspector of the Local Government Board, held an enquiry into an application of the Corporation to borrow various sums of money, including £1,000, for lighting the market hall by electricity.

Stalybridge Foundry Company, Limited.—This Company has been registered with a capital of £15,000 to acquire the Britannia Foundry, at Cockbrook, Ashton-under-Lyne, and to carry on business as iron, steel, and brass founders, mechanical and electrical engineers, etc.

West India and Panama Telegraph Company.—For the first half of the current year the directors recommend a dividend of 6d. per share. For the two weeks ended October 15 the receipts show an increase of £224 as compared with the corresponding period of last year.

Appointment Vacant.—The Corporation of Cardiff require an electrical engineer to take charge of their electricity works. Applications are to be addressed to Mr. J. L. Wheatley, town clerk, Town Hall, Cardiff, not later than October 22. The salary offered is £3 per week.

Hastings.—The Board of Guardians have ordered a number of bills to be paid, including one for 11s. 9d. for electric light in the Wellington-square offices. Several members expressed their surprise at the smallness of the bill, but the clerk explained that during the summer quarter the light was not used very much.

Sandycroft.—The Sandycroft Foundry and Engine Works Company are at present engaged in laying an electric line of railway from their works to the side of the London and North-Western Railway. The line is a short one, and the company are sanguine

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that they can do the running of their trucks cheaper by electricity than by steam.

Technical Association of London, Limited.—This Company has been registered, with a capital of £100,000 in £100 shares, to acquire, by purchase or otherwise, any patents, licenses, inventions, concessions, grants, etc., and to develop and turn to account the same in such manner as the Company may deem expedient.

City and South London Railway.—The receipts of the Company for the week ended October 14 were £921, against £851 for the corresponding week of 1893, or an increase of £70. The total receipts for the current period of the present half-year amount to £12,931, as against £12,146 in the corresponding period of 1893, an increase of £785.

Fulham.—The Town Hall Committee of the Vestry have discovered now that the work of decorating the Town Hall is being proceeded with, that gas is likely to spoil the decorations. The hall is not wired, but the committee have instructed the surveyor to obtain information and report as to the probable cost of installing the electric light.

Dover.—The preparations for introducing the electric light, although not progressing so rapidly as was expected, are now fast approaching completion. The mains are all in; the station at Park-street is practically completed, the main cables are being drawn into the pipes along the streets, and all the transformer sub-stations are nearly finished. The completion of the engines seems now to be all that is needed.

Liverpool.—The monthly meeting of the Markets Committee was held on Tuesday. Mr. Walker stated that the markets were the pink of perfection, but urged that they should as soon as possible light them by electricity. Mr. Dean agreed to the necessity for the suggested improvement in lighting. Mr. E. Paull, the chairman, also thought it would be necessary soon to light the markets with electricity.

Richmond.—The Electric Lighting Committee of the Town Council reported that the plan deposited by the company shows a proposal to carry the main as far only as the Wick, and recommended the Council to call upon the company to undertake to continue the main to the full extent of the added area—viz., to opposite the Star and Garter Hotel—when required to do so by the committee. This was agreed to.

The Electric Railway to Snowdon.—The electric railway to Snowdon, which has so much been spoken of, is now beginning to take shape. A company has been registered, under the name of the Hotels and Railway Company of North Wales, Limited, with a capital of £6,000 in 60 shares of £10 each, to construct a railway from Llanberis, Carnarvon, to a point near the summit of Snowdon, and to erect and carry on an hotel at or near the summit.

Market Harborough —An electric light and power plant is to be installed by Messrs. Lea, Sons, and Co. in Messrs. Lymington's large corset factory. There will be required two steam dynamos, one of 50 b.h.p. for lighting (700-800 lamps), and one of 80 b.h.p. for transmission of power by means of eight electric motors placed in different portions of the factory. The plans were drawn out by Mr. Arthur H. Lea, M.I.M.E., and the work will be done under his personal supervision.

London, E.C.—Messrs. W. J. Wolfe and Co., 11, Queen Victoria-street, E.C., and 7, Folkestone-road, Dover, are at present carrying out electric light installations in the City for Messrs. Perrin and Co., Crosby-square, Bishopsgate-street; Messrs. J. F. Duboc; and the Imperial Contract Corporation, Limited, at their offices, Wool-exchange, Coleman-street. Messrs. Marshall, Girling, and Co., and Mr. Herbert Cubison, are also having their offices fitted at West India House, Leadenhall-street.

Walsall.—The Gas Committee of the Town Council have reported that the Local Government Board having refused to approve of the arrangement proposed, whereby the sum of £2,250 was to be paid to the credit of the gas undertaking out of the proposed loan for electric lighting, for the site of the electric generating station at Wolverhampton-street Gasworks, the committee had approved of the sum of £90 per annum being charged the electric lighting undertaking as rent for the site of the station.

Radcliffe.—Mr. S. Walker, the chairman of the Local Board, at a meeting of that body gave an account of his impressions at the recent Sanitary Congress held in Liverpool, and stated that among the questions which greatly impressed him were those referring to sewage and electric lighting. He had been on both committees, and, as most of them knew, he had urged that if possible they should have the two works close together on one plot of land, so that they might be worked one to the advantage of the other.

Isle of Man Electric Tramway Company.—The directors of this Company have issued a circular in which they state that, having carefully considered the profits for the past season, and having consulted with the auditors, they have, after providing a large sum for the reserve and renewal fund, and making provision for further dividends at the end of the year, decided to pay an interim dividend at the rate of 6 per cent. per annum on the preference and of 7½ per cent. on the ordinary shares for the six months ending October 31.

Ealing.—The Local Board have referred to the Electric Lighting Committee a communication from the Free Library Committee stating that the latter would be prepared to use the electric light on the library premises at an annual sum to be agreed upon. A memorial from residents on the north side of the railway (The Parade, Woodville-road, etc.), asking that the electric light mains might be carried over the Feathers Bridge and into the northern part of the district, was referred to the Electric Lighting Committee.

St. Martin-in-the-Fields.—A copy of the annual report by Mr. Chas. Mason, A.M.I.C.E., A.R.I.B.A., surveyor to the Vestry of St. Martin-in-the-Fields, Charing Cross, W.C., has reached us for the year 1893-94. With regard to electric lighting, Mr. Mason says that several reports have been submitted by him upon the desirability of lighting the streets of the parish by means of electricity. The question has, however, been postponed, as it is found, he states, that the cost of lighting with electricity will exceed the amount now paid for gas.

Carlisle.—The Town Council have decided that the application of the County of London and Brush Provincial Electric Lighting Company, Limited, for a provisional order for the supply of electricity within the city of Carlisle be opposed, and that the Council be recommended to make application for a provisional order in the ensuing session of Parliament, for the purpose of authorising the Corporation to supply electrical energy for public and private purposes within the city of Carlisle, and to acquire all proper and necessary powers in connection therewith.

Dublin.—A deputation of the residents of Moore-street waited upon the Electric Light Committee of the Dublin Corporation on Thursday of last week in reference to the decision arrived at recently of the inhabitants to advocate the lighting of the place by electricity. The deputation was received favourably by the committee. The borough surveyor, Mr. Harty, also attended. It is understood that the work of laying down the mains will begin soon, and the deputation were in a position to state that a number of the residents of the district was prepared to take the light.

Windermere.—The electric supply company have written asking whether the Local Board favoured their intention of applying for a provisional order. The Clerk said it would be better for the Board to wait until the provisional order was actually before them. He had sent to the Board of Trade for a copy of such provisional order, but found that it was not much of a guide, the schedules, of course, not being filled up. He thought that the interests of the Board would be very well protected. Mr. Irving asked if the provisional order gave a monopoly to the company to supply the place. The Clerk: Practically so.

Taunton.—The Electric Light Committee of the Town Council have reported that they had a letter from Dr. Fleming offering to act as consulting engineer for the year ending September 1, 1895, for a fee of 25 guineas, with a fee of 10 guineas per visit to Taunton and travelling expenses. The committee recommended that his offer be accepted. The committee also recommend that Mr. A. J. Howard (whose pupilage expired on the 1st inst.) be retained as an assistant electrician at a salary of £40 a year. The report was adopted. The borough surveyor was instructed to arrange for placing temporary electric lamps in Mill-lane and Steven's-court, North-street.

Warminster.—A special committee of the Local Board have reported that they had received tenders for dynamo, cable, etc., required in the electric light installation, and the expenditure would not exceed the amount previously estimated—viz., £234. In the course of the discussion it was stated that six additional electric lamps were proposed to be erected for the illumination of the principal streets, and in the event of the experiment proving successful other parts of the town would probably be lighted by electricity. The clerk was directed to apply to the Local Government Board for their sanction to a loan to carry out the installation.

Newport (Mon.).—The handsome columns selected by the Electric Lighting Committee of the Newport Corporation for the arc lights are being rapidly placed in position along Commercial-road and Commercial-street. The columns are placed alternately on each side of the roadway, and judging from the distance they are apart would appear to provide adequately for the lighting of the thoroughfares. Some disappointment is felt in some of the suburbs at the conduits not being laid as extensively as was thought probable, and householders who have been waiting for the electric light have in consequence resorted to latest improvements in gas and oil for their dwellings.

Burslem.—During the visit of the Princess Louise to Burslem temporary electric lighting was carried out by Messrs. Crompton and Co The electric illuminations of the town consisted of six arc lamps of about 3 000 c.p. each. One was placed by the Manchester and Liverpool Bank, another by the Town Hall, another by the Conservative Club, another at the Wedgwood Institute, another on Swan Bank, and the sixth in St. John's-square. The whole of the plant was fixed by Messrs. Crompton, and the lamps lent by the Sneyd Colliery Company, Limited, as also about 100 incandescent lights for four of the triumphal arches—viz., the one at the top of Newcastle-street, that at the top of Nile-street, that at the top of Moorland road (Market-square end), and the one in Waterloo-road. Messrs. Crompton lent the dynamo and the conductors, etc., for the lighting, and the motive power was supplied from the steam-roller situate in Brickhouse-lane.

Venezuela Telephone and Electrical Appliances Company, Limited.—The accounts show a profit of £7,413. 5s. 11d., to which is added the balance of £1,558. 9s. 7d. standing to profit and loss account. After providing the interest on the first and second mortgage debentures, amounting to £4,393. 8s. 6d., the directors have written off the sum of £1,711. 15s. 3d. from the discount and expenses on debenture issues. This leaves a balance of £2,866. 11s. 9d., out of which the directors recommend that a dividend on the Company's share capital be declared for the year ended June 30, 1894, at the sate of 4 per cent. per annum, which will absorb

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£2,800, and that the balance of £66. 11s. 9d. be carried forward. The Company's property having been fully maintained, as set forth by the general manager's certificate at the end of the balance-sheet, the Board does not consider it necessary at the present time to make any allowance for depreciation of plant.

Electric Traction at Dublin.—The conversion of the Dublin Southern District Tramway Company's lines, stretching over the entire distance from Dublin to Dalkey—eight miles along some of the most beautiful scenery in Wicklow—will soon be actually begun; in point of fact the material and plant is being ordered, and the contractor is preparing to break ground, so that the entire service may be operated by electricity before next summer season fairly commences. Water-tube boilers are to be used in the generating station, two 300-h.p. Babcock boilers being first installed; whilst the engines—of the compound condensing horizontal type, coupled to the dynamos by belting—will be three in number, of 150 h.p. each. When completed this line ought to prove one of the best and most profitable in the whole country, even more so than the Isle of Man electric tramway, as it will not be dependent solely upon a summer traffic, great as that may be.

London, E.—The Bow Vestry have considered the proposals of the Poplar District Board to instal electric light in the district. The Poplar Board are circularising the inhabitants in order to ascertain if there is a desire for a supply of electricity. The price proposed to be charged is 6d. per Board of Trade unit for light, and 4d. for power. Meters would be supplied by the District Board at 10 per cent. on the cost, the connection with the mains and the inside fittings being supplied at the expense of the consumer. As far, however, as Bow is herein concerned, the proposal has been left over until the next election. The Whitechapel District Board have decided to inform the secretary to the City of London Electric Lighting Company that the site they offer to the Board for a power station will not be required, as in their present destructor premises excellent accommodation is afforded. By the utilisation of the waste heat in the destructor premises, the Whitechapel governors hope to justify their provision of electric light, which they can supply at 5d. per unit, as against 8d. charged by the City company.

Yarmouth.—The Town Council have decided to light the Fish Wharf by electricity. The Council was recommended to light the Town Hall electrically. The surveyor estimated the lowest possible cost at £300. After November 1, 134 gas lamps will not be required in the town, and necessary notices were ordered to be served on the gas company, saving an annual expenditure of £500 The Elder Brethren of the Trinity House recommended the screening of two of the electric lights near the Sailors' Home. The screens, they stated, would not interfere with the light delivered on the parade and beach. The number of applications received for the supply of current to October 2 was 12 for 700 lights, including the School of Art; but not the Fish Wharf, Town Hall, police station, and free library, which would require 700 more lights. The plant is equal to 4,500 lamps in use, which would allow for installing about 6,000 lamps. It was decided to engage a man at 32s. per week for making connections with private consumers, and tools for the same purpose at a cost of £15 were ordered. The report was adopted.

Wolverhampton.—Councillor Rhodes has asked at a meeting of the Town Council whether it was proposed to take the electric light below Chapel Ash. Councillor Cousins asked what time they might expect that the lighting arrangements would be completed. Alderman Gibbons wished to know why the circuit had not been taken below St. Mark's Church. Councillor Weaver said it was decided some time ago that St. Mark's Church clock should be lit up. Considering that some 20,000 persons looked to that clock for the time, it ought. he thought, to be illuminated. The junction of Chapel Ash and Tettenhall-road, Compton-road, and Merridale-road was one of the darkest spots in the town, and he was of opinion that the electric light ought, if possible, to be taken there. The Mayor said it was his wish to see as large an area as possible of Wolverhampton lit with the electric light, and at the earliest possible moment. He was in hopes that it would have been installed by this time All the contractors contracted to complete their work before September 18 last, but owing to the carpenters' strike and other causes, it had got behind. It would, however, be completed in a few weeks.

Birmingham Central Tramways.—An extraordinary general meeting of shareholders of the Birmingham Central Tramways Company, Limited, has been called for the 24th inst. to reconsider the question of the reduction of capital recommended by the directors. Messrs. Neale, Round, Booth, and Mantle, directors of the Company, in a circular asking for proxies, say: "As long as the capital remains at the excessive amount at which it stands, a much larger sum must be set apart for reserve than will be necessary if the capital is reduced. It is notorious that a part of it is lost, and neither the shares nor the dividend will ever attain the steadiness which they ought to do until the reduction is effected. We, as directors, the auditors you have yourselves appointed, and the principal shareholders are unanimous that it is necessary for the future prosperity of the Company. It is for you to consider whether you will allow the personal feeling of one or two members of the Shareholders' Association against the chairman, who has rendered such great services, to wreck the Company and destroy the value of your property. If you are opposed to the latter course, please send us your proxy at once, and give us any other support in your power."

Brazilian Submarine Telegraph Company, Limited.—The report of this Company for the half-year ending June 30 states that the revenue amounted to £94,679, and the working expenses to £20,269. After providing £12,880 for debenture interest and sinking funds, and £1,736 for income tax, there remains a balance of £59,794, to which is to be added £2,207 brought forward from December, making a total of £62,001. A quarterly interim dividend, amounting to £19,500, has been paid, and £15,000 transferred to the reserve fund. The directors now recommend the declaration of a final dividend of 3s. per share, making, with the interim dividends, a total distribution of 6 per cent. for the year, and also the payment of a bonus of 1s. per share, both free of income tax, which together will amount to £26,000, leaving a balance of £1 501 to be carried forward. On July 31 the sum of £18,700 was transferred to pay off 187 bonds, the balance of the 1884 issue. The receipts include £1,500, the dividend to December 31 on the Company's shares in the African Direct Telegraph Company. The directors report that Sir Henry D. Gooch has resigned his seat at the Board, and that it is not considered necessary to fill the seat at present. The various sections of the line are in good working order.

Dewsbury.—A quarterly meeting of the governors of the Dewsbury and District Technical School was held on Tuesday evening, the president, Mr. S. J. Chadwick, in the chair. The president brought forward the question of introducing the electric light into the school, and said the attendance of pupils was now so large that the air in the several classrooms became bad, this being aided by the foul air arising from the combustion of gas. It would be a benefit to have each classroom lighted by electricity, but the question was, could they afford it in the present state of their finances? Mr. Hobkirk observed that the light would be very beneficial and Messrs. Richards and Thompson spoke to the same effect. Ultimately it was unanimously resolved on the motion of Mr. Hobkirk, seconded by Alderman Richards, that the Corporation should be asked to give an estimate of the expense of putting in the necessary fittings, and the annual cost of supplying electricity according to a plan of lighting to be sent in. It was remarked that if the Infirmary Board thought of introducing the new light into the institution the present application might lead them to enquire now, and that there was reason for believing that the trustees of Springfield Chapel intended to have an installation.

Oxford.—Good progress has been made in connection with the electric light in Oxford during the past year It is a little more than two years since the electric light station was opened, and during this time the business of the company has increased in a very satisfactory manner. In October, 1892, there were 2,000 lamps connected to the mains; in October, 1893, this number had grown to 7,000; at the present time the number is 11,000. If this rate of progress is maintained the company will have to considerably augment their generating plant at Osney. It has already been found necessary to put an additional generator in the sub-station at St. John's College, and a site has been found for a new sub-station in North Oxford. Amongst important installations which have been carried out this year under the management of Mr. Hardie McLean, M.I.C.E, are those in Trinity, Oriel, Exeter, Worcester, and Wadham Colleges, Magdalen College School, the house of Mr. Daniels, bursar of Worcester, the Turkish baths, and the Clarendon Hotel, in addition to numerous shops and private houses. During the year the company's mains have been laid in St. Aldate's, Beaumont-street, King Edward-street to Oriel College, and over Magdalen Bridge. The extension to North Oxford, now in progress, should be an important feature in the history of this electric lighting, taking in, as it does, the principal residential parts of the city.

Woking.—The Sanitary and Lighting Committee of the Local Board in their report referred to an interview they had had with Messrs. New and Mayne with respect to the diameter of the base of the standard, and also as to their difference in height and shape from the original standard selected by the committee. The clerk read a letter from Messrs New and Mayne, who regretted that owing to a misunderstanding the lamp-posts for the street lighting had been made lighter than those shown on the drawing. If the Board would grant them an extension of time until November 6 to carry out their contract they would at once put in hand new bases and columns. Mr. Storey said that the difference in the size of the standards was very considerable, and he should think the weight would be reduced by about 35 per cent. The Sanitary Committee arranged, subject to the Board's consent, to grant the extension asked. He believed that the contractors acted in perfectly good faith, but they made a very serious mistake, which they recognised. Ths delay in the lighting would of course be a great delay to the contractors themselves. Mr. Butt asked if the contractors made any suggestion to the committee that the Board should accept the columns at a reduction? Mr. Storey: No, nor do the committee, because they regarded the columns erected as most trumpery and a disgrace to the town. On the motion of Mr. Harris, seconded by Mr. Harding, it was agreed to grant the extension.

Crystal Palace.—The Crystal Palace District Electric Supply Company are issuing prior lien bonds bearing 4½ per cent. interest, and secured as a first charge on the entire property of their undertaking, on which it is understood that upwards of £70,000 has already been expended. According to the prospectus of these bonds, the business of the company has progressed in a most satisfactory way, the number of lamps equal to 8 c.p. installed on July 1, 1893, being 2,850, whilst at the end of September they had reached a total of 6,180. Amongst the recent customers of the company is the north tower at the Crystal Palace, the lifts for which are worked by the aid of electric motors, and the tower illuminated with current supplied by the company. It is intended to extend the company's mains immediately to

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Forest Hill, in order to meet a demand by the principal business establishments in that locality. The Crystal Palace District Electric Supply Company, Limited, were summoned on Tuesday at the instance of the Lewisham District Board of Works for causing an effluvium to issue from their works at Springfield, Wells-road, Sydenham, contrary to the provisions of the Public Health Act, 1891. Mr. Young appeared for the Board to prosecute, and Mr. W. H. Nash was counsel for the defence. A number of witnesses were called, who stated that from time to time offensive vapours had been proceeding from a shaft at the company's works. On the other hand, it was contended that the smell did not come from the company's premises, and that if there was any smell it was from the burning of refuse. Mr. Laws, a solicitor, said that since the issue of the summons he had noticed no smell of which he could complain. The summons had been standing over since August. Mr. Young said that, in view of the improvement, he was willing to agree to an adjournment *sine die*, and to this Mr. Nash consented, on the distinct understanding that he made no admissions of any kind, and the company did not admit that there was any nuisance. Mr. Offor, the managing director of the company, said that there could not have been any improvement, because no alteration of any kind had been made. The summons was then adjourned *sine die*.

Portsmouth.—The Electric Lighting Committee, at a meeting of the Portsmouth Town Council, have submitted a report dealing with their receipts and expenditure since the starting of the works. The sum authorised by the Council for the carrying out of the installation was £60,000. The estimate was made up to £56,385 for land, engines, dynamos, cables, etc., and £3,615 for capital and contingencies. The Local Government Board sanctioned the former sum, but struck out the latter, with the intimation that it could be had from time to time as required for those purposes. Since then two sums of £550 and £1,265 had been sanctioned for extensions in Russell-street, South-parade, Clifton-road, and the drill hall, bringing the full amount up to £58,200, besides which the committee had now joined up 160 house services, at an average cost of £10 per house, which sum it would now be necessary to borrow. They, therefore, recommended that application be now made to the Local Government Board for permission to borrow £1,800, the remaining balance of the £60,000, which would leave a small amount in hand for immediate necessities. In moving the adoption of the report, Alderman Ellis said there was every probability of the committee paying its way on the first year's working. So far as the public lighting was concerned, the cost was £1,800, which was £200 less than the figures originally suggested by Dr. Garnett, and accepted by the Council. He had put down £5,000 for private lighting, and though that was only an estimate, he thought he could show it was a very fair one. They had taken the average earnings in the towns in the United Kingdom having the electric light. The average was 19s. 11d. per lamp per annum. In Portsmouth most of their consumers were shopkeepers, and he thought the committee was justified in putting down 20. During the first (the summer) quarter—and it should be remembered that it was rather less than a quarter, because many persons were not connected until after the quarter had started—they had earned £1,000. The expenses were more difficult to work out. In concluding, Alderman Ellis said he had been assured by competent authorities that their light was better than that of the City of London Mr. Couzens seconded. In answer to questions, Alderman Ellis said it was not intended to light the esplanade lamps during the five winter months, but the question as to whether it should be lighted up on Sundays had not been decided. The report was adopted.

Kensington.—The Select Electric Lighting Committee of the Vestry submitted the following report: "That the committee have had before them, pursuant to the reference by Vestry of June 13, 1894, a letter from the Notting Hill Electric Lighting Company, notifying, in pursuance of the provisions of the Electric Lighting Act, 1882, the intention of the company to apply for a provisional order empowering them to supply electricity in the area recently abandoned by the House-to-House Electric Light Supply Company in the northern part of the parish, and specifying the compulsory streets to be scheduled in the application; and also (in pursuance of the reference by the Vestry of July 4, 1894) the notice under the Electric Lighting Acts from Messrs. Jordan and Son, on behalf of the Commercial Electricity Supply Company, of the intention of the company to apply for a provisional order empowering them to supply electricity in various parishes, districts, and extra parochial places in the Metropolis, including the whole or some part of the parish of St. Mary Abbotts, Kensington, and the committee recommended that the vestry clerk be directed to forward a communication to each of the companies named, intimating that the Vestry will be prepared to further consider their respective applications as soon as the draft provisional orders are before them. That the committee have (in pursuance of the reference by the Vestry of September 26, 1894) had before them the letter from the Board of Trade forwarding, for any observations which the Vestry desire to offer thereon, copy of regulations and conditions for securing the safety of the public and for ensuring a proper and sufficient supply of electrical energy in the House to-House Electric Light Supply Company's area, together with an amended description of the system by means of which energy is to be supplied. Your committee have deemed it expedient, before arriving at any decision as regards the amended description of the system proposed to be sanctioned by the Board of Trade, to obtain further information on certain points from the House-to-House Electric Light Supply Company, and they have accordingly directed the vestry clerk to apply to the company for the required information, and also to write to the Board of Trade asking that the Board will await the observations of the Vestry before approving the said amended description of system of supply." Mr. Brayè moved that the matter be referred to the Electric Lighting Committee. Mr. Holmes asked the Vestry to remember that they represented a district of some repute, and advised them not to act in a dog-in-the-manger style. The matter was then referred to committee.

Tonbridge.—The clerk to the Local Board presented the following statement in reference to a notice received from the Holloway Electricity Supply Company, Limited, and the question of obtaining a provisional order: "The Holloway Electricity Supply Company, Limited, are applying to the Board of Trade for a provisional order authorising them to supply electricity for public and private purposes within the district of the Tonbridge Local Board. If the application is granted, the company will be in a position to control the lighting of the district with electricity for 42 years from the date of the provisional order, and may make contracts with any other company or firm for the supply of electricity. Should the Board oppose the application, they will have to show cause why the provisional order should not be granted, and the practice of the Board of Trade is now to grant these applications unless the local authority are themselves prepared to apply for the powers. If a provisional order were obtained by the Board, they would be allowed a nominal period of two years in which to commence the work, but if not begun in that time no steps would be taken by the Board of Trade to rescind the order unless an application (involving a considerable outlay) were made by some person who would have to show that the requirements of the district were being neglected by the Board. Having obtained the order, the Board would be in a position to contract with a company or firm to supply with electricity and to make such terms as they thought fit The cost of a provisional order, including the necessary printing and a fee of £50 to be paid to the Board of Trade, would probably be about £150." The Chairman said that if the Board went for these powers it would be a question whether they could not make a profit by farming them out to some company. He thought there would be no difficulty in getting their money back again. Mr. Race remarked that electric lighting was making great strides, and the Board should not neglect this opportunity, or they might hereafter regret it. Mr. Jones held that the Board ought to have this power in their hands the same as they ought to have had the power of supplying gas and water. He considered that the few should suffer for the many instead of the many suffering for the few, as was now the case. He did not happen to have any vested interest in the supply of gas and water, but he had seen by the papers that at Ealing the town refuse and sewage sludge were used in the generation of electricity, and if that could only be done in Tonbridge it would be a glorious thing, for then they would not have Mr. Hollomby complaining of the destruction of fish in the river, or resident gentlemen of the smells arising from the deposit of sewage on the farm land. Why, the place would become a little heaven below, and all for the sake of £150. By all means let them have electricity at once. After some further discussion, it was resolved to apply for a provisional order.

Cardiff.—A meeting of the Cardiff Lighting and Electrical Committee was held at the Town Hall on Tuesday morning, under the presidency of Alderman Carey. The Mayor asked when the electric lighting works would be formally opened. It was announced that the current would be turned on on Monday night, and a large number of people assembled in the streets. The Chairman said he was not in a position to answer the Mayor, but there was a report from Mr. Massey, which he would ask the clerk to read. Mr. W. H. Massey reported to the committee that Messrs. Siemens were busy testing their dynamos, rectifiers, and lamps, and, judging from the preliminary runs, everything seemed to answer very well. As soon as the contractors had finished their tests the works might be started and formally opened. Mr. Massey, however, called the committee's serious attention to the fact that the number of incandescent lamps wired in Cardiff (as distinct from mere applications for the supply of current) was too small to warrant the committee using the machinery at the station regularly night and day. The present staff was quite sufficient to run the street-lighting and to supply current during the evening to a few shops, but it would be well, in anticipation of heavier work being required during the coming winter, to advertise for a practical foreman. The Mayor said they were sustaining a heavy loss through not having the light ready. Many persons had been prepared for two or three months to take the new illuminant, but, in consequence of the delay in supplying it, they were putting in new burners for gas. He was wrongly reported when he was made to say that there was apathy among the townspeople in this matter. The apathy was on the part of that committee in not bringing the light to perfection. He would like to know why penalties had not been enforced in the case of contracts which had not been completed in the specified time. The borough engineer, Mr. Harpur, said the Corporation were not losing money. If they turned the light on now they would lose £700 to £1,000 a year, because of the small number of lamps which had been wired for private consumption. At the present time there were not more than 500 wired, and they wanted 4,000 to 5,000 to make the electric light pay. Mr. Gerhold: Are the streets not to be lit with electricity until 4,000 to 5,000 private lamps are wired? The Borough Engineer: I am speaking of running night and day, to which Mr. Massey refers. Mr. Good: If you have private consumers you must run night and day. The Chairman thought the Mayor was correctly reported when he said there was apathy

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among the townspeople. There certainly was apathy compared with other towns where electric light had been introduced. They had requested the inhabitants to go on wiring, and the committee would be ready as soon as they were. He believed they would be able to run the light in a fortnight. The lighting of the streets would mean a loss of about £500 per annum, and unless the Corporation were assisted by private consumers the loss would be much heavier. Alderman Jacobs: Everything is going on satisfactorily, and it is no use turning on the light until the proper tests are made. After some further conversation, the subject dropped.

PROVISIONAL PATENTS, 1894.

OCTOBER 8.

19065. **Improvements in or relating to the production of electricity.** Henry Ashur Tobias, William Henry Cadman, and Richard Joseph Crowley, 71, Shoe-lane, London.

OCTOBER 9.

19121. **Improvement in electric arc lamps.** John Edward Woolverton, 70, Wellington-street, Glasgow. (Complete specification.)

19150. **Improvements in the method of and apparatus for the electro-deposition of metals.** William Henry Beck, 115, Cannon-street, London. (Charles R. Fletcher, United States.)

19155. **Improvements in or relating to arc lamps.** Alfred Julius Boult, 323, High Holborn, London. (Paul Laminne, Belgium.)

19157. **Improvements in or relating to electric battery plates.** Henry Le Roy Bridgman, 323, High Holborn, London.

19184. **Improvements in electric heaters.** Jesse Ruckman Davis, 53, Chancery-lane, London.

19185. **Improvements in electric switches or circuit breakers.** Frank Stevens and Robert Rodwell Kesteven, 45, Southampton-buildings Chancery-lane, London. (Complete specification.)

19186. **Improvements in electric thermostatic fire-alarms.** Lewis Garwood Rowand, 47, Lincoln's-inn-fields, London. (Complete specification.)

19191. **Improved means for securing the conducting wire to the carbon electrode in elements of galvanic batteries.** Franz August von Alimonda and Nino von Alimonda, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

OCTOBER 10.

19220. **Improvements in and relating to electric ship logs.** William David Whyte and David Muirhead, 144, Broomielaw-street, Glasgow.

19247. **Improvements in electrical ceiling roses.** George Frederick Kenyon and Edwin Moorhouse, 8, Quality-court, Chancery-lane, London.

19285. **A novel construction or arrangement of electric and/or gas chandeliers.** Martin Vincent Luis and Ernest Crawshaw Elgood, 166, Fleet-street, London. (Ludwig Priebe, Germany.)

19286. **Improvements in electric motors, and appliances connected therewith partly applicable also to electric generators.** Llewelyn Birchall Atkinson, 1, Queen Victoria-street, London.

OCTOBER 11.

19291. **Improved electric signal device.** Donald Frank Adamson and Clarence D'Oyley Hutchins, 72, Finsbury-pavement, London.

19343. **Motor vehicles for railways and tramways driven by gas or oil motor-engines in combination with electro-motors and accumulators** Charles Denton Abel, 28, Southampton-buildings, Chancery-lane, London. (The Gasmotoren Fabrik Deutz, Germany.)

19362. **Improvements in electrical safety devices.** John Smith Raworth, 46, Lincoln's-inn fields, London.

19364. **Improvements in electromotors and like electromagnetic apparatus.** Charles Connors and Walter Langdon Davies, 24, Southampton-buildings, Chancery-lane, London.

OCTOBER 12.

19387. **Improvements in magnetic shielding.** George Francis FitzGerald, 7, Ely-place, Dublin.

19421. **A method of hauling by electricity and apparatus for that purpose.** Fritz Bernard Behr, 28, Southampton-buildings, Chancery-lane, London.

19423. **Improvements in the construction of retorts or furnaces for the production of gases by the use of electricity.** John Henrique Dunn, 8, Spencer-road, Holloway, London

19443. **Improvements in the electrical production of musical notes.** Percy Tilt Letchford, 22, Southampton-buildings, Chancery-lane, London.

19444. **Improvement in electric arc lamps.** George G. Stout, 55, Chancery-lane, London.

OCTOBER 13.

19481. **An apparatus for heating water by electricity.** John William Ewart, 23, Ampthill-square, London.

19508. **Improvements in cut-outs for use in electric circuits.** Charles Philip Coote Cummins and James Leonard Golding, 55, Chancery-lane, London.

19517. **An improved apparatus for indicating the lamp-hours of electric lamps.** Robert Wende, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1888.

19045.* **Telephone-call apparatus.** Handford. (Western Electric Company.) (Amended specification.)

1890.

3900. **Insulation and cooling of electrical inductoria.** Pyker and Barnett. (Second edition.)

1893.

5505. **Electric switches, bell pushes, etc.** Watkin. (Reprint, with alterations.)

18175. **Telephone switchboards.** Franz and Otto.

18734. **Electric meters.** Olsen.

20625. **Carbon electrode connections.** Barnett.

22186. **Lock and block electric apparatus for railways.** Tyer.

22395. **Electric systems and apparatus.** P. E. and R. B. Pownall.

23283. **Connecting electric conductors.** Penson.

23331. **Electric current regulators, etc.** Cuttriss.

23337. **Electric meters.** Holden.

23385. **Galvanometers.** Jewell and Zimmerman.

24243. **Electrical arc lamps.** Lauder.

1894.

4170. **Alternating-current motors.** Thompson. (Bradley.)

4171. **Alternating-current motors.** Thompson. (Bradley.)

5754. **Electrical arc lamps.** Lauder.

6212. **Electric railways.** Cattori.

13377. **Electrolytically treating salts.** Jensen. (Störmer.)

14651. **Electrical heating devices.** Dymond. (Trudeau.)

14922. **Electrically operating semaphore signals.** Fiedler.

15900. **Shunt arc lamps for alternating currents.** Siemens Bros. and Co. (Siemens and Halske.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	5	5½-5¾
Bournemouth Electric Company	—	—
Brush Company, Ordinary	3	2¾-2¾
—— Nom. Cum , 6 per cent. Pref.	2	2¼-2¾
—— 4½ Debenture Stock	100	111-114
Charing Cross and Strand	5	4-5
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	13¼-14¼
—— 6 per cent. Cumulative Pref.	10	14¾-15¼
—— 5 per cent. Debenture Stock	115	131-133
City and South London Railway, Consolidated Ordinary	100	36-38
—— Debenture Stock	100	121-123
—— 5 per cent. Pref. Shares	10	13-14
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	94-99
Electric Construction, Limited	2	¼-½
—— 6 per cent. Debentures	—	87-92
—— 7 per cent. Cumulative Pref.	2	1¼-2
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1⅝-1⅞
Elmore's French Company	2	3/16-5/16
Elmore's Wire Company	2	1¼-1⅜
Fowler-Waring Cables	5	½-1½
W. T. Henley's Telegraph Works, Ordinary	10	8-9
House-to-House Company, Ordinary	5	1-1½
—— 7 per cent. Preference	5	5½-5¾
India Rubber and Gutta Percha Works	10	24¼-25½
—— 4½ per cent. Debentures	100	102-104
International Okonite, Ordinary	—	—
Kensington and Knightsbridge	5	4¾-5½
—— 6 per cent. Pref.	—	6½-6¾
Liverpool Electric Supply, Ordinary	5	6½-7
—— Pref.	—	—
Liverpool Overhead Railway	10	7¾-8½
—— Pref.	10	13-13½
—— 4 per cent. Mortgage Debentures of £100	100	111-113
London Electric	5	½-1⅞
Metropolitan Electric Supply	10	9¼-10
—— 5 per cent. Reg. Debentures, 1-10,000 in Bonds of £10, £20, and £40	—	—
National Telephone, Ordinary	5	4¾-5¼
—— 6 per cent. Cum. First Pref.	10	15-15½
—— 6 per cent. Cum. Second Pref.	10	14-15
—— 5 per cent. Nom. Cum. Third Pref.	5	5¼-5⅜
—— 4½ per cent. Deb. Stock	—	102-112
Notting Hill Company	10	5¼-6¼
Oriental and Electric Company, £1 shares	1	7/16-9/16
—— £5 Shares	—	7-7½
—— £4½ shares	—	5¾-6¼
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7¼-7¾
—— 7 per cent. Pref.	5	8¼-9
Swan United	—	—
Telegraph Construction and Maintenance	12	41-43
—— 5 per cent. Bonds	100	106-109
Westminster Electric Supply, Ordinary	5	6¼-7
Yorkshire House-to-House	4½	4¼-4⅜

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NOTES.

On the Brain.—Water power—a contemporary has got it there.

"Electric" Belts.—A series of articles is being devoted in the *Bazaar* explaining how "electric" belts are made.

Dundee Institute.—The annual conversazione of the Dundee Institute of Architecture, Science, and Art will be held in the rooms of University College on November 10.

Institution of Electrical Engineers.—The annual dinner of the Institution is fixed to take place at the Freemasons' Tavern, Great Queen-street, on Wednesday, November 21.

What About Electricity?—A leading article in the *Times* states that "if one were obliged to condense the history of the nineteenth century into a single word, that word would be Steam."

Electro-Harmonic Society.—A smoking concert will be given this evening at the St. James's Hall Restaurant (Banquet-room). We gave the programme in our last week's issue.

African Cables.—The Hon. S. R. French, Postmaster-General for Cape Colony, has arrived in this country. He is endeavouring to induce the Home Government to get a reduction, if possible, in the cost of cablegrams.

A Cleric on the Electric Light.—A lecture was given the other evening at Bristol by Canon Barnett on the subject of "An Ideal City." This, he said, should be lighted by electricity. The canon has got hold of the right end of the poker.

"English Illustrated Magazine."—We have received the November issue of this magazine, which contains a well-varied collection of articles and stories, while the artistic portion is well looked after, there being numerous well-executed illustrations.

Fire at Telegraph Works.—W. T. Henley's Telegraph Works Company, Limited, inform us that the fire which occurred at their works on the 17th inst., and which was referred to in our last issue, was a small one, and in no way interferes with the working of their business.

Electric Traction in Italy.—A new conduit system of electric traction is now being experimentally tried in Turin. This method, which has been devised by Signor Alfredo Diatto, is being tested in the engineering works of Messrs. Tedeschi and Co., at the Barriera di Lanzo, Turin.

Telephony in Germany.—Telephonic communication has been established between Munich, Pasing, Ismaning, Nuremberg, Fürth, Bamberg, Bayreuth, Erlangen, Würzburg, Augsburg, Regensburg, and Berlin. For ordinary conversations the charge is 2s. for three minutes. Pressing communications, taking precedence, are charged a triple rate.

French Atlantic Cable Company.—A Dalziel cable from Paris says there is now apparently little likelihood that the proposed amalgamation of the Compagnie des Cables sous Marins and the French Atlantic Cable Company will take place. The shareholders of the latter company are using every effort to prevent the combination being carried through.

Electric Lighting in Spain.—A company has been formed in Spain under German auspices to establish a central station in Seville for the distribution of current for lighting and motive-power purposes. The capacity of the station is primarily to be for 12,000 lamps of 16 c.p., and the installation will be arranged so that it can readily be extended to 20,000 lamps.

The Franklin Institute.—The Franklin Institute, Philadelphia, has awarded the John Scott legacy premium and medal to Mr. Clement Payen, the inventor of the chloride storage battery, on the report of its Committee on Science and Arts. The report in question appeared in our issue of last week.

Athletics.—A general meeting of the City Electric Lighting Athletic and Football Club took place on Saturday at the White House, Hackney Marsh, the primary object being the election of officers, etc., for the football section of the club. Mr. Costigan occuped the chair. The officers duly elected were as follows: captain, Mr. Taylor; vice, Mr. Ebden; football committee, Mr. Mackie, Mr. Doswell, Mr. Jennings, and Mr. Barton.

British-Dutch Telepheny.—It having been suggested to the Netherland Chamber of Commerce that telephonic communication between London and the Netherlands would be a desirable addition to the existing means of communication between the two countries, the Chamber is addressing merchants and tradesmen on the subject in order to find whether the scheme would supply a trade requirement and consequently meet with support.

Coventry Technical Institute.—On Tuesday last the new buildings connected with the Coventry Technical Institute, which have been built by the trustees of Spencer's Industrial Arts Trust, were formally opened. A set of buildings has been erected costing about £5,000, and including a science lecture theatre and mechanical engineering shops. There was on Tuesday a show of telephonic apparatus, and Messrs. Philip Harris and Co., of Birmingham, had a special exhibition of chemical and scientific apparatus.

Electric Transmission in Germany.—The arrangements of the Frankfurter Societätsdruckerei, at which are printed the *Frankfurter Zeitung*, the *Wochenblatt der Frankfurter Zeitung*, and the *Kleine Presse*, are being altered so that most of the printing machines used there will be driven by electric motors. Current will be obtained from the town mains. Each machine will have an alternating-current motor attached, and these are being made by Messrs. Brown, Boveri, and Co., of Baden, Switzerland. At Königsberg the bascules of the Köttel Bridge are to be worked by means of an electric motor.

A Novel Invention.—A correspondent of the *Western Press* who is a village blacksmith writes to that paper: "I see in the *Press* something about an electrical experiment (*sic*) at Worcester, that they are utilising water power. I have made a motor which can be fixed in the Bristol Channel, and once fixed, needs no attendance whatever, not even a boy. Of course it will wear out in time. I could make a wheel to develop 100,000 h.p. It could be fixed at the new passage or any tidal river. No matter which way the tide is running, my wheel always works one way. It works automatically, and has taken me 20 years to think it."

Telegraph Extension in North Bornee.—Reuter's Agency has received from the British North Borneo Company the following communication: "The work of cutting the track for the telegraph line across the country continues to progress very satisfactorily. Some miles of posts and wire have already been erected on the West Coast We hear in connection with this important work that the track will open up some sections of land which are admirably suited for cultivation. Menumbok, on the west coast, where the Eastern Extension Telegraph Company's cable was landed, has greatly developed, a large sago factory being now under construction, in addition to the three in operation, and 36 Chinese shops are doing a thriving business."

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Electro-Chemical Patents.—The Deutsche Elektrochemische-Gesellschaft, whose first annual meeting in Berlin was referred to in our issue of the 5th inst., is mentioned in a recent number of the *Elektrotechnische Zeitschrift*. It appears that the assembly had under consideration one branch of electrotechnics that has received too little attention, not only in Germany, but also in other countries. This fact is shown by the small number of patents of an electro-chemical character. The number of patents secured for any particular application of electrochemistry is, according to the journal in question, about 70 per annum in Germany, not much higher generally in the United States, and only 49 in Great Britain during 1893.

Electricity in Mining.—A meeting of the Derbyshire and District Metallurgical and Engineering Association was held on Friday evening at the Portland Arms Hotel, Codnor Park, Mr. J. T. Whitehouse, president, occupying the chair. Mr. H. B. Edwards, of Wakefield, read a paper on "Electricity as Applied to Mining," illustrating his remarks by means of a small apparatus. Mr. Edwards made special reference to the electrical plant which he has just completed at the Pollington Colliery, New Brinsley, belonging to Messrs. James Oakes and Co. A discussion followed, in which Mr. J. H. W. Laverick, manager to Messrs. Oakes and Co.; Messrs. Tomkins, Mosely, Lewellyn, of the Butterley Company; and Mr. Annable, Sheffield, and the President took part.

"**Street Railway Journal.**"—We congratulate our New York contemporary on the fact that it has reached its tenth anniversary, and on the very fine issue which it has published in honour of that occasion, and of the Atlanta meeting of the American Street Railway Association. It contains a 16-page article on Atlanta, a 10-page article on the association, a 30-page article on the street railway systems of the Southern cities, and a 20-page article on the history of the street railway industry. All of these are handsomely illustrated—containing over 400 illustrations, among which are more than 125 portraits of street railway men. There are in all 122 pages of matter, apart from advertisements, and the number is one which does much credit to technical journalism.

The Hermite System.—Speaking of the report on the Hermite system of sanitation by electrolysed seawater drawn up by Mr. Newton, the assistant engineer, and by Mr. Lindsay, the president of the Singapore Municipality, says *Indian Engineering*, said he thought there could be only one opinion expressed on reading this report—viz., that they should convey the thanks of the Commissioners to Mr. Lindsay and Mr. Newton, who he was glad to see had returned. They had supplied them with an admirable report, from which it was obvious that this system, whatever it might ultimately become, had not yet reached that stage when any practical use might be made of it here, but he had no doubt the matter would engage the attention of the engineer's department, so that if further advances were reported they would be able to reconsider the matter.

"**Electricity in its Infancy.**"—It is about time that even ignorant people should give up the use of this expression. Specially ignorant is the anonymous correspondent of a Liverpool daily, who, discussing the suggested purchase by the Corporation of the Liverpool Electric Supply Company's business, says: "Regarding electricity, this is only in its infancy, and large sums may have to be lost in gaining experience to place the handling of this illuminant on the same basis of practical knowledge that gas already stands upon. Both gas and electricity require very thoughtful consideration, and should not be discussed in the newspapers in a clap-trap style by irresponsible people of little practical knowledge of either, but simply putting into print the experience of others." The unconscious satire on himself in which the writer indulges is highly amusing. It is, however, rather surprising that he had sufficient wisdom not to make his name public.

Communication with Lighthouse Stations.—In the course of a lecture which he delivered at Carnarvon on Monday evening on "The Practical Application of Electricity," Mr. W. H. Preece, C.B., chief electrician of the Post Office, dwelt at length upon the means adopted by the authorities to establish telephonic communication between the land and lighthouses, etc. He stated that the whole of Anglesey was now so connected with the exception of two parts—viz., Llanddwyn and Llanynghenedl. With the co-operation of the Carnarvon Harbour Trust, he hoped before long to see communication established between Carnarvon and the former station, but with regard to the wretched parish of Llanynghenedl all the efforts made by the Post Office had so far been unavailing, for the required rights had been refused the authorities unless they paid a handsome rent for them. In his opinion, it was not right that any Government should be forced into competition with anyone on such a humane question as the saving of life.

The Simplon Tunnel.—The Swiss Federal Council has approved in principle the project of the Jura-Simplon Railway for cutting a tunnel through the Simplon, and the contracting firms—Messrs. Brand, Brandau, and Co., of Hamburg, Sulzer Bros., of Winterthur, and the Bank of Winterthur—have undertaken to carry out the works. The contractors have joined in a firm with the name of "La Société d'Entreprise du Tunnel de Simplon." The company contracts to complete the tunnel within 5½ years from the commencement of the works, and to throw it open for traffic with one track by that time. At the same time a lateral gallery is to be driven for a second tunnel and a second track. The Jura-Simplon Railway, on its part, undertakes to pay the contractors £280,000 for preparations; £1,900,000 for making the first tunnel with one track and a widening at its highest point for a crossing, as well as for the gallery of the second tunnel and cross galleries; and £600,000 for the construction of the second tunnel if built. The railway company has to decide within four years whether this second tunnel is to be made, for the completion of which a time of four years is stipulated. Compared with former projects, the building period has been reduced from eight to five and a half years, and the cost of construction has likewise been considerably cut down. It is not expected that Italy will pay a subvention towards the cost of the work, but it is thought probable that the Swiss Federation will exceed the grant of £180,000 already made. It will be remembered that electric traction has been recommended for use on the line.

Electric Lighting in New Zealand.—Last session the Gore Electric Light and Power Syndicate, Limited, promoted a Bill in Parliament to allow the Borough Council to grant a concession to light the borough with electricity. The current was lately turned on to the mains, and the success of the light from the two arc lamps was very pronounced. There are two arc lamps of 3,000 c.p. each, erected in the main street at about 50ft. from the ground. Private consumers are being rapidly connected on at the mains, and from the general satisfaction the light is giving the syndicate has every reason to expect a very large number of consumers before next winter. The system of distribution is the three-wire, using a low-pressure current. Two four-pole Battersea dynamos will be run when a full load is on, these being driven through Lancashire belts by two horizontal automatic engines. The engines can be run independently—either high pressure or condensing—

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an independent condenser being placed between them. The boiler is of steel, 17ft. long by 5ft. 3in. diameter, and is fired with the local lignite, there being two quite independent feeds—one a Tangye duplex, taking its water from the condenser hot-well, and an ordinary donkey pump drawing from the cold-well. The engines, condenser, and steam and exhaust piping have been made by the New England Engineering and Electrical Company. The boiler was made by Messrs. Morgan and Cable, and the poles to carry the wire were supplied by Messrs. Massey and Co.; in fact, the only imported goods are the dynamos, instruments, and copper wire, of which some six miles have been used. The installation was designed and carried out under the personal supervision of Mr. R. H. Postlethwaite, M.I.E.E., and the plant is now in charge of Mr. A. Ramsay.

Local Authorities and Technical Instruction.—A return has been made to the Department of Science and Art showing the manner in which and the extent to which the councils of counties and county boroughs in England and Wales, and the county councils, town councils, and police commissioners of police burghs in Scotland are devoting funds to the purposes of science, art, technical, and manual instruction. It shows that the total amount expended on technical education during the year 1892-93 in England, Wales, and Scotland was £529,718, and that the estimated total amount allocated to technical education for the year 1893-94 was £696,328. Out of the 49 county councils in England (excepting the county of Monmouth) 41 are applying the whole of the residue received under the Local Taxation (Customs and Excise) Act, 1890, to technical education, and eight a part of it to the same purpose. Of the councils of the 61 county boroughs, 53 are devoting the whole of the residue to technical education and seven a part of it, while in one case only (the county borough of Preston) the residue is being applied, not to educational purposes, but to relief of rates. In addition, the councils of 10 county boroughs are levying a rate, or making grants out of the rates, under the Technical Instruction Acts. The 13 county councils and the councils of the three county boroughs in Wales and Monmouth are devoting the whole of the residue to intermediate and technical education, chiefly under the Welsh Intermediate Education Act, 1889. In addition, the councils of six counties and county boroughs are levying a rate or making grants out of the rates under the Technical Instruction Acts. In the case of Scotland, 23 out of the 33 county councils are applying the whole of the residue to technical education and seven a part of it, while one has the matter under consideration, and two are applying the residue to the relief of rates. Of the 194 burghs and police burghs, 21 are applying the whole and 50 a part of the residue to technical education; one has not decided, and 122 are applying the whole to the relief of rates.

Sir F. Bramwell on "Science."—The distribution of prizes and certificates to the successful students at the Westminster Technical Institute took place on Monday. Sir Frederick Bramwell delivered an address, in the course of which he said that the students before him had sufficiently proved their knowledge of the value of the institution to which they belonged by the fact that in four or five years their numbers had increased from 20 to 1,000, a result which could hardly have happened unless those who had made that increase believed they were doing something for their own advantage. When he was a boy his master taught him all he could teach, and that embodied a good deal of practical work, without much theory. The fact was that theory was not taught by his master, because he had no theory to teach. What they had secured in the institutions of the present day was not only a substitute for what was imparted in by-gone days, but included a great deal of information which could not formerly be obtained. They now saw why they did certain things, and why certain results followed. Formerly they only did what they were taught, because their forefathers had done the same things for generations. But though it was well to know why results happened, they ought not to despise practice. He was one of those who believed that if, from generation to generation, good iron was made from the iron ore of a particular district by a certain process, it was better to follow that process than to depart from it at the bidding of a scientific man. Indeed, if a philosopher told him that that which had answered for generations was entirely wrong, he should begin to doubt whether the philosopher had not lost sight of a bit of his philosophy. He would, however, advise his hearers not to despise the beginnings of science, trivial though they might seem at first. They should remember that it was not so very long ago when a man in an Italian city found that, by a certain arrangement of metal plates, he could cause a frog's legs to kick. People then said: "It might be wonderful, but what was the good of it?" Well, the good of it had since been amply demonstrated, and one of the illustrations of what might be got from a new scientific fact was to be found in the lighting up of that large hall by the incandescent electric light.

The Pacific Cable.—The failure of the negotiations with Hawaii for the purchase of Neckar Island as a station for the proposed Pacific cable, says a Reuter's telegram, has given rise to varied Press comments at Ottawa. Under the heading of "British Blundering," the *Ottawa Citizen*, after pointing out how necessary for the success of the Pacific cable scheme it was to secure the island, says: "There is a general belief that the Canadian Government urged upon Great Britain the necessity of taking possession of this desirable spot while it was still no man's land, and months before its capture by Hawaii. The Home Government, with that incredible apathy which sometimes marks its treatment of the most important affairs of and outside the empire, neglected the favourable moment, and allowed a foreign Power to step in and seize the coveted prize. Is Great Britain unequal to the responsibilities entailed by her great possessions? Whatever the cause, the stupid negligence and procrastination exhibited in such matters as that of Neckar Island are particularly exasperating to us in the colonies, who are putting forth every effort to bring together the possessions beyond sea of Great Britain, and who expect that at least as keen an interest shall be taken in the schemes for that purpose at the heart of the empire as is felt here." A Reuter's telegram from San Francisco dated 24th inst., says: "Mail advices received here give the following additional information respecting the negotiations entered into with the Hawaiian Government by Mr. Mercer, of the British Foreign Office, and Mr. Sandford Fleming, one of the directors of the Canadian Pacific Railway, regarding the proposed Pacific cable. The two commissioners ask Hawaii for a lease of Neckar Island and for a subsidy of £7,600 for 15 years. In return, they will lay the cable, and make the rate 1s. a word over the line and a special Government and Press rate on condition that Hawaii cede the island to Great Britain in the event of a Hawaiian annexation to the United States. The Hawaiian Government, it is added, is willing to consider the proposal if the commissioners accept a lower subsidy and forego the provision for the session of Neckar Island to Great Britain in the event of annexation."

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Information Concerning Electric Light.—The following circular has been issued by direction of the Electric Lighting Committee of the Hammersmith Vestry: "The Vestry of Hammersmith having obtained their provisional order in Parliament as undertakers for the supply of electricity to the Hammersmith area, and also a complete report on a scheme for the proposed undertaking, are desirous of gauging approximately the amount of support they are likely in the first instance to obtain, in order that the initial outlay on the works may be regulated accordingly, and utilised to the best advantage. The Electric Lighting Committee, therefore, would be glad if probable consumers would fill up the enclosed form in order to enable them to obtain this information. The committee also append the following notes as a guide as to the cost of installation and working of the electric light and the method of supply generally: (1) Private supply service—The supply of current (at low pressure) will be continuous day and night, and the light will therefore be available at all times. (2) Cost of current—An 8-c.p. electric incandescent lamp may be taken as effectively replacing an ordinary gas burner consuming four cubic feet of gas. Electricity will be supplied at 6d. per unit, and the consumption measured by meter. At this rate an 8-c.p. lamp costs rather less than ¼d. per hour. From statistics compiled by Mr. W. H. Preece, C.B., engineer-in-chief to the General Post Office, as to comparative cost of gas and electricity in nine chief towns of the United Kingdom, it has been ascertained that, light for light, gas rated at 3s. per thousand cubic feet is equivalent to electricity at 6d. per unit. (3) Initial cost of installation—The cost of wiring and fittings depends upon the premises wired, number of lamps installed, and the individual taste of the consumer. It may be done effectively for 20s. and upwards per lamp. (4) Other uses of electric current—The current may be used for every kind of lamp, arc or incandescent; also for motive power, cooking or heating, and special reduced rates will be offered for current used for these latter purposes. (5) Streets to be first served—The following is a list of streets in which electricity will be first supplied by the Vestry: King-street, from Broadway to Ravenscourt-park; Broadway; Hammersmith-road, from Broadway to St. Paul's Schools; Queen-street, from Broadway to further side of St. Paul's Church; Brook Green-road; Shepherd's Bush-road; Shepherd's Bush Green; Goldhawk-road, from Shepherd's Bush Green to Starch Green-road; Uxbridge-road, from Uxbridge-road Station to Percy-road. If it be desired that electricity should be supplied in other streets in the parish, the Vestry will be prepared to consider applications if made under the terms of the provisional order by a sufficient number of owners or occupiers in any street."

Electrical Advertising.—We have previously referred to some amusing protests which made their appearance in some of the daily papers at the time when the electric advertising projector first made its appearance in Trafalgar-square, and apparently the protestors had resigned themselves to the inevitable. However, all at once a certain "L. H. M." has bobbed up serenely in the correspondence columns of the *Times* with the following comic letter: "I beg you to grant me a little space to add one more to the (unfortunately) few letters which have already appeared in the leading papers in defence of a cause which should require no pleading from Englishmen. I refer to the scandalous and incredibly unpatriotic way in which one of our finest monuments, raised to the memory of the greatest sailor and one of the greatest heroes that ever graced a page in English history, is being made the means of advertisement of some vendor of 'patent foods' whose name is unknown to fame, and justly so. I refer to the Nelson Monument in Trafalgar-square, on which every night an advertisement, some 20ft. high, is made to pass backwards and forwards by means of an electric search-light. Where is this mania for advertisement to stop? Our streets and public buildings, and even the rivers and fields, are desecrated and made hideous by boards of all colours, and yet, not content with these means, the advertiser of to-day must lose all sense of honour and patriotism and attack our monuments, which should be as sacred as the walls of Westminster Abbey. Can nothing be done to prevent this disgrace? Such an insult to a nation would not be permitted for one moment in France or in Germany; but England is a 'free' country, and therefore nothing is done! All I can say—and I am sure I echo the sentiments of many others—is that, if such things as these are to be the outcome of our much-vaunted 'freedom,' Englishmen will soon have little reason to be proud of their birthright." Of course, if, as stated by this writer, the name of the vendor of patent food is unknown, that shows his good sense in obtaining such an effective advertisement. Another gentleman, writing lately to the *P. M. G.* (not the Postmaster-General, but the *Pall Mall Gazette*), suggested that someone should go to Trafalgar-square with a more powerful projector and blot out the advertisements by that means. This would, of course, all be good for the electrical trades. Yesterday a Mr. John Richmond, styling himself "hon. treasurer N.S.C.A.P.A."—whatever that means—wrote to the *Times* as follows: "This society has been moved by its own members, by the Vestry of St. Martin's-in-the-Fields, as well as by sympathy with the protests which have appeared in the Press, to endeavour to discover a means of checking the vulgar disfigurement of Trafalgar-square by electric flash advertisements which is now of nightly occurrence. The feeling aroused against this scandalous abuse of public monuments is wide and growing, and if Parliament were in session something would probably be done at once to check so obvious a nuisance. But in the meantime we have got counsel's opinion that 'the owners of the buildings afflicted by the advertisement can proceed for trespass or nuisance.' A short clause amending the Metropolitan Police Act of 1839, and extending its control to this form of advertisement, could be passed when Parliament meets. But must we wait till then? Cannot the County Council or the First Commissioner of Works do something for us at once?"

Electric Lighting in Germany.—The central electric light station at Salzungen, which has been erected by Messrs. Schuckert and Co., is so far ready that an experimental run has been made. Current will be supplied both for street and for private lighting. Mr. Beck, of Esslingen, has proposed a scheme to the Municipality of Göppingen for the erection of a central station. The small town of Oberehnheim is receiving the electric light. Overhead conductors fixed on high poles are being employed. The Municipality of Barmen have decided to instal the electric light in the buildings of the advanced school. The Emperor William Memorial Church, Berlin, will be the first in the city to receive the electric light for internal illumination. The new Peter Church at Frankfort-on-the-Maine is also to be lighted electrically. The central electric light station at Frankfort is virtually completed. The electric lighting mains are being extended in the town of Hanover. A commencement has been made in connection with the central electric light station at Bergedorf. The neighbouring community of Sande-Lohbrügge propose either to take current from the Bergedorf station or else to establish a plant of their own. Mr. R. Genge has received the concession to erect a central electric light station at Schwerin-on-the-Warthe. It will have a capacity of 1,500 incandescent lamps and 50 arc lamps, and the work will be

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carried out by Messrs. Lehmann and Mann, of Berlin. The Allgemeine Electricitäts-Gesellschaft, of Berlin, is erecting an electric light plant for the whole of the buildings of the Eastern Railway Station, Königsberg. There will be about 50 arc lamps and 500 incandescent lamps. The work in connection with the central electric light station at Graz is nearly finished, and it is expected that it will be opened next month. The annual report of the Berliner Elektricitätswerke Aktiengesellschaft for 1893-94 states that the number of consumers is now 2,580, of lamps 194,400, and the consumption of current 57,500,000 ampere-hours. The number of motors connected has risen from 232 of 786 h.p. to 380 of 1,364 h.p., and since the termination of the business year there have been added 70 of about 300 h.p. The gross profits amounted to £144,016, and the net profits to £64,653, out of which a dividend of 10½ per cent. has been declared. A central electricity station has been opened at Flensburg. The installation comprises four compound steam-engines of from 80 h.p. to 120 h.p., seven tubular boilers, and eight dynamos of 130 volts and 200 amperes. A battery of accumulators is also to be provided. The station has a capacity of 4,000 lamps of 16 c.p., and can be extended to 7,000 lamps. The local authorities of Nuremberg have again had under consideration the question of the electric lighting of the town, two schemes having been drawn up by Mr. Oscar von Miller. They are in favour of the alternating-current project. Messrs. S. Schuckert and Co. are to be asked to make a tender. Representatives of the three firms—Messrs. Siemens and Halske, Messrs. Schuckert and Co., and Messrs. Kummer and Co.—who are to unite in carrying out the central electric light station in Dresden have met there to discuss the details. The villages of Elzach and Singen propose to establish a central electric light station, and a deputation has visited Triberg to inspect a local plant. The Municipality of Kaiserslautern have decided to light the streets by means of 25 arc lamps. Mr. Pebermann intends to light his mill at Neustadt electrically. The Municipality of Strasburg, West Prussia, are going to erect a central electric light station in connection with their slaughter-house. The building will be carried out by the town, and the plant will be supplied by the Helios Elektricitäts-Gesellschaft, of Cologne.

Transatlantic Cables.—The following item from the *Scotsman* indicates the difficult position of pluralist directors when the interests of their various companies come into conflict: "The fusion of interests which has been established between the French Submarine Cable Company and the Paris to New York Cable Company is destined to have an unfavourable influence on British submarine telegraphic interests. There has been a good deal of agitation in the Paris Press with the object of urging the Government to give the combined undertaking pecuniary aid for laying another Transatlantic cable. The present French cable is quite out of the race in the competition, and seriously injured itself when it broke away from the pooling arrangement. That the combined undertaking will greatly benefit by putting down another cable is doubtful. There are already a dozen lines across the Atlantic, eleven of which are working. Of these, four are owned by the Anglo-American Company, three by the Commercial Cable Company (now leased to the Western Union), one by the Direct United States Cable Company, two by the American Cable Company, and one by the Paris to New York Cable Company. The first three companies pool their receipts, while the others work independently. This would at first sight seem to be all sufficient—more than enough, in fact, seeing how unremunerative is the business, especially to the premier company. But the project of the French companies to lay another cable is not the only new one of the kind. It has been virtually arranged to lay down a German cable. As regards the French scheme, there is a certain amount of good reason for it. In the first place, the existing line might at any moment break, and communication between France and the United States would depend wholly on the Anglo-American Company. At the present moment the latter company does, as a matter of fact, attract a good deal of the French business owing to its alliance with the Western Union, which controls the land lines across the Atlantic. But there is another reason for this anxiety to establish another cable. By the amalgamation of the two French companies it is hoped to attract a great deal of distant traffic from which it is at present virtually cut off. Thus the Submarine Company has 6,754 kilometres of lines which knit together Cuba, Hayti, San Domingo, Martinique, Guadeloupe, Dutch Guiana, French Guiana, and taps Brazil at Para, Venezuela, and other ports. To send messages from Brazil to the United States over the company's wires is, however, more expensive than to forward them to Europe, and thence over the English lines to the United States. Consequently there is a scheme to form a junction with the cable of the French Transatlantic Company, so as to make a complete circuit. This scheme, it may be taken for granted, will be carried out. As regards the scheme for a German cable, this will need the close attention not only of the shareholders in the Anglo-American Company, but of those also in the Globe Telegraph and Trust Company and the Submarine Cables Trust Company. The German Government have all but agreed to grant an annually subsidy of £70,000 per annum for such a line, the right having been obtained by the concessionaires to touch at Lisbon and the Azores. As, however, the German Government are bound by their contract to use the Anglo-American Company's system until 1900, the affair is some way off. The singular point is that the Eastern Telegraph Company has obtained the right to exploit the cable from the original concessionaires, and its present purpose is to carry out the scheme. The competition will naturally be severe. Yet the same directors sit on the Boards both of the Anglo-American and the Eastern Telegraph Companies, so that they purpose to rule the destinies of two rival concerns. But this is not all. The chairman of the Anglo-American Company is also on the Board of the Globe Telegraph and Trust Company, and of the Submarine Cables Trust Company, which concerns have an interest to the extent of about £1,750,000 in the Anglo-American, the Direct United States Cable, and the Commercial Cable Companies, whose business is to be cut into by the German project. The cost of this competition to the Anglo-American Company will probably not be less than £70,000 per annum, which is equal to about 1 per cent. of dividend, or half what it is now paying. The directors seem to allege that by starting this competition with their existing companies, they will make it less severe than if it fell into outside hands. But to this the obvious answer is that they will be bound to give all their Eastern business which now goes over the Anglo-American system to their new concern, whereas an outside company would not have such an advantage. Besides, to speak of not driving the competition too hard is equivalent to a promise that the interests of the shareholders in the new enterprise are to be in some measure sacrificed, which hardly seems just. But whatever may be the ultimate arrangement, it is certain that a desperate Transatlantic cable fight is in prospect, and that existing interests must suffer severely."

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ELECTRICITY AS A MOTIVE POWER.

In our issue of August 24 we gave a paper read before the Iron and Steel Institute at the Brussels meeting by Mr. D. Selby-Bigge on "Electricity as a Motive Power." In this paper Mr. Selby-Bigge described the Herstal installation. Owing to the want of time the paper was not lengthily discussed at Brussels, but since then Messrs. Charleton, Richards, and Thwaites have contributed lengthy criticisms on the paper, which appear in the institute's *Transactions* as follows:

Mr. A. G. CHARLTON considered the author's paper one of exceptional interest to engineers—not only to those engaged in the iron and steel industries, but to many who, like himself, were more particularly connected with other branches of metal-mining at home and abroad. As an example, he would mention that, whilst recently engaged in laying out a large mining and dressing plant in the Pyrenees, he was very much struck by the immense use to which electricity might be applied in several different ways: (1) to drive the machinery at the mine, which was situated at a high altitude, in a position rendering it somewhat inconvenient, and indeed difficult, to employ steam or other forms of power transmission; (2) for lighting the works; (3) for the magnetic separation of the ore, the employment of electromagnetism rendering it possible to produce a marketable zinc blend from low-grade material (carrying magnetic iron), which would otherwise have been unsaleable.

There was, however, it should be mentioned, the very great advantage of splendid water power in the neighbourhood conveniently situated to operate turbines or Pelton wheels for current-generating purposes. Until he read Mr. Selby-Bigge's paper he was certainly under the impression, however (as he believed most engineers were), that where the advantage of water power could not be commanded, electricity was in most cases only commercially applicable for long-distance transmission. The economy which should result where steam was used, both in fuel consumption and labour, with the various minor advantages the author claimed (through laying out works in the manner he suggests), had indeed not impressed him with the force they now did, in view of the very clear manner in which the matter was put in his paper. One paragraph in particular was of special interest—namely, that "few engineers really realise what is actually lost in the transmission of power through long lines of main shafting, countershafting, pulleys, belts, etc. The power lost has often been ascertained to vary between 30 and 69 per cent. of the total power transmitted."

In a paper recently read before the North of England Institute of Mining and Mechanical Engineers, "On the Choice of Coarse and Fine Crushing Machinery and Processes of Ore Treatment," he took occasion to say "that it appeared to him we must look for advancement in the future rather towards perfecting the details of the machinery and processes we at present possess, than to the discovery of new principles. "We might substitute, for example, a small motor of the Diehl type for the flywheel, belt, and pulley of a rock-breaker, or other machine, and drive it direct in this way, perhaps with advantage in some situations." Now, when he made that suggestion he was entirely unaware that anything had been done practically in this direction, and he was extremely glad to find the feasibility of the idea confirmed and actually applied on a large scale, where power had to be distributed amongst a number of machines and belt transmission was inconvenient or costly. The advantages of electricity for power transmission were daily becoming better recognised in the mining districts of the Western States of America, in localities where water power could advantageously be turned to account. In that connection it might possibly be of interest to members of the Iron and Steel Institute if he mentioned what had been done in two notable instances.

I. The plant of the Aspen Mining and Smelting Company, of Pitkin, Colorado, which was the first mining company in America to use electrical power for hoisting. The mines where this plant was erected were situated on the north-west flank of a mountain which presented a slope of about 28deg. The ore, which was found at the contact of a mass of blue limestone with an underlying bed of dolomite, dipped north 30deg., west at an angle of 60deg., and was reached by an adit (driven south into the mountain at a vertical depth of some 500ft.) about 1,000ft. in length, given a grade of 3 in 100, which was used for both drainage and transport. In order to develop this ore body, drifts were run right and left from the inner end of the adit tunnel along the strike of the deposit, and to incline planes were sunk with the idea of sinking them to a considerable depth. One was begun near the inner end of the adit-level, the other 300ft. distant in the drive north of it. Power of some kind being necessary to raise the ore and waste materials ("deads") to the main tunnel level, it was decided to try electricity, as both steam and compressed air offered serious objections. Accordingly, a "flume" was constructed to carry the water of the neighbouring mountain streams to a 5ft. Pelton wheel, under an effective head of 63ft., and a 50-h.p. 500-volt constant-potential Edison dynamo was installed in connection with it, at a distance of 6,000ft. from the mouth of the tunnel. The hoist, which consisted originally of a 7½-h.p. street car motor manufactured by the Sprague Electric Railway and Motor Company, was placed at the head of the Veteran tunnel July, 1888, and was provided with an auxiliary drum to draw the empty cars in the tunnel by a tail rope system, the loaded train running out by gravity. Notwithstanding the trying conditions under which this plant was operated, one of which was the condensation of moisture on the machine owing to the dampness of the workings, it proved a success. The iron pinions on the armature shaft were, however, exchanged for raw hide pinions, which diminished the noise when running, and the liability of leakage of current to the levers and other parts of the machinery, and it worked so successfully that a second hoist was placed at the head of the other incline. Each of these hoists was designed to raise 250 tons 250ft. up a 60deg. incline every 24 hours, reckoning 16 hours' actual work. The original motor had been in use for three years in the autumn of 1891, during which time the cost of repairs is stated to have been as follows:

Replacing field-magnet coils	£8	6	0
Rewinding one armature	16	0	0
Replacing commutator	15	0	0
	£39	6	0

That statement did not include the small item of commutator brushes, the copper brushes first employed being responsible for the last item of repairs mentioned. Since the adoption of carbon brushes the motors have run without "sparking" and the wear upon the commutators was inappreciable. The burning out of the insulating material on the field-magnet coils might have resulted from one of several causes, whilst the bursting of the binding wires on the armature could have been guarded against had it been anticipated. An extra armature that can be used in either motor hoist was now, however, kept on hand in case of accident. The total time lost in making the repairs alluded to was 12 hours. In 1890 the Aspen Company decided to erect a generating plant of its own (the original one, belonging to R. F. Electric Light and Power Company), and they erected for this purpose four 42in. Pelton wheels, set in pairs on the same shafting. Each wheel was actuated by a double nozzle, which discharged the water in two streams, at a pressure of about 35lb. per square inch, obtained by utilising an effective fall of about 80ft. The flume which carried the water to the head of the pipe had a capacity of 1,000 cubic feet per minute, and a length of 1,300ft. The plant was coupled to two 50-h.p. Thomson-Houston motor-type dynamos wound for a constant potential of 500 volts generating 100 e.h.p. The power generated in this way was automatically regulated to the demand made upon it by deflecting the waterwheel nozzles (which work on a ball and socket joint) by means of a Woodward governor, set to maintain a constant speed of the waterwheel shaft from which it was actuated. The wheels were enclosed in an iron hood 4ft. by 4ft., which could be removed with little trouble, the joints being made tight with rubber gaskets. The adjoining ends of the

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waterwheel shafts carry a friction clutch, by which they could be run as one when it was desirable to apply the motive force of both dynamos to the one common line, and the dynamos were connected with the switchboard in the generating station by overhead wires hung from the trusses. The current was conveyed from the power station to the tunnel 6,000ft. by bare 0·0 copper wire, except for a short distance (about 300ft.) at the end of each line, where an underwriter's insulated wire of the same gauge was used. Inside the mine the current was conducted to the hoisting stations, a distance of 1,000ft. and 1,200ft., by kerite seven-strand conductors, having a heavy insulation $\frac{14}{32}$in. in diameter. Okonite or Grimshaw insulated wires were used in all the circuits inside the mine, where the insulation must necessarily be of the best, and in none of the interior circuits was there a loss of more than 5 per cent. The loss on the outside circuit carrying the maximum load required, up to the time these particulars were given, was 5 to 6 per cent. The cost of generating current (not including interest or depreciations) obtained by dividing the cost of labour and lubricants by the horse-power required, was found to amount to two-thirds of one cent per horse-power per hour, but greater amounts of power could be furnished at a lower rate per horse-power; as up to 100 h.p. no increase of plant would be needed, the cost of labour would remain the same, and the cost of lubricants would not be much increased. In July, 1890, Mr. F. G. Bulkley, the manager, put in an electric diamond-drill, operated by a 3-h.p. Thomson-Houston motor, designed to bore 400ft. holes $\frac{15}{16}$in. in diameter. It was used for 12 months to explore the hard blue, often silicified, hanging wall of the Aspen mine, and the brown dolomitic footwall, and drilled, it is stated, at the rate of 1½in. to 2in. per minute, or in a shift of eight hours, allowing for delays inseparable to such work, from 6ft. to 32ft., depending on the character of the rock. The average progress, allowing for time lost in setting up and drawing cores, was put at 15ft., and it was served by one man with a helper; 4,400ft. were drilled by this machine from starting to July 6, 1891, at a cost, inclusive of all expenses, of 68 cents per foot. Subsequently a 25-h.p. C. & C. electric motor was substituted for the original 7½-h.p. hoist erected at the head of the main incline. This machine was geared to raise a load of 3,000lb. up a 60deg. incline 275ft. per minute, and had been proved capable by trial of making the round trip, from a depth of 550ft., in three minutes, with the full load. Electrical power was now, he believed, applied at the mine to run a small machine-shop, saw-mill, and wood-working machinery, and the company proposes to employ an electric locomotive for surface conveyance, and to make trial of a Thomson-Van Depoele electric percussion drill, a motor-transformer supplying the drill with a current of 220 volts taken from the 500-volt mains. The main levels of the mine are lighted by electricity taken from the power mains, employing five or six 100-volt incandescent lamps, connected up in series, which absorb about 8 h.p. electrical energy.

Mr. M. B. Holt summarises the advantages of electrical power for mining operations in his account of this interesting installation by remarking: (1) that it can be transmitted long distances with small loss, thus making it possible to use power at such a distance from its source as would render it otherwise unavailable, as in the case before us; (2) the conductors for conveying electrical power from one point to another require less space, are more easily put in place and repaired, are easily tapped for branch circuits, and form a more flexible system throughout than any other mode of transmission permits; (3) the electrical system is ideal viewed from the standpoint of cleanliness; (4) the stations for utilising electrical power can be made to occupy a minimum space; (5) if this system does not assist ventilation, it does not, on the other hand, vitiate the air in mine workings; (6) after three years' use under varying conditions of mining work, the electrical current of 500 volts has proved itself to be free from danger to life, and has caused no inconvenience further than one or two severe shocks.

II. The second notable case he should like to instance was "the plant" of the Standard Consolidated Company of Bodie, California, they having lately erected an electrical power plant to run their 20-stamp mill. In 1891 milling cost them on an average 3·89 (16s. 2½d.) per ton, crushing about 1,309 tons per month, and as the price of fuel was 10dol. per cord in this locality, their fuel bills frequently exceeded 2,000dol. a month. On this account, and for other reasons, it was decided to try electricity. An excellent water power was found at Green Creek, a mountain stream on the northern slope of Castle Peak in the Sierra Nevadas, forming one of the chief feeders of Walker River, and an arrangement was made for a perpetual right to its use, for power purposes, on very favourable terms. This stream carried 500 miners' inches of water at its lowest stage, and ran six or seven times that amount when the snows melt in "the spring." An old ditch was cleaned out, and practically rebuilt for a length of nearly a mile, and a site selected for a power-house, 355ft. vertically below the lower end of the ditch. The work of cleaning the ditch, building dam, head-gate, waste weirs, flume, penstock, and power-house, and of laying and anchoring the pipe was pushed during the months of August, September, October, and in November, 1892. The waterwheels were put in place, so that by December the water-power plant was completed and ready to run. A pole line was constructed following a straight line, 12 miles in length, over the mountains from the power-house to the mill, upon which to hang the wires, and 14 miles of telephone line was built between the Bodie office and the power-house, but at a distance from the power line, in order to avoid induction and consequent bad service of the telephones. The motor foundations were also put in at the mill, and a motor-room 26ft. by 18ft. was built, whilst the necessary countershafting and pulleys for making the connection between the motor and battery shafting were made ready to put in place. Lumber from the old Bulwer Standard Mill and other material was used in the construction of the works at Green Creek, thereby greatly reducing the cost. The power-house, 30ft. by 40ft. in size, was the former mill salt-house, and the penstock was one of the water-tanks at the mill, while the steel receiver at the lower end of the pipe was made at the mine from an unused steam-drum. The ditch was 4,558ft. long and was connected with the penstock by a short piece of flume fitted with the usual screen, sand-bore, waste-weir, and flushing-off gate. The pipe was led into the above-mentioned steel receiver, 40in. in diameter by 9ft. 8in. long, from which four taper pipes carried the water under pressure of 350ft. vertical head to as many 21in. Pelton waterwheels, each pipe being fitted with two nozzles and each wheel capable of developing 62½ h.p. The wheels ran at 865 revolutions, and the wheel shaft was connected by a patent insulating coupling to the armature shaft of a Westinghouse 120-kilowatt alternating dynamo generating current at 3,530 volts. A Doolittle governor was attached to the wheels, and a No. 2 Pelton motor had also been put in to run the "exciter" necessary for generating the initial current in the fields of the large machine. The poles of the line are of round tamarack timber 21ft. long, 5in. in diameter at the top; 25ft. poles being used in the town and where the ground required it. They were spaced 100ft. apart, and fitted each with a 4in. by 6in. by 4ft. cross-arm, boxed into the top of the pole and fastened with one bolt and one lag-screw. The wire was No. 1 B. & S. gauge soft-drawn bare copper, and was attached to standard double-petticoat deep-grooved glass insulators carried on Klein ¾in. by 8in. pins. The wire used was of large section, but the distance of transmission was just at that half-way point where the cost of converters about equals the difference in price between a No. 1 and No. 6 wire, hence it was considered better to use a higher potential and a large wire and avoid the complicated and often troublesome converter. The loss of potential on the line was estimated at 15 per cent., and the current delivered to the motor will therefore be 3,000 volts tension. The motor was 120 h.p., and would be brought up to speed by a small motor of 3 h.p. to 4 h.p., which was built on the same bed-plate as the larger one, and thrown out of circuit as soon as the latter was at proper speed, running in synchronism with the generator at the power station. Two "transformers," ratio 30 to 1, of a capacity of 100

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incandescent lights each would be used for lighting the mill and offices at Bodie. The cost of this plant was given as follows:

Water power, including ditch, pipe, waterwheels, etc.	£1,783
Wire line (12·46 miles) £168 per mile	2,095
Motor-room, countershafts, and pulleys at mill	358
Telephone line (14 miles) 78dol. 52 cents per mile	220
Sundry expenses	61
Dynamos and electric plant	2,242
Total	£6,759

The plant was not ready to run till October, 1893, owing to various unlooked-for delays, but during that month it ran continuously with the exception of two days, and the saving effected was clearly shown by the cost of milling that month—viz., 9s. 8d. per ton, as against the average cost for the preceding eight months of 15s. 9d.—a difference in favour of the electric power of 6s. 1d. The mill was operated by electric power all through December, effecting an almost equal saving, but trouble was experienced in November, and again in January, 1894, due to the freezing of the water-ditch. In concluding his report for the year ending January 31, 1894, Mr. T. H. Leggett, the manager, says: "We have the advantage now of being able to operate the mill by electric power, enabling us to work a higher grade and less quantity of ore without the loss of time and money accompanying each start and stoppage of the mill when the same is being driven by steam power. This aside from the direct saving in fuel consumption of from £7 to £8 per 12-hour shift." The idea of utilising the surplus waste gases of blast furnaces for firing boilers to generate electrical work in districts like Cleveland appeared to be a very valuable one, capable of large practical application. The absolute checks over the coal consumption and running expenses which electric power afforded, indicating exactly what the various machines in the works were doing, were certainly features which should recommend it to consideration.

Mr. L. RICHARDS, referring to that portion of the paper dealing with the application of electric motive power in place of steam at the blast furnaces, steelworks, and rolling mills, thought that the author over-rated the amount of the waste gases that would be available after the requirements of the blast furnaces had been supplied. But would there be any advantage derived from the use of electricity as a motive power, rather than steam, in the blast-furnace department, beyond possibly driving overhead and perhaps other travelling cranes, and, of course, the lighting? Pumping water for lifts and other hydraulic machines constituted most that was to be done by motive power outside of the blowing engines. In pumping machines generally the motive power was made to produce rectilinear motion direct, rotary motion playing only a small part—that was to say, the pressure of the steam on one piston was made to act direct upon another piston, or plunger, as the case might be, so as to force the water into the accumulator and the tanks, a light flywheel in some instances having been used to clear over dead centres, and to ensure regular running. It was difficult to see how any advantage was to be gained by the substitution of electric motive power for that of steam direct in machines of that class. Coming to the steelworks and rolling-mills, the author stated that the coal consumption per horse-power of work turned out was from 8lb. to 15lb., and even more. In another place, when referring to rolling-mills, the consumption of coal per indicated horse-power was given as 7lb. to 8lb. It would be very interesting to know how these figures have been arrived at, especially those giving the horse-power upon the work turned out. With regard to the figures (7lb. to 8lb.) given as the consumption of coal per indicated horse-power per hour, they seemed abnormally high. He presumed that the indicated horse-power had been calculated from full work diagrams, and from an assumed uniform piston speed for the minute of time. That, however, was not the case with reversing engines. With regard to the figures given as the horse-power upon the work done, or rather turned out, he was well aware of great injustice being done to rolling and other engines in connection with rolling mills in this respect, owing to the irregular system of working. It was the system of working that was mostly at fault. The stokers at the boilers never knew when the work was coming on, and so they dared not bank the fires, or even slack firing, and the consequence was that much fuel was burnt to no purpose. With the same system prevailing, it was difficult to see how matters could be any better with regard to firing the boilers supplying steam for the engines of the electric generators.

The author characterised all the engines in connection with rolling mills as uneconomical, using low-pressure steam, with little or no cut-off. But he (Mr. Richards) failed to see any reason whatever why all the engines in a rolling mill, with the exception of the reversing engines, should not be economical as regards steam consumption. There was nothing in the way of having early cut-off, or of having compound or triple expansions, nor of having steam of 150lb. per square inch, or any other desired pressure, if suitable boilers were put up. Nor was there need to have any long lines of steam-pipes to connect the auxiliary engines with the main boilers, as managers have of late years been fully alive to the advantages of utilising the waste heat of the heating furnaces for generating steam, and making direct steam-pipe connections between the furnace boilers and the auxiliary engines. Under the circumstances detailed, it was again difficult to see the advantage of electric mover power over that of steam direct. Most engines such as were tabulated in the paper had to do a great variety of work in which the power absorbed varied between very wide limits, and hence it was necessary to provide power for the heaviest, and often more or less unknown work, and if the engine was provided with an automatic variable cut-off, nothing could be much amiss. The employment of electric motors for doing the same class of work would be under similar circumstances—that was, a punching machine or a straightening press would be dealing with a light section at one time and a very heavy one at another—so that it appeared that to take an electric motor to measure the power absorbed at any one time, would be of little value for determining what the permanent motor should be.

With regard to the application of electric motive power for driving reversing rolling mills, the author spoke with what he (Mr. Richards) considered proper reserve. Being well acquainted with the reversing rolling-mill engine from the time of its introduction, he was of opinion that there was no other engine, not even the marine engine when working under the most trying circumstances, that could be compared with it as regareded the work it had to do and the manner it had to be driven. Owing to the long stroke of 5ft., which was very commonly adopted, the piston speed ran up to 1,000ft., and even 1,200ft. at times, and it had to be reversed from 12 to 15 times in about every 2½ minutes. With an electric motor running in the manner just described, there would, he thought, be some considerable difficulty in governing the electric generator with the energy taken from it in great gulps at one instant, and none in the next. The effect upon the motor driving the rolls was also difficult to foretell. There was, however, no doubt that the reversing rolling-mill engine was susceptible of improvements as regarded economy in the consumption of steam. There was, too, room for great improvements in the mode of generating steam for it. He had long thought that the cylindrical multitubular marine boiler, or any other boiler in which there would be a maximum concentration of evaporative power, with a minimum of occupied space, should be adopted. Such boilers would admit of being placed close to the main engines for which they were to supply steam, and the great loss of heat, not only from condensation in the present long lengths of steam-pipe connections, but also that from conduction from the external flues of the Lancashire boilers, through the brickwork surrounding them. Also the heat absorbed in the brickwork itself, and in the great weight of water contained in a large battery of such boilers, which for the most part was thrown away when they were let out at the end of the week, and had to be replaced at the time of relighting, would be saved.

(To be continued.)

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ELECTROLYSIS OF WATER-MAINS.*

BY G. H. BENZENBERG.

Since the last meeting of this association the subject of corrosion and the destruction of water-mains, gas and service pipes, cables and other underground conductors in streets where electricity has been introduced as the railway motive power has, at the hands of the various engineers and the chemists, received a much more scrutinising and scientific consideration by closer investigation or by experiments and laboratory tests; and thereby much of the mystery which seemed to surround this destructive process some 12 months ago has been removed. The doubt which seemed to exist in the minds of many as to the corrosive action occurring only at such points where the current left the enforced conductor has been entirely removed, and the fact established that only where the pipe or cable is positive to the earth and to some other conductor, and where the pipe or cable assumes the position of an anode to that other conductor, be it the rail, some other pipe or cable, or the generator itself as the cathode, with the intervening earth as the electrolyte, that corrosion takes place by electrolytic action. It has also been established in experiment by more than one investigator that it needs but an extremely low potential, not exceeding one-hundredth of a volt, coupled with other favourable conditions, to produce electrolytic action, though it may take considerable time to cause the results to become apparent.

During this time, also, information has been received from many additional cases where injury to water-mains, service pipes, or cables has been reported. The investigation of some of these injuries was placed in the hands of electrical experts or commissions, whose reports thereon have been published from time to time in some of the technical publications. All of these reports agree with the views held heretofore, that the trouble is caused by the imperfect means provided by the electric street railway companies for the return of the current, and suggest sundry improvements upon the methods employed to return this current, from the double overhead trolley system or the continuous perfectly insulated underground cable return to the various methods of bonding the rails and the use of an ordinary continuous return wire connected with the rails. Of these methods, undoubtedly the first two, while in perfect condition, would afford the most complete protection; but there are sufficient serious objections to them on the part of the street railway companies to prevent their being adopted, and the remedies, therefore, must be sought along the line of more reasonable requirements and against which the companies cannot sustain valid objections. By this statement it is not meant that it should be inferred that the electric railway companies should not be held to provide for positively adequate means of returning the current to the generator without damage to other property, but that if such object can be accomplished by other more moderate and suitable means, the companies, who are deeply interested in the return of the current at as high a potential as possible, will undoubtedly more readily provide the means of protection.

The rails, which in the first instance receive the return current, unquestionably possess, if of ample section and without a joint, a sufficient conductivity to return all the current to the generator, excepting what in any case, under the law of divided circuits, is certain to escape to other conductors, if such exist. Therefore, all that is necessary to obtain the most perfect uninsulated and available conductor is to reduce all possible resistance at the rail ends by providing a most perfect bond between them, equal to the rail in conductivity, or, in other words, by riveting a copper bond of about 12in. length to the rail ends, the section or number of these bonds to increase as the power-house is being approached, supplemented by similar cross bonds, connecting the four rails to each other every 100ft. to 120ft. These rail-bonds should in section or number anticipate increase in traffic and extensions. If a number of railway lines are operated from one power-house, and particularly if the power-house is not on the line of the railway, ample return feeders should radiate out to the various centres so as to relieve the overloaded rails, and these return feeders should be well insulated to preserve them and also to prevent leakages to the ground.

However, even with such careful and ample provision for the return current through the rails and insulated return feed wires or cables, a certain percentage of the current is, especially in moist earths, bound to leak through it to some other conductor, and the amount thereof will depend upon the combined resistance of the earth and conductor compared to that of the rail or other return circuit. If this amount does not increase to such an extent as to make this conducting medium, be it water, gas-pipe, or cable, at any point, positive to either the rail or any other conducting medium, so as to cause the current to leave it, there would be no harm done, providing the conductivity of the pipe were uniform throughout and made continuous to the generator by an ample and perfect connection at some suitable point. With a proper bonded rail circuit, reinforced by insulated return wires or cables from central points, such increase of current on any water-pipe is not easily possible, as the resistance offered by the water-pipe is very low, the metallic section of a 6in. water-pipe being one and one-half time that of a 70lb. rail, while that of an 8in. pipe is two and one-quarter, and of a 12in. pipe three and three-quarter times as great; therefore, the perfecting of the circuit from the pipe to the generator in such cases is generally sufficient provision to protect the water-pipe from electrolytic action.

But in all cases where the resistance to the current in the rails has not been reduced to a minimum, the proportion of the leakage becomes greater, and, where the bonding is poor or imperfect, the resistance in the rail circuit becomes so great as to cause the water-pipe to become the main return feeder, if not along the entire line, at least, in many sections, and thus the pipe at many points becomes positive to adjacent or parallel conductors, at once establishing conditions which will produce electrolytic action, the extent of the destructiveness of which to the pipe will depend upon the low resistance offered by the earth, and upon the amount of soluble salts, the electrolysis of which is injurious to the iron, that are contained therein. These salts, according to extensive experiments made by Prof. D. C. Jackson, of the University of Wisconsin, and reported by him in a paper read before the Western Society of Engineers, consist of chlorides, nitrates, and sulphates, given in the order of the effect of their activity upon the iron pipe when acted upon by the electric current; a mixture of these salts causing intermediate results. These salts in some one form or another are to be found to a greater or lesser extent in almost every street soil, and, as Prof. Jackson has demonstrated, "only a minute quantity of soluble salt is sufficient to start action, and it will then continue as long as a current flows." It is clear, therefore, that the conditions are favourable to the corrosion of the pipe. Again, quoting from Prof. Jackson's most valuable paper on this subject: "The problem of preventing the destructive electrolytic effects upon the pipes of the railway return current is shown to consist simply of the prevention of electrolysis of the salts of the soil, when the products of electrolysis are of such a nature as to attack iron."

To accomplish this it is but necessary to prevent the pipe at any point from becoming positive to the rail or any other possible conductor. Whether the pipe is positive or not can be easily determined by a few observations with a voltameter at points radiating out from the power-house and along the line, where, by a perceptible difference in the potential between rails, the existence of poor or defective rail-bonds is shown. This fact and the points where the pipe is positive having been determined, the railway company should not lose a moment to re-establish the proper conditions for the protection of the pipe.

If not already provided, ample and suitable connection by an insulated cable should at once be made between the pipe and the generator to afford the least resistance for the proper escape of the current to its destination. If this has already been supplied, and if the pipe is still positive, the rail-bonds of such points should be perfected, and if the conditions are such that an increase of the section or number of such bonds will not entirely remove the diffi-

* Report of the committee on electrolysis at the recent convention of the American Waterworks Association.

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culty, proper and suitable metallic connections should be made at such places between the pipe and rail so as to permit the return of the current to the rail, until the proper equilibrium, dependent upon the relative resistance, has been established without the necessity of passing the current through an electrolyte and of developing electrolytic action in the accomplishment of such result. Insufficient rail section, inadequate return feeders, or especially wet soil, presenting an easy avenue for the current to reach the pipe, may make it necessary to add to the number of such connections, but they should only be made where the pipe is positive in order to relieve the pipe, and for no other purposes. If this method be followed, no damage, it seems, can arise to the pipe, but, to the contrary, the best possible protection given it against an agent whose permeating power it is impossible entirely to escape.

The only question which may arise in connection herewith is as to the uniform conductivity of the pipe, whether there is sufficient resistance in the lead joints to cause some of the current to pass around, and in doing so produce electrolytic action. In a measurement made on August 9, 1894, at the lead joint of an 8in. water-main in front of the power-house of the Milwaukee Street Railway Company, through which main 16 per cent. of the entire output of the station (or 421 amperes) is being returned (31 per cent. being the entire amount returned through the water-mains), a drop of potential of but ·0198 volt was found to exist between the ends of the pipe, indicating a resistance of ·000047 ohm, certainly not sufficient to produce electrolysis even with the most favourable conditions existing at the joint.

But do any favourable conditions exist? Prof. Jackson, by his great number of experiments, has established that "in no case is the (corrosive) action due to the electrolysis of water; where oxygen is liberated at the anode, it does not attack the iron;" and again, "in order to have the first electrolytic process go on—that is, direct electrolysis of iron—a soluble iron salt must be present in the soil, reaching from anode to cathode. The analysis of street soils shows no such salts." Corrosion at the joints, therefore, can only be caused by the electrolysis of the soluble salts heretofore mentioned, if they exist between the hub end and the adjoining pipe at the joint. A most careful examination of the pipes and the lead joint in the 8in. main above referred to did not show the least perceptible action or corrosion, although the main had been used as a conductor for years. It does not seem, therefore, that there is the least cause for any anxiety that corrosive electrolytic action may take place at the lead joints, and hence a water-main of like diameter may safely be considered to possess a uniform conductivity throughout, and capable of conducting without injury so much of the current as under the law of divided circuits it cannot avoid conveying.

The 8in. water-pipe, where the same is connected by a 500,000 circular mil cable to the generator, was subjected, on either side of the connection and under the clamps, to a most careful scrutiny and examination, but, notwithstanding the clamp and cable had not been touched for 15 months, not even the least discernible change could be detected at any point. Where the iron pipe had been filed to form a contact with the clamp, the fine markings of the file were as sharp and distinct as on the day they were made.

Other connections between the rails and pipe which were examined were found to be in equally good condition, and all possible information obtained so far indicates that all corrosive electrolytic action on or along the pipes has been arrested.

Undoubtedly, electric street railway companies will soon, if they have not already, learn to appreciate the economy stored in a perfect return circuit of least possible resistance, and perfect, by improved copper bonds and return cable feeders, their present, in many instances, inadequate system.

The line of enquiry and investigation for the waterworks engineer to pursue and the remedy, if needed, to be demanded at the hands of the railway company have been made clear at least by the investigations and experiments which have been made, and he can now, by his own observations, ascertain whether or not any part of his pipe system is endangered.

THE DISPOSAL OF TOWN AND OTHER REFUSE.*

BY JAMES DEAS.

The question of dealing with town's refuse has occupied the attention of local and municipal authorities in this country for many years. Various schemes have been suggested to remedy the evil, but all are now agreed that the most economical and safest, from a public health point of view, is to destroy it by fire. Since the year 1870 many furnaces have been designed and constructed for the disposal, but they have either been faulty in design or failed to comply with what is required in a perfect destructor—namely, the complete deodorisation of all noxious vapours or gases during the process of burning. Thanks, however, are due to those early pioneers in trying amid determined opposition to improve and secure the interest of the public health. I need not detail in full the earlier types of destructors, as you doubtless are all aware of their construction, and my remarks will therefore be confined to the present forms, and more particularly to a new design in which I am directly interested, as a few facts and figures relating to this will be of special interest to some of you who are now considering the question of destructors. The essential points in disposing of town's refuse by fire is to burn or destroy all noxious gases without causing any nuisance or offence to anyone living either in close proximity to the works or any distance from it. At the same time due precaution must be taken (and this, of course, depends upon the type of destructors in use) that no fine ash, charred paper, etc., is allowed to escape from the chimney shaft. This is a nuisance very common with certain forms of destructor. Blame is often attached to the attendants, but my experience leads me to infer that the apparatus is faulty in design. In one of the London vestries the author saw charred paper coming out of the chimney shaft as large as a man's hand, and this is in the centre of London. Such occurrences like this must to a large extent direct public influence and opinion against the general adoption. The principal objection against many forms of destructor is the charging arrangement. While the material is being burnt on the grate bars the gases given off pass the mass of material lying for the following charge on the back hearth into the main flue and thence to the chimney; or, to quote from the report of the London County Council, the outlets of combustion are at the back of the furnace, and that whilst a charge is burning upon the furnace bars the next charge is upon the dead hearth at the back, near the outlet flue, where it undergoes drying and partial decomposition, with the result that offensive vapours are given off without being exposed to sufficient heat to render them inoffensive. The following are the necessary conditions for a perfect destructor: (1) to destroy rapidly all unscreened refuse from a town of whatever description without committing any offence or possible nuisance; (2) to reduce the refuse dealt with to the least possible amount of clinker; (3) to deal with the refuse and the by-products with the greatest efficiency. In the map before you a new type of destructor has been introduced which complies with the above conditions; it has been in actual operation at Warrington, and worked continuously night and day for the last 13 months. You will notice that the material is carted up a short incline to top of platform, which measures 8ft. 9in. from ground level, half the height of the incline to other destructors. The refuse is tipped direct into a hopper, and falls down on to the inclined path, where it is partially burnt and dried, and all the gases are absolutely destroyed by the radiation of the intense heat of the furnace by being drawn through and over the hottest part of the fire, entering into ignition and complete combustion in the chamber (where a temperature of 2,000deg. F. is maintained) before finally passing away through the boiler. This intense heat and form of furnace does away with the necessity of a secondary fire, and follows the suggestions set forth in the London County Council Report—see p. 4—(any arrangement which makes it possible for the imperfectly heated gases from drying refuse to escape into the flue without being compelled to pass through the hottest part of the fire is an imperfect one). It is true that such gases may be completely burned by subsequent exposure to the heat of a cremator, but the most satisfactory and economical method appears to be to secure the most complete combustion in the cell itself. To guard against the accumulation of gases in the corners of the feed path means are provided to draw them off by the the two side pockets or openings, where they are drawn along the cavity side walls and there get heated on their transit to the combustion-chamber, where complete combustion takes place by means of the introduction of heated air coming in contact with the gases at the top of the back wall or bridge, as shown. The inlet for air is at the side, and is regulated by means of a valve, and gradually increases in temperature by coming in contact with the heated brickwork on its way to the top of the bridge. The gases after leaving combustion-chamber pass through boiler, as shown by the arrows. I shall refer to this later on. The gases have been analysed several times by Mr. Carter Bell, county analyst, and the following is the analysis:

Carbonic acid	7·2
Oxygen	11·8
Nitrogen, sulphurous acid, water vapour	81
	100·0

The results are given in percentages by volume. He adds: "I drew various samples of gases from the chamber at the foot of the chimney shaft, and in no case did I find the slightest trace of sulphuretted hydrogen or mephitic vapours. There is no trace of carbonic oxide." The object of this destructor is to effectually burn all organic vapour present in the refuse, and for that purpose air is introduced in a closed ashpit by means of a fan. One point in burning refuse is to

* Paper read before the Sanitary Institute at Liverpool.

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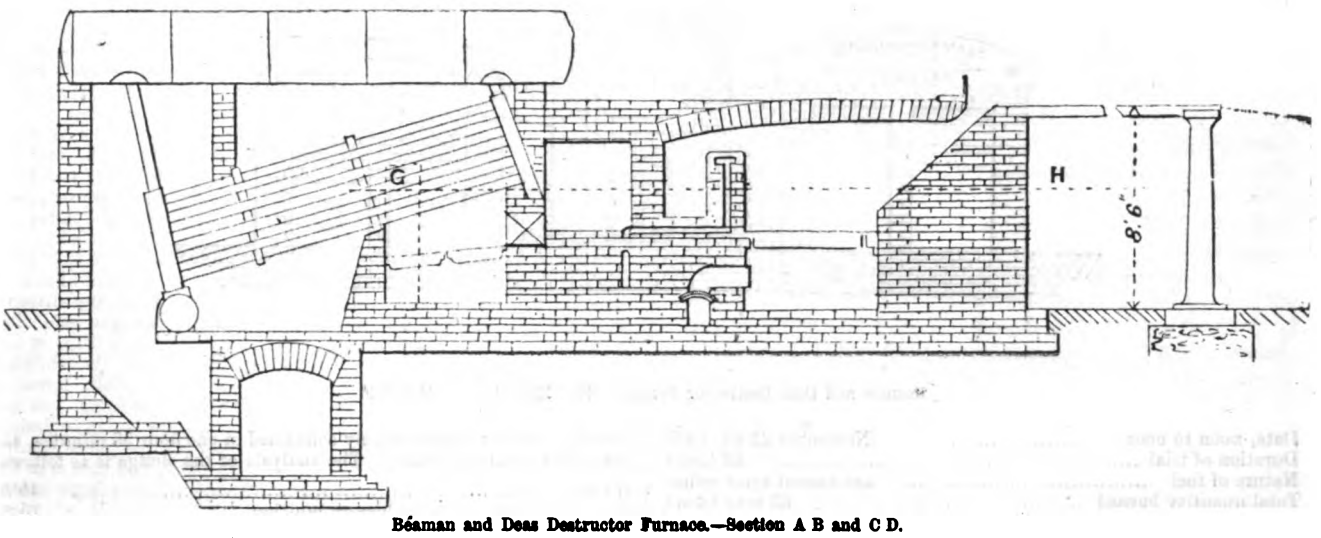
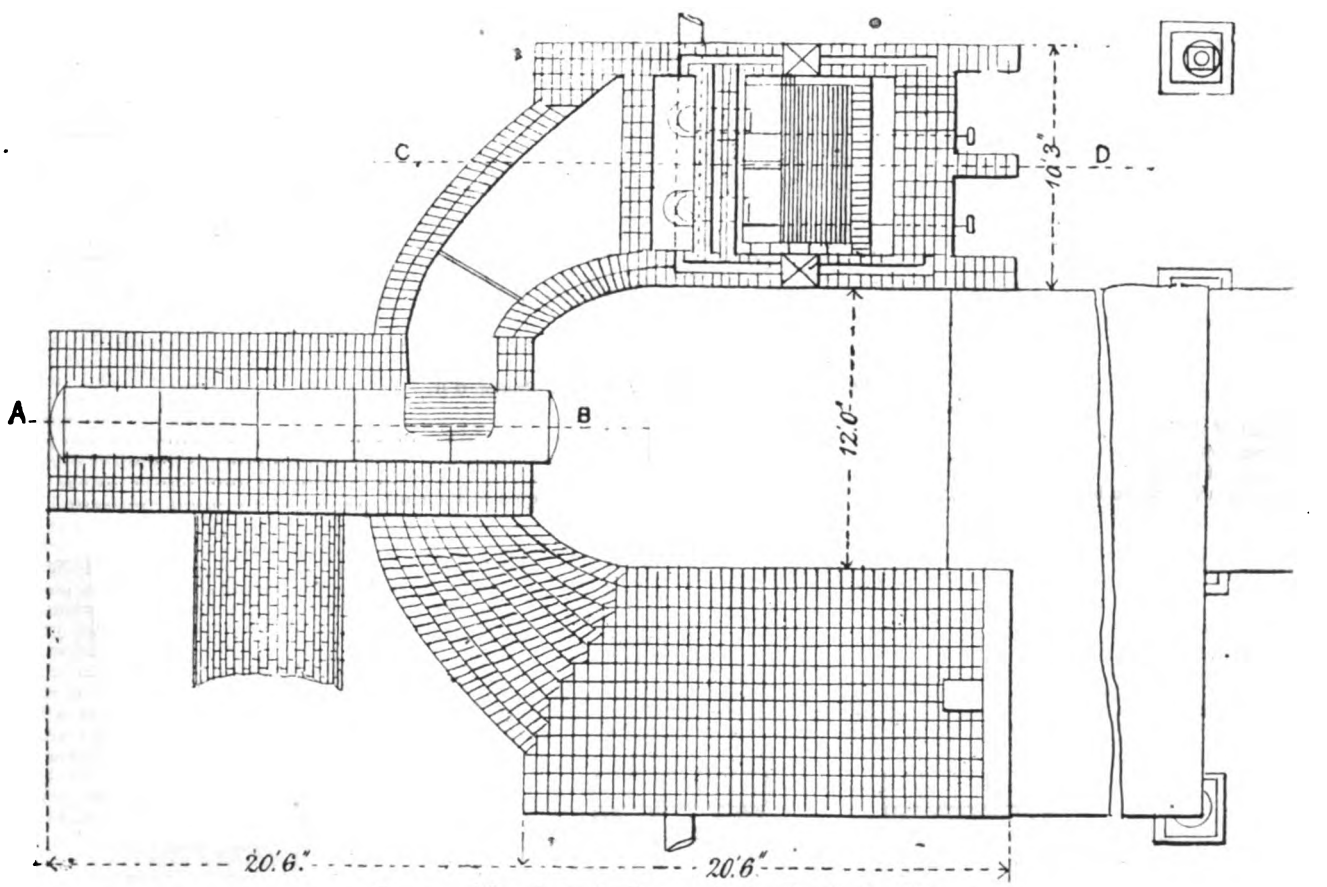
ascertain as near as possible the amount of carbon present. This is generally found out by close personal and practical observations from day to day and from season to season. After this is ascertained, the next point is to deliver or supply the proper quantity of air necessary for complete combustion. At Warrington we allow from 220 to 250 cubic feet of air to every pound per minute. Another feature of special importance is the form of furnace bars used. I have tried several, both rocking, and also having the fins immersed in water, and in my experience I find that the stationary bar gives by far the best result. In furnaces working on what is termed the slow-combustion process a large space is allowed and required between each bar for the admission of air, but this must necessarily at the same time allow a very large amount of material to pass through unburnt which the furnace gets the credit of destroying. I visited a

side of furnace handy to attendant. Behind the combustion-chamber provision is made to further utilise the heat (as shown in chamber) for destroying infectious bedding mattresses, etc., and also for burning the tin and zinc from the old buckets and meat-tins which form such a formidable nuisance and obstacle at every depôt. Objection has been raised by parties viewing this destructor at Warrington as to the high temperature attained and the possibility of the brickwork being rapidly burned away. The experience of 13 months' continuous working does not confirm this opinion, as no repairs have been necessary, and no expense has been incurred. During the process of burning Nature supplies the preserving agent, which is present in the refuse, as very fine particles of dust are formed during the process, and these fix themselves on the crown of the arch and exposed portions of the furnace in a stalactitic form, thus protecting the



Béaman and Deas Destructor Furnace.—Section A B and C D.



Beaman and Deas Destructor Furnace.—Section Plan—Section G H.

London vestry some time ago and questioned the official in charge as to the large amount of material in his ashpits. He informed me that what had fallen through the firebars was incombustible, and was of no use. I only wish we had some of it in our Lancashire towns. It would materially assist us in disposing of our refuse. It consisted of small pieces of coal and cinder. The bars here have a space between them of only $\frac{3}{16}$in., and the weight of fine ash passing through from a week's work of five days only amounts to (and burning 100 tons) 3½cwt. The air culvert passes through the bottom of the furnace, on the top of which are two air-blast pipes. The air is controlled by means of baffle-valves acted by the handles on either

brickwork from the intense heat. The following analysis was made by Mr. J. Carter Bell of the stalactite:

Silica	55·364
Oxides of iron	15·711
Alumina	17·362
Lime	5·390
Magnesia, potash, soda, etc.	6·173

In clinkering no trouble is experienced, and the clinker comes easily off the bars. No new bars have been required, and, in my opinion, the present ones will serve for many years to come. I find

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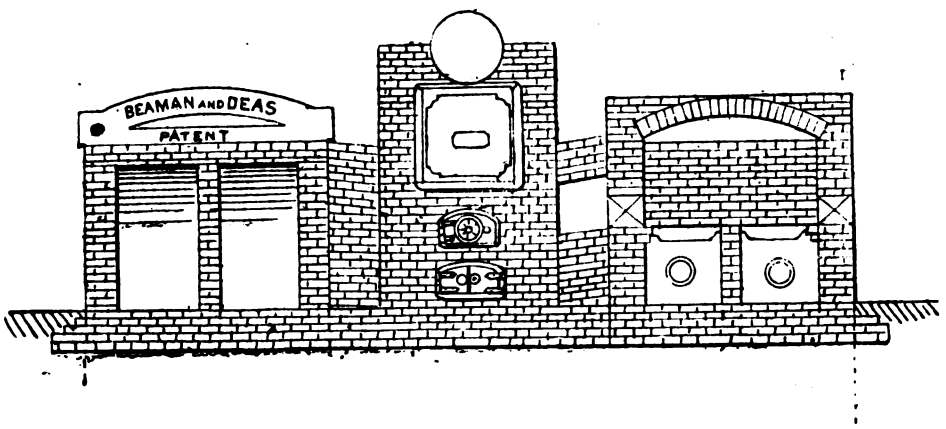
in Mr. M. G. Watson's paper, read at a meeting of the Yorkshire College Engineering Society, that the average amount of refuse burnt by destructors now in use is given at 6½ tons per cell per day. The following figures are given by an independent 24 hours' test made on this destructor at Warrington by the Leeds Corporation:

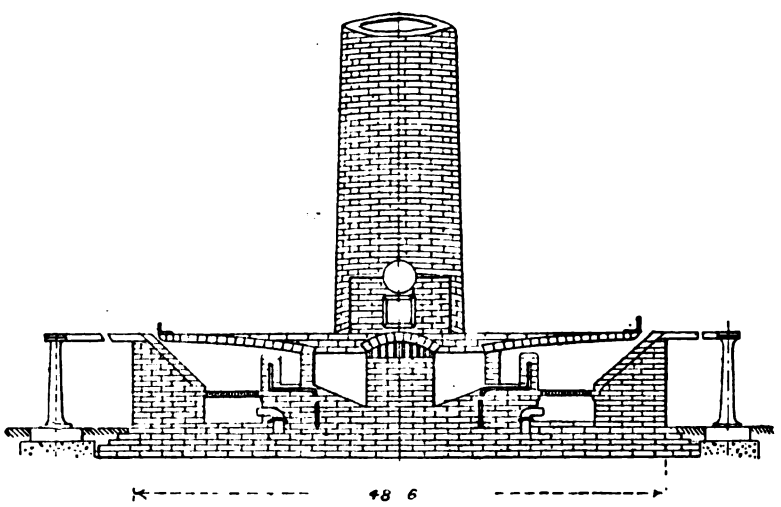
The whole refuse is weighed at the works, and the daily amount burnt in this furnace amounts to 20 tons per day. I have made several experiments in burning sewage sludge mixed with town refuse with success. The following test was made a few weeks ago—namely, burning one ton of sludge with one ton of refuse, weight for weight; the whole two tons was entirely consumed in one hour 35 minutes, and gave 25 per cent. residuum. The analysis of the sludge is as follows:



Beaman and Deas Destructor Furnace.—End Elevation—Section E F.

Date, noon to noon	November 23-24, 1893.
Duration of trial	24 hours.
Nature of fuel	unscreened town refuse.
Total quantity burned	23 tons 18cwt.
Quantity of fuel per hour	19cwt. 3qr.
Total quantity of water evaporated	6,134 gallons
Quantity of water per hour	255 gallons

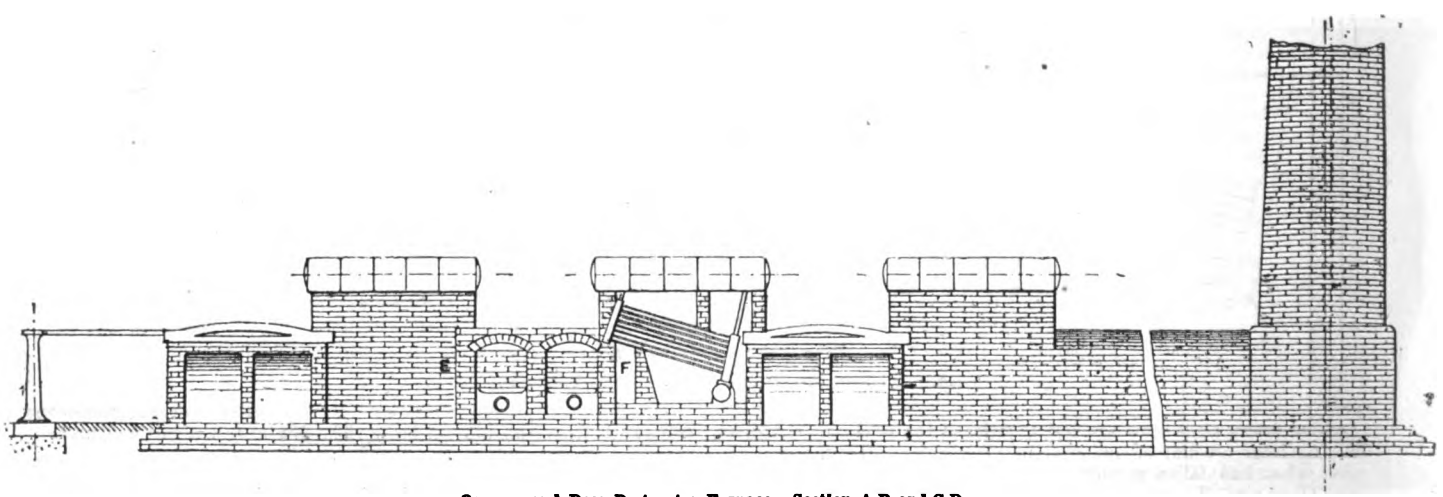
Water	46·36
Organic matter and other loss on ignition	15·86
Mineral matter	37·78
	100·00



Beaman and Deas Destructor Furnace.—Section G H.

Weight of clinker	6 tons 13cwt.
Per cent. of clinker	27·9
Pressure of steam	68lb.
Temperature of air in boiler-house	45

Lime	5·84
Carbonate of lime	18·07
Phosphates	1·01
Nitrogen equal to ammonia	·68



Beaman and Deas Destructor Furnace.—Section A B and C D.

Temperature of feed water	104 F.
Temperature of gases leaving damper	650
Quantity of water evaporated per pound of house refuse	1·14
Average air pressure	2½
Average temperature by copper-wire test	2,000 F.
Draught velocity in feet per minute	820

I am considering the question of another system of burning sludge which will give superior results to above, good as they are. I find from Mr. Jones's book on destructors that he mixes two of refuse to one of sludge, but does not give the chemical analysis, which is very important.

Turning now to the question of steam. In my opinion, the question

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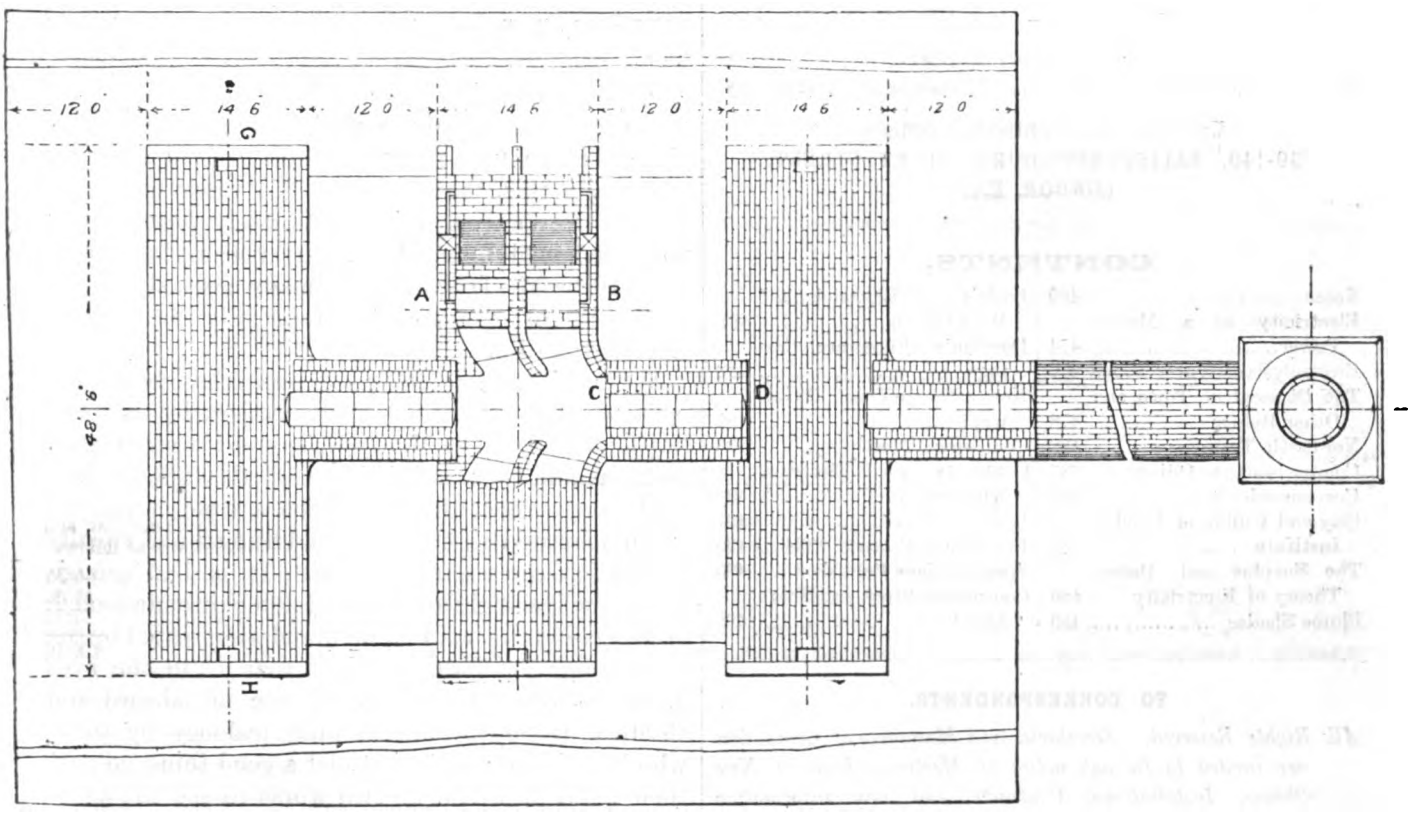
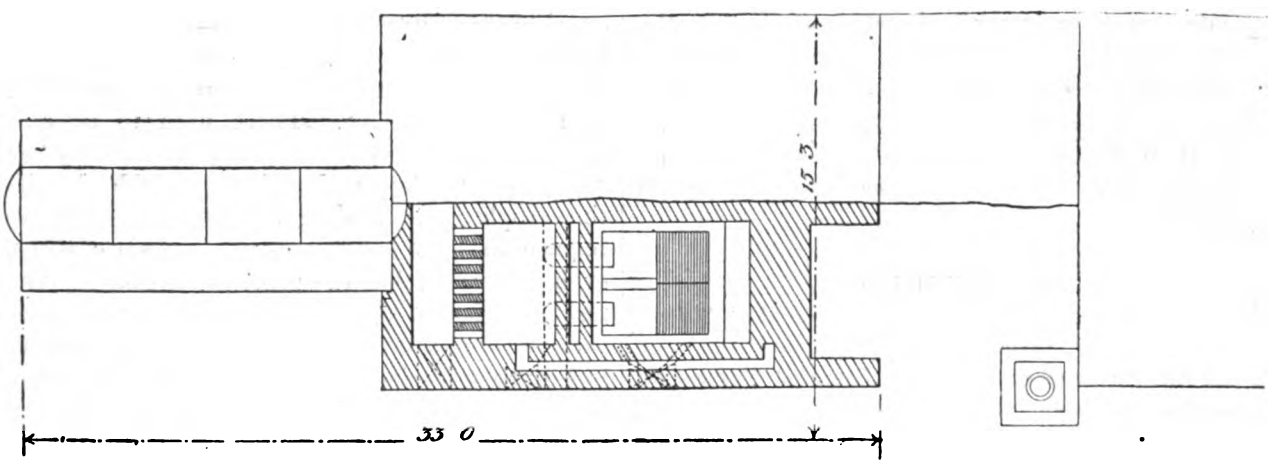
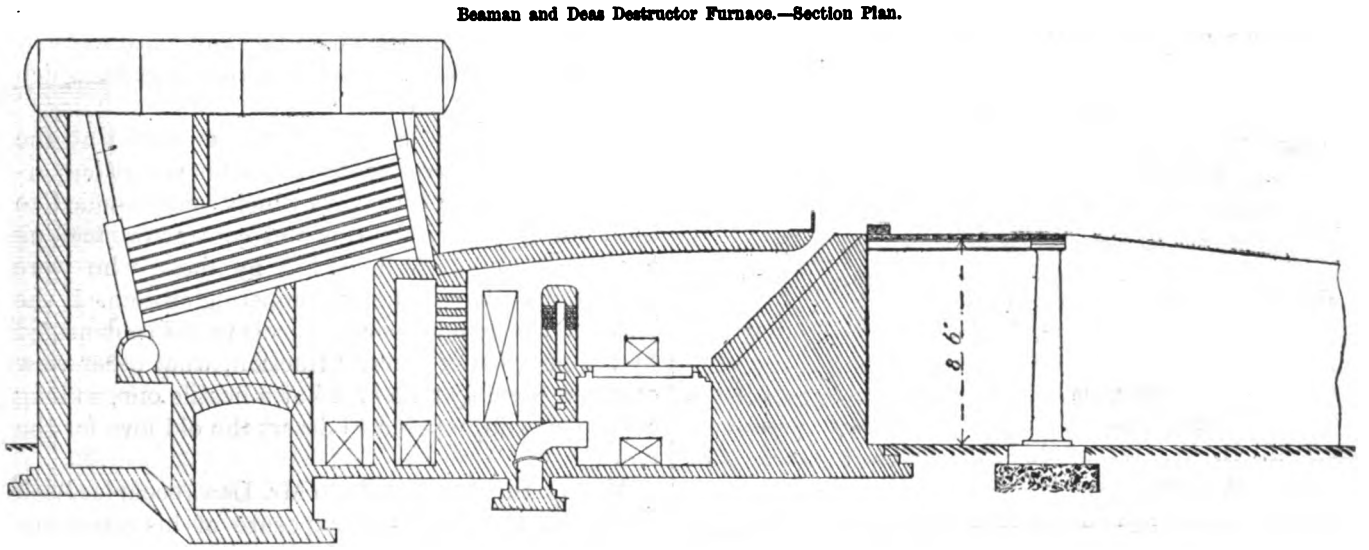
of steam generated from the burning of town's refuse will form one of the most important points in reducing the present cost of the disposal of town's refuse. At the present moment accurate figures cannot be got as to the true calorific value of town's refuse. In all results were given in pounds of water evaporated." And in this I even go further, and maintain that experimental tests ought to be made every week, as the material varies so much, when an accurate result of one year's working may be taken, and results definitely



Beaman and Deas Destructor Furnace.—Plan—Section E F.



Beaman and Deas Destructor Furnace.—Section Plan.



Beaman and Deas Destructor Furnace.—Longitudinal Section.

Mr. Tomlinson's report on the utilisation of town's refuse for power production, in Mr. Jones's treatise on refuse destructors, the figures there given from different towns are very conflicting, and cannot be definitely depended upon. I quite agree with him in the following, to quote his own words: "It would much facilitate comparison if got from practical experience. From separate trials and tests in Warrington, I find that in the furnace I have described in this paper I have got on the average 11lb. of water evaporated from 1lb. of unscreened town's refuse; and from these repeated evaporative tests the only true calorific value of any town's refuse can be ascertained."

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NEWCASTLE TRAMWAYS.

In the month of June last (see the *Electrical Engineer* of June 8 and 22) we published the report of Mr. W. G. Laws, city engineer of Newcastle-on-Tyne, respecting the tramway system of that place, and also a criticism thereof, in which defects and incompleteness of Mr. Laws's report were pretty clearly shown up—the conclusion arrived at being practically this, that although the views expressed to the Corporation might ultimately prove to be wise and well founded, yet the reasons and facts adduced by Mr. Laws were in many cases absolutely erroneous or exaggerated, especially as regards electric traction.

We now have another—if somewhat belated—opportunity of returning to the subject by the publication of a reply to Mr. Laws's report from Messrs. Siemens and Co.: and if it be worth while kicking what may prove, after all, to be a dead horse, we again take up the matter for additional and equally emphatic expressions thereon. It is bad enough to see the gas-lighting interest knocking its foolish head against the solid stone foundation reared by the electric lighting industry—bad, that is, in the eyes of those who do not like to see an absurd and childish display of unreasoning jealousy by those who have been so silly as to let a good thing go past them; but it would be still worse to see the advocates of cable or steam traction shutting their eyes to the advantages of electric motors merely because they involve a new principle, and might develop into powerful rivals to the endless rope or steam locomotive. There used to be an old puzzle in the primers of political economy which asked what the undertakers would do if all the people left off dying. Obviously they would require to bury something else—electric wires, or even gas-pipes; but the principle is clear. When a new and better method of working is introduced, then those who have been used to previous modes, and have even depended upon them for daily bread, must simply adapt themselves to the new circumstances or clear out into something different. Can it be supposed that a great number of people are to be inconvenienced by losing the advantages of improvement in order to maintain a condition of affairs by which a few have benefited?

We take this position because, as stated at the time, Mr. Laws practically based his report on particulars of electric tramways which were supplied to him, not by electrical firms and contractors making a speciality of such lines, but by those who were confessedly advocates of a competing system. If the latter consider that their prospects would be damaged by the progress of electric traction, what other view can they possibly take of it but a hostile one, so long as they are unprepared to desert the old love for the new?

Messrs. Siemens's reply to Mr. Laws occupies itself almost entirely with an exposure of his erroneous statements respecting the Budapest conduit line, and we think certainly that the Newcastle Corporation would have been well advised in sending Mr. Laws over to Budapest in person, and under the guidance of the engineers who built the line, rather than

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depend upon second-hand evidence from a source which might conceivably be prejudiced against the line. Replies similar to that of Messrs. Siemens's might equally well be made with regard to the other points or heads of Mr. Laws's report; but as some of these were criticised at the time in our pages, we refrain from repeating the strictures they deserve. We can only hope that not only will other corporations take care to avoid the error of the Tyneside city, but that by the time these lines are in print Newcastle itself may have considered its ways and been wise.

COMPARISONS ARE ODIOUS.

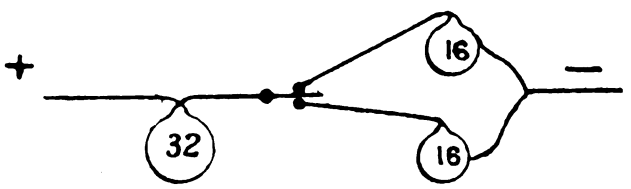
Some time since we gave tentatively a partial analysis of the Board of Trade accounts. This was given more or less by request. A careful consideration of the criticisms upon such an analysis soon forced us to the conclusion that, unless given with an overwhelming mass of explanations, the value was distinctly antagonistic to the industry. In order to be of any real value the figures would have to refer to a common system of units, and this is impossible. The man behind the scenes understands that a direct comparison cannot well be made between two central-station accounts—no, not even when these stations are within a comparatively short distance of each other. The authority, however, which is to be tempted to give its allegiance to one designer over others is not made fully acquainted with all the circumstances of the case, and is frequently persuaded by means of figures that are neither more nor less than pretentious lies—that is, they pretend to be valuable comparisons when they are not. We have not yet a sufficiency of central stations working in similar places to obtain satisfactory figures. Perhaps we may go further, and say that we have as yet no single station working at its maximum economy. This statement may be combated. Mr. Crompton, for example, may contend that the point has been reached at his excellent station at Kensington, where, if not absolute figures, a very fair idea of economical working is obtained; but we fancy he will not go so far as to say that finality is reached. We have tried again and again to insist upon the fact that a central station which pays its way now ought to be a little gold mine in years to come. The use of electrical energy is certain to develop in many directions which at present are thought unremunerative. It will be interesting for our descendants in the middle of the twentieth century to compare the average load curve for every quinquennial period. We expect a continuous change in the load curves, not that we ever expect to get rid of the two-hours' peak, but the average curve will be higher and the area of the curve greater. This affects central stations, as has often been explained, from the fact that a large proportion of their outlay is for the future, that the greatest economy of generation will come when the load curve is full and constant. By-and-by the extra demand in the evening two or three hours will be met differently to what it is now. It is impossible, by means of any set of figures obtained during a growing industrial period, to explain these and many other things that lead to successful results. The figures do not even tell the cost of coal per ton at the furnace door of the boiler, nor do they say the cost of water, nor a score of other little things, the aggregate of which have their effect upon cost.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TWO-WIRE DISTRIBUTION.

SIR,—Referring to the remarks in your current issue on a two-wire distribution at 200 volts, some of your readers may be interested in knowing that seven years ago I put in an installation on this principle. I am still in charge of this installation, and have never had any trouble with it. As a rule, incandescent lamps are easily arranged in pairs of 100 volts, two in series; but in a few instances I have put a 32-c.p. lamp and then divided the current from this through two 16-c.p. lamps in parallel. In one case I have put a switch thus:



which is quite satisfactory, two of the three lamps being always wanted, but not all three together. There is no practical difficulty in this system. I keep lamps alight all day, charge accumulators, pump by an electric motor, and run two dynamos in parallel or separately, as occasion requires. I consider, however, that 200 volts is too great a difference of potential to supply to any private house, as I know from my own experience that a shock from it is very painful, and that it takes away all the natural control of the muscles for the time being.—Yours, etc.,

F. G. ANSELL.

Wickwar, Gloucestershire, Oct. 20, 1894.

ARC LAMPS.

SIR,—In these days when the question of improved arc lighting is now so prominently before the public, it may interest your readers to know that we have been successful with our new simplified Crompton-Pochin type of lamp in obtaining the order for the street-lighting of Edinburgh. Although a large number of makes of lamps were tendered for, only three were selected for trial, and of these our lamp was judged best suited for the purposes of the Corporation. The conditions of competition were not limited to the comparative excellencies of the lamps, but the question of the economical use of carbons was also taken into consideration. We believe this is the first time that a tender has been so carefully adjudicated on, so that the results in this case are especially gratifying to ourselves.—Yours, etc., CROMPTON AND CO., LIMITED.

Mansion House-buildings, London, E.C.,
October 22, 1894.

CITY AND GUILDS OF LONDON INSTITUTE.

LECTURE VII.—THE CONSTRUCTION AND ACTION OF ELECTRIC BELLS—THE ARRANGEMENTS OF BATTERY CELLS, AND OF CIRCUITS FOR BELLS.

(Specially contributed.)

Suppose we take the four cells we have here two-by-two, Fig. 1, join up the zinc of one to the zinc of the other, and the carbon of one to the carbon of the other, we thus get a double set of cells in parallel. If now we connect the

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zinc of one set to the carbon of the other, the two sets are in series, and we get a combination battery, partly parallel

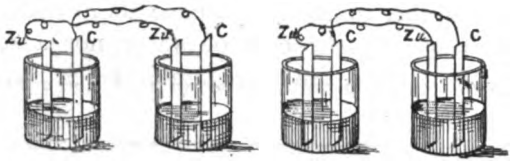

FIG. 1.

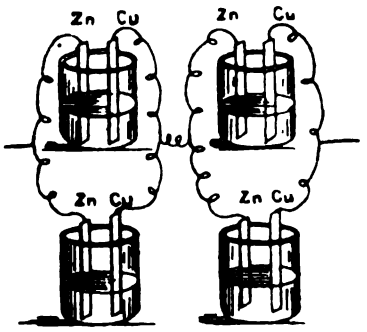

FIG. 2.

and partly series, Fig. 2, in which the total E.M.F. is twice that of one cell, and the total internal resistance is just that of one ordinary cell, for by coupling two cells in parallel the internal resistance of that combination is half the resistance of one cell. Represent the resistance of one cell by r, the internal resistance of the two cells in parallel is $\frac{r}{2}$; and as a similar combination is in series with this one, the total internal resistance is $\frac{r}{2}+\frac{r}{2}=r$.

Thus Ohm's formula becomes in this case

$$C=\frac{2E}{R+2\frac{r}{2}}=C=\frac{2E}{R+r}.$$

Generally, if we have m cells in parallel and n of the parallel combinations in series,

$$C=\frac{nE}{R+n\frac{r}{m}}.$$

Example.—Find current from 12 Fuller cells, E.M.F. of each 2·1 volts, internal resistance of each ·5 ohm, when joined in series with an external resistance of 2·5 ohms.

$$C=\frac{nE}{R+nr}=\frac{12\times 2\cdot1}{2\cdot5+12\times\cdot5}=\frac{25\cdot2}{8\cdot5}=2\cdot96.$$

Answer.—2·96 amperes.

Example.—A current of 2·5 amperes is to be sent through a wire of 20 ohms resistance with Grove cells, each of E.M.F. of 1·96 volts, and internal resistance 0·3 ohm; how many connections in series will be wanted?

$$C=\frac{n.E}{R+n.r}=\frac{n\times1\cdot96}{20+n\times0\cdot3};$$

$$2\cdot5=\frac{1\cdot96\,n}{20+0\cdot3\,n};$$

$$50+\cdot75\,n=1\cdot96\,n;$$

$$50=1\cdot96\,n-\cdot75\,n=1\cdot21\,n;$$

$$n=\frac{50}{1\cdot21}=41\cdot3;$$

but it is impossible to have 41·3 cells; we must have 41 or 42, and as 41 are not enough, we should require 42.

Answer.—42 cells.

Example.—Given 10 Daniell cells in series, each 1·07 volts E.M.F., with internal resistance 0·2 ohm; what is the resistance of external conductor when 1·5 amperes goes through it?

$$C=\frac{nE}{R+n.r}=\frac{10\times1\cdot07}{R+10\times0\cdot2};$$

$$1\cdot5=\frac{10\cdot7}{R+2};$$

$$1\cdot5\,R+3=10\cdot7;$$

$$1\cdot5\,R=10\cdot7-3=7\cdot7;$$

$$R=\frac{7\cdot7}{1\cdot5}=5\cdot1\dot{3}.$$

Answer.—5·1$\dot{3}$ ohms.

Example.—A battery of eight cells in series, each of internal resistance 0·5 ohm, sends a current of 0·82 ampere through an external resistance of 15 ohms; find E.M.F. of each cell.

$$C=\frac{nE}{R+nr}=\frac{8E}{15+8\times0\cdot5}=\frac{8E}{19};$$

$$\cdot82\times19=8E;$$

$$E=\frac{15\cdot58}{8}=1\cdot9475.$$

Answer.—1·9475 volts.

Example.—Given 12 cells in series, each with E.M.F. of 2 volts and internal resistance of 0·15 ohm, with two wires, A and B, of 10 and 12 ohms resistance respectively; find current in A when connected to battery alone.

" " B " " " "
" " A and B " " " " in parallel or multiple arc.

A alone.— $C=\frac{nE}{R+nr}=\frac{12\times2}{10+12\times0\cdot15}=\frac{24}{11\cdot8}.$

$$C=\frac{24}{11\cdot8}=2\cdot03.$$

B alone.— $C=\frac{nE}{R+nr}=\frac{12\times2}{12+12\times0\cdot15}=\frac{24}{13\cdot8}.$

$$C=\frac{24}{13\cdot8}=1\cdot739.$$

I have assumed in all these questions that E of any cell remains under all conditions of external resistance constant. This is not quite correct, but for the purpose of exercising you in these formulæ we assume it is correct. Then—

First, find the joint resistance of A and B;
Secondly, find the total current through this resistance;
Thirdly, divide this total current between the two branches inversely as their resistances.

1. Joint resistance of A and B $=\frac{10\times12}{10+12}=\frac{120}{22}=\frac{60}{11}$ ohms.

2. $C=\frac{nE}{R+nr}=\frac{12\times2}{\frac{60}{11}+12\times0\cdot15}=\frac{24}{\frac{60}{11}+\frac{18}{10}}=\frac{440}{133}=3\cdot308.$

3. Divide 3·308 as 10 : 12;
as 5 : 6;

thus $\frac{3\cdot308}{11}\times6$ is current through A = 1·804 amperes,

and 3·308 − 1·804 = current through B = 1·504 amperes.

Example.—Given six cells in parallel, each = 1·75 volts, with r = 0·15 ohm; what current do we get through a resistance of four ohms:

$$C=\frac{E}{R+\frac{r}{6}}=\frac{1\cdot75}{4+\frac{0\cdot15}{6}}=\frac{1\cdot75}{4+0\cdot025}=\frac{1\cdot75}{4\cdot025}=\cdot0434.$$

Answer.—·0434 ampere.

Example.—The E.M.F. of a cell is 1·5 volts, r = 0·2 ohm; find current of 24 such cells arranged in multiple series, six rows, four cells in a row, through a resistance of 5 ohms.

There are six rows in series—

E.M.F. of any row = E;
∴ E.M.F. of six rows = 6E.
Resistance of a cell = 0·2;

" " four cells in parallel $=\frac{0\cdot2}{4}=0\cdot05$;

" " six rows in series = 0·05 × 6 = 0·3.

$$C=\frac{6E}{5+0\cdot3}=\frac{9}{5\cdot3}=1\cdot69 \text{ amperes.}$$

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Or we might have worked directly from the formula—

$$C = \frac{\frac{n}{m} E}{R + \frac{n}{m} \cdot \frac{r}{m}},$$

where n = total number of cells,
and m = number connected in parallel.

Example.—The E.M.F. of a cell is 1·9 volts, $r = 2·8$ ohms; find current in each of three wires in parallel having respective resistances 2, 3, and 6 ohms.

$$\text{Total resistance} = \frac{2 \times 3 \times 6}{2 \times 3 + 2 \times 6 + 3 \times 6} = \frac{36}{36} = 1 \text{ ohm.}$$

$$C = \frac{E}{R+r} = \frac{1·9}{1+2·8} = \frac{1·9}{3·8} = \tfrac{1}{2} \text{ ampere.}$$

Divide $\frac{1}{2}$ ampere in the proportion 2 : 3 : 6, the joint resistances of wires having 2 and 3 ohms resistance $= \frac{2 \times 3}{2+3} = \frac{6}{5}$, so that to find current going through, say, wire of 6 ohms resistance, as we know the joint resistances of the other branches is one-fifth of this, we divide $\frac{1}{2}$ ampere into six equal parts, giving one part to the wire having 6 ohms resistance, and five parts to the other two wires.

$$\tfrac{1}{2} \div 6 = \tfrac{1}{12} \text{ and } \tfrac{1}{12} \times 5 = \tfrac{5}{12} = ·417.$$

$\therefore$ ·417 ampere goes to the other two wires, and ·5 − ·417 = ·083 goes to wire having 6 ohms resistance.

Now, ·417 ampere has to be divided in proportion 2 : 3, the larger part going to the wire having resistance of 2 ohms.

Thus $\frac{·417}{5} \times 3 = ·2502$ ampere going to 2-ohm wire, and ·417 − ·250 = 1·67 ampere going to 3-ohm wire; total current = ·5 ampere.

Current through 2-ohm wire = ·250
" " 3 " " = ·167
" " 6 " " = ·083

Total = ·5 ampere.

Maximum Current with a Given Battery.—You have seen that with a given number of cells it is possible to obtain a considerable variation of the E.M.F. and internal resistance. The rule to obtain the greatest current in the external circuit is a very simple one, and can easily be proved by anyone who has a little knowledge of algebra. My purpose will be served, however, by simply stating it. To obtain the greatest current in the external circuit, so group your cells that the *internal resistance of the battery is as nearly as possible equal to the external resistance of the circuit.* You can use this formula for the solution of questions relating to grouping for maximum current.

Let n = total number of cells;
x = number of cells in parallel;
y = " " series;
and E, R, r, and C as before.

then $x y = n$; $y = \frac{n}{x}$; $R = \frac{n}{x} \times \frac{r}{x} = \frac{n r}{x^2}$;

whence $$x = \sqrt{\frac{r}{R} n};$$

$$y = \sqrt{\frac{R n}{r}}.$$

Example—Find best way of grouping 24 cells, having E.M.F. = 1 volt and r = 2 ohms, to get maximum current through electromagnet coils of 4 ohms resistance.

$$x = \sqrt{\frac{r n}{R}} = \sqrt{\frac{2 \times 24}{4}} = \sqrt{12} = 3·46.$$

Now x can only be an aliquot part of 24, and the nearest to 3·46 is 3, so we arrange in three rows of eight cells in series in each row; 4 is almost as near and will practically give similar results with four rows of six each.

Let us see how this works out:

Eight cells in series give $8 \times 2 = 16$ ohms resistance; but there are three cells in parallel, so $\frac{16}{3} = 5\frac{1}{3}$ ohms is the resistance of the battery.

Suppose we try six rows of four in parallel, we get

$6 \times 2 = 12$ ohms as resistance of each series row

$\frac{12}{4} = 3$ ohms as resistance of battery.

The current obtained is in first case

$$C = \frac{E}{R+r} = \frac{8 \times 1}{4 + 5\frac{1}{3}} = \frac{8}{9\frac{1}{3}} = \frac{6}{7};$$

in second case $$C = \frac{E}{R+r} = \frac{6 \times 1}{4+3} = \frac{6}{7}.$$

The Voltaic Cell.—The cells before you, as you see, consist of two essential parts:

1. The voltaic couple—in one case zinc and carbon, in the other zinc and copper. Generally the couple consists of two dissimilar metals, though they may be formed of a great many different substances.

2. Of a liquid called the electrolyte in which the couple is immersed, which must be capable of acting chemically on one of the metals of the couple; also must be capable of conducting the current, and of being decomposed during the action of the cell.

If we confine our attention to the copper-zinc couple, it will admit of simpler explanation than the Leclanché.

First, I immerse the couple in the dilute sulphuric acid. So far as you or I can see, while the metals are separated externally no change takes place, but undoubtedly the maximum E.M.F. of this couple is set up.

I now connect them externally by this wire, and you immediately see the hydrogen bubbles on the copper plate. One effect of these bubbles I have explained to you—that of polarisation in setting up a counter E.M.F.—but they also increase the internal resistance of the cell, and so have a twofold evil effect.

What phenomena are there now going on?

1. The sulphuric acid is decomposed. Chemists symbolise this acid by H_2SO_4, showing that it is composed of hydrogen, sulphur, and oxygen in certain proportions. When a metal displaces the hydrogen in sulphuric acid a sulphate of the metal is formed; thus we have here a formation of sulphate of zinc, leaving the hydrogen free.

2. The hydrogen seems to be liberated mainly at the surface of the copper plate.

3. The electrolyte is heated.

4. The external conductor is heated.

5. A current is going through the circuit, and continues to do so as long as any acid remains to be decomposed or zinc to be acted upon—that is, so long as chemical action continues.

6. Effects are produced in the space around the conductor which we shall learn more about when we come to investigate magnetic phenomena.

Getting Rid of the Hydrogen.—Many attempts have been made to avoid the ill effects of polarisation.

1. Mechanical means have been employed: brushing away the bubbles, agitating the liquid to get rid of them, but none of these have proved very effective.

2. A much better way is to surround the copper plate, or the plate that is covered with the hydrogen bubbles, with some powerful oxidant, that will oxidise the hydrogen and have little or no evil effect on the battery. Cells of this kind are numerous.

3. Using the hydrogen for some chemical decomposition that is not inimical to the cell. Thus one of the best-known cells takes this course.

Daniell's Cell.—Prof. Daniell in 1836 made one of the first successful attempts to modify the evils of polarisation. An examination of his battery will show you how he overcame the difficulty. Here is one of his cells, consisting of an outer glass jar containing, in the first place, this split cylinder of zinc, which just now is immersed in dilute sulphuric acid, Fig. 3. Inside the zinc is a porous jar of unglazed earthenware, and inside this is a copper cylinder immersed

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in a saturated solution of copper sulphate. You see at the top a perforated ledge, on which are a lot of blue-stone or blue vitriol crystals. These are the crystals of copper sulphate, and are kept here so that the liquid solution may always be saturated, for as some of the sulphate is used up more is dissolved. Now let us see what happens when the cell is in action—that is, when its zinc and copper plates are joined by a wire of not too great resistance externally.

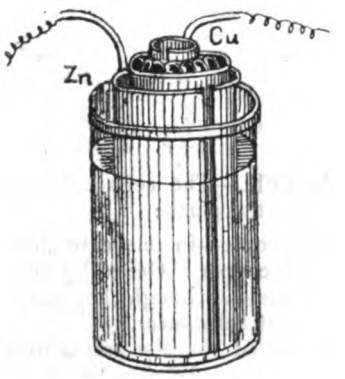

FIG. 3.

Directly this is done the zinc is attacked by the acid. For a moment let us represent the zinc and acid by their chemical symbols, thus:

Zinc Zn.
Sulphuric acid H_2SO_4.

The final result of this action is the formation of zinc sulphate, thus chemically symbolised—

$$Zn + H_2SO_4 = ZnSO_4 + H_2,$$

which you may read: zinc added to dilute sulphuric acid displaces the hydrogen of the sulphuric acid and forms zinc sulphate, leaving the hydrogen free.

Suppose that represents the chemical action outside the porous jar.

Let us follow the hydrogen. It passes through the porous jar, and comes into contact with the copper sulphate.

Chemically copper sulphate is symbolised $CuSO_4$.

Now when the zinc was in question it was powerful enough to oust the hydrogen and take its place, but with copper in question the opposite is the case: the hydrogen is the more powerful, it ousts the copper and take its place, leaving the copper free, so that instead of the hydrogen being given off on the copper plate, the copper it has replaced in the copper sulphate is given off and fixed on the copper plate, thus leaving us always with a nice clean copper surface. The chemical action inside the porous jar is thus symbolised:

$$H_2 + CuSO_4 = H_2SO_4 + Cu,$$

that may be read,—hydrogen added to copper sulphate ousts the copper and takes its place, forming sulphuric acid, which many call hydrogen sulphate, setting the copper free. This, then, is what Prof. Daniell accomplished. He used copper sulphate to take up the objectionable hydrogen, copper being deposited upon the copper plate. We thus get a cell without polarisation. Its E.M.F. is small—1·07 volts, and its internal resistance is rather high.

THE SURPLUS AND DEFICIT THEORY OF ELECTRICITY.

BY W. PERREN MAYCOCK, M.I.E.E.

The explanations generally given of various simple experiments in electrostatics, or so-called "frictional electricity," with which it is necessary that every young science or engineering student should be familiar, are by no means so clear and satisfactory as they might be, even in works by authors of repute. The elementary student wants some simple theory that will satisfy his present needs, and which, if he pursues the subject beyond the limits usually reached by the young engineer, may be easily replaced by some more advanced and perfect one—such as that of Dr. Oliver Lodge, as given in his most valuable work, "Modern Views of Electricity." Without much further preface, I shall endeavour to explain the various electrostatic effects given in the different headings according to what may be termed the *surplus and deficit theory*, a theory which, so far as I am aware, has not been utilised by modern authors to explain results obtained in experiments in "frictional electricity;" with much consequent confusion in the minds of young students, who, having generally been told to assume that there is but one kind of electricity, are straightway confronted with the oft-repeated expressions *positive electricity* and *negative electricity*; and who, reading in one case that a *positive charge runs away to earth*, cannot exactly understand why a negative charge should go to earth also.

(*a*) *Positive* (+) *and Negative* (−) *Electrification.**—The confusion occasioned by the use of the expressions *positive electricity* and *negative electricity*, would not exist were the terms *positive electrification* and *negative electrification* employed instead. Whatever electricity or electrification may be, it is admittedly more correct to think not of two kinds of electricity, but of one kind of electricity and two states of electrification—positive and negative. Let us think of electricity as an imponderable something which pervades or exists on the surface of all bodies, conductors and insulators alike; and let us further imagine that when any body is in what we call the ordinary unelectrified state, it is because it has just its proper share of electricity. A body positively charged, or in a state of positive electrification, is one which has more than its proper share—that is to say, one with a surplus of electricity upon it; on the other hand, a negatively-charged body, or one in a state of negative electrification, is one from which electricity has been abstracted, leaving it in a state of deficit—*i.e.*, with less than its proper share. Thus when glass and amalgamated silk are rubbed together,† electricity may be supposed to be removed from the metallic surface on the silk, and heaped up upon the surface of the glass; the former is then left negatively electrified, and the latter positively electrified. On the other hand, when fur or flannel and ebonite are rubbed together, it is convenient to suppose that electricity is displaced from the ebonite to the fur or flannel, and thus the ebonite is left in a state of negative electrification.

(*b*) *Positive and Negative Potential and Potential Difference* (*P.D.*).—Just as we measure heights and depths according to their distance above or below sea-level, and temperature with respect to that of melting ice (on the Centigrade and Reaumur scales) so we take the electrification of the earth as zero, and speak of the latter and of all bodies in electrical contact with it as being at zero electrical potential, or zero electrical level. As a rule (*vide* sections *e*, *f*, and *g*), all unelectrified bodies are at zero potential, or at the same electrical level as the earth; for when connected with the latter by a conductor, there is no tendency for electricity to flow either to or from the earth. When a body is in a state of surplus or positive electrification, it is constantly endeavouring to get rid of this surplus, and consequently, if connected with the earth, there will be a flow of electricity from the body to the earth until all this surplus has been given up to the latter. Thus, a positively-electrified body is said to be at a positive potential, or at a higher potential or electrical level than the earth. When a body is in a state of deficit, or negative electrification, it may be supposed to be constantly endeavouring to draw sufficient electricity into itself to fill up this deficit, preferably from the earth, or any neighbouring earth-connected conductor, or from a body that has a surplus—*i.e.*, one that is positively electrified—so that if a conducting path be provided between the two, electricity will flow from the earth, or other conductor, to the body, not from the body to the earth, as in the case of a positively-charged body. Therefore, we say that a negatively-charged body is at a lower potential or electrical level than the earth.‡

Electricity will always flow from a point or place at high potential to one at a lower potential if a sufficiently good conducting path be provided, and will continue to flow so long as a difference of potentials is kept up. Consequently, electricity will flow between two positively-charged bodies (or bodies at a positive potential) if one be more highly charged than the

* The signs (+) and (−) wherever used in this article signify *positive* and *negative*.

† Students are often left to assume that the so-called "electric amalgam" used on silk and other rubbers has some mysterious property attached to it. The reason why greater effect is obtained with amalgamated silk and glass than with plain silk and glass, is that the amalgam provides a flexible metallic surface, the silk in this case acting merely as a holder for the amalgam. On looking at any "frictional series" table, we find that glass and metallic surfaces are much farther apart on the list than are glass and silk, hence the increased amount of electrification developed.

‡ From climatic and other causes, there is generally a P.D. between places on the earth's surface separated by any great distance. This gives rise to what are called "earth currents," which exercise disturbing effects on telegraph lines. During thunderstorms, owing to the electrostatic induction taking place between electrified clouds and the earth, momentary differences of potential may exist between adjacent places. For all practical purposes, however, we may assume that the earth at any particular place is at one uniform potential which we call zero.

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other—*i.e.*, at a greater positive potential than the other. Similarly, a flow of electricity will take place between two bodies at a negative potential, provided their potential values differ.

To illustrate the above remarks, let us refer to Fig. 1, where G_1, G_2, G_3, and G_4 represent metal gasholders of equal size or capacity placed in a large chamber, C. Let the latter be fitted with air at what we will call the normal or zero pressure. Let G_1 and G_2 be filled with air at pressures above the normal, say +3 and +6; while G_3 and G_4, we will suppose, have had air pumped from them, and are therefore at a negative pressure, or at a lower pressure than the normal. Let these pressures be

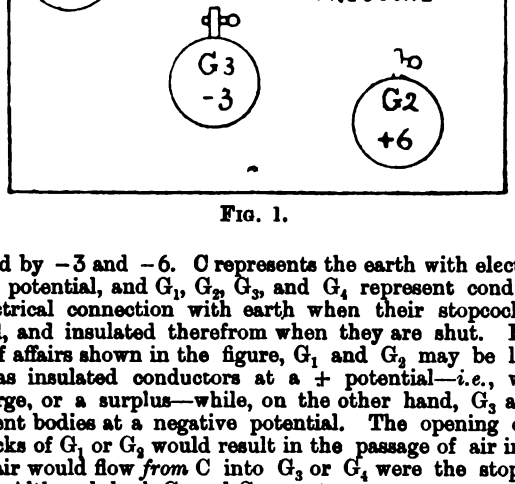

FIG. 1.

denoted by −3 and −6. C represents the earth with electricity at zero potential, and G_1, G_2, G_3, and G_4 represent conductors in electrical connection with earth when their stopcocks are opened, and insulated therefrom when they are shut. In the state of affairs shown in the figure, G_1 and G_2 may be looked upon as insulated conductors at a + potential—*i.e.*, with a + charge, or a surplus—while, on the other hand, G_3 and G_4 represent bodies at a negative potential. The opening of the stopcocks of G_1 or G_2 would result in the passage of air into C, while air would flow *from* C into G_3 or G_4 were the stopcocks open. Although both G_1 and G_2 are at a + pressure or potential, if they were connected there would be a flow from G_1, which is at the higher pressure or potential, to G_2. Similarly, there would be a flow from G_4 to G_3 on connection, for although both are at a negative pressure or potential, yet G_4 is at a higher pressure than G_3. The effect of connecting G_1 and G_3 or G_2 and G_4 would reduce the pressure in each to the normal, the surplus in the one being just sufficient to fill up the deficit in the other, they being all of equal capacity.

The effect of opening all the stopcocks would be to reduce the pressure everywhere to zero value, assuming that C was relatively much larger than the gasholders than is shown in the figure, and that the passage of air either to or from the latter did not materially alter the pressure in C. Leaving the reader to follow up the argument, I may here remark that while analogies are seldom perfect, those drawn between electricity and gas are far more satisfactory than those between electricity and water, for the reason that gas is compressible, and electricity may be supposed to be so, while water is not.

When a constant difference of potentials is kept up between any two points in a conducting circuit—*i.e.*, when we have a constant flow or current of electricity—it is because work is being done. The discharge between the terminals of an influence machine when the condensers are disconnected, may be looked upon as an intermittent current. To maintain the P.D. (potential difference) which gives rise to the stream of sparks in this case, it is necessary to do work in turning the machine, the latter being considerably harder to turn than it would be were the sectors taken from the plates, and the electrical action thereby stopped. In a primary or a secondary cell we have a P.D. kept up as the result of chemical work done. When the brushes of a self-exciting dynamo are disconnected from the commutator, very little power is required to rotate the machine as compared with that necessary when the dynamo is allowed to develop a P.D. and set up a current (section *j*).

(*c*) *Density.*—Density is usually defined as the amount of charge per unit of area. Thus the density of a positive charge

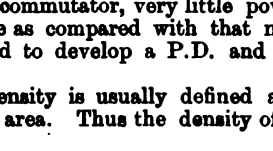

FIG. 2.

may be expressed according to the number of units of electricity over and above the normal amount—*i.e.*, the surplus—heaped up on a square centimetre of area at any point or place on the surface of the conductor. In dealing with negative charges, instead of vaguely talking about so many units of "negative electricity," it is more satisfactory to define a negative density as the number of units of electricity that have been abstracted from (or the deficit on) the square centimetre unit of surface under consideration. In the diagrams one finds in books, both positive and negative densities are indicated by an outer dotted line. It is here suggested that it would be more graphical to denote a + density by an outer dotted line, and a − density by an inner dotted line, as shown in Fig. 2, representing two spheres—one with a positive charge, or surplus, and the other with a negative charge, or deficit.

(To be continued.)

POOLE'S "ELECTRICIAN'S" WIRE GAUGE.

The gauging of wire has become of much importance, and the necessity of some substitute for the clumsy slot gauge hitherto in general use will be obvious. The latter form of gauge simply shows if a wire conforms to some one or other number of a certain gauge, such as the standard or Birmingham wire gauge, but gives no other information. To obtain the actual size of a wire recourse must be made to a micrometer gauge, or to more than one if measurements in foreign units are required. These instruments are expensive, and give no indication of gauge numbers or other particulars of the wire, such as sectional area, which governs its tensile strength and its carrying capacity for electrical currents, for which reference must be made to tables given in books, etc., and there are not always available when required. Some of these tables—such, for example, as the excellent ones issued by Messrs. W. T. Glover and Co.—no doubt give a large amount of information in regard to electrical and other properties of all the wires of a certain gauge, but constant reference to them is tedious, and they give no details of intermediate sizes or of wires of a different gauge.

The Poole gauge has been brought out to give in one small handy and compact instrument all the information in regard to wires, especially in regard to copper wires, which is constantly required by electricians, such information being given at a glance without calculation or recourse to vernier scales, which are known to be puzzling to most people.

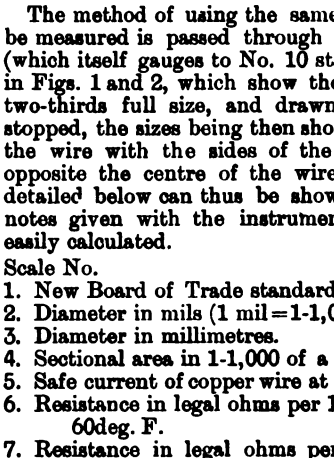

FIG. 1.

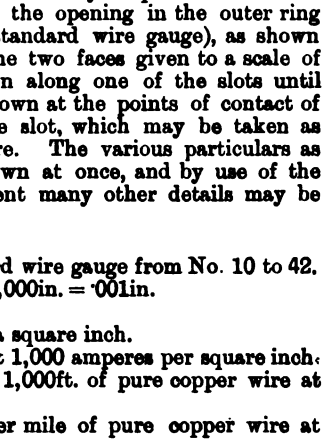

FIG. 2.

The method of using the same is very simple. The wire to be measured is passed through the opening in the outer ring (which itself gauges to No. 10 standard wire gauge), as shown in Figs. 1 and 2, which show the two faces given to a scale of two-thirds full size, and drawn along one of the slots until stopped, the sizes being then shown at the points of contact of the wire with the sides of the slot, which may be taken as opposite the centre of the wire. The various particulars as detailed below can thus be shown at once, and by use of the notes given with the instrument many other details may be easily calculated.

Scale No.

1. New Board of Trade standard wire gauge from No. 10 to 42.
2. Diameter in mils (1 mil = 1-1,000in. = ·001in.
3. Diameter in millimetres.
4. Sectional area in 1-1,000 of a square inch.
5. Safe current of copper wire at 1,000 amperes per square inch.
6. Resistance in legal ohms per 1,000ft. of pure copper wire at 60deg. F.
7. Resistance in legal ohms per mile of pure copper wire at 60deg. F.
8. Length in yards per legal ohm of pure copper wire at 60deg. F.
9. Weight in pounds per 1,000ft. of pure copper wire at 60deg. F.

It will be seen from the above that the gauge is very comprehensive. The limits chosen for the gauge as shown above were adopted because it is very seldom that single wires larger than No. 10 S.W.G. are used as conductors, those of larger capacity being made up of smaller wires stranded together, so that by gauging one of these and multiplying or dividing by the number of strands the particulars for the whole may be nearly obtained. Certain special notes are appended to the sheet of

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instructions, by the use of which the gauge may be made even more comprehensive.

The gauge has been invented by Mr. Poole, electrician to the New Telephone Company, of Manchester.

DOULTON'S STONEWARE CASINGS.

In our issue of Aug. 4, 1893, we gave a description of Doulton's stoneware casing for underground electrical mains. Since the conduit without injury to the cables within it and inserting a service box of stoneware or brick. The underground systems of two important schemes—viz., Edinburgh and Sunderland—have been carried out during the past year with Doulton casing. The mains at Edinburgh, which are being put down on an extensive scale, have involved the use of some 16 or 17 miles of this conduit. We illustrate in Figs. 2 and 3 an inexpensive form of house service box designed by Prof. A. B. W. Kennedy, F.R.S., for the Edinburgh electric lighting scheme, in connection with which upwards of 1,000 of this pattern have been used. The box consists of a short length of casing (with two, three, or four "ways"), the substance of which during manufacture is partially divided longitudinally in such a way that the upper and lower portion may be separated when required, as shown in Fig. 3. The box is laid in the same way as an ordinary length of casing. When it is required to make a house connection, both halves are removed from the line of conduit, and ample access to the cables is thus afforded. The cable connections having been made, the box is replaced, and in making the joints with the adjacent lengths of casing, a special cast-iron collar is used provided with an outlet through which the branch cables are conveyed. In Fig. 4 we illustrate Doulton casing in course of being laid down.

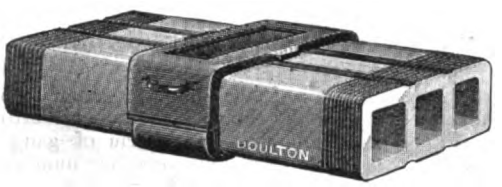

FIG. 1.

then the system has been very extensively used, upwards of 70 miles of "ways" having been laid. It has been adopted by several of the London supply companies, and its capability of meeting their requirements has been satisfactorily proved. The casing, which we illustrate in Fig. 1, is easily and rapidly laid, and the method of jointing the lengths permits of deviation from the straight line without difficulty. The tough nature of the

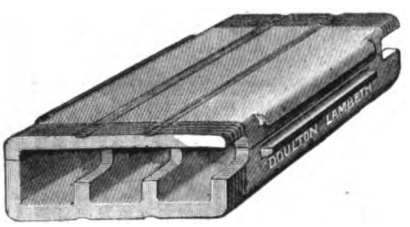

FIG. 2.

material also permits of its being readily cut on the site of the works. This adaptability of the casing is, of course, of great importance, especially in localities when the ground is already occupied by gas, water, and other pipes. The method ensures a separate continuous and smooth "way" for each cable. The ducts in adjoining lengths of casing, in the process of jointing,

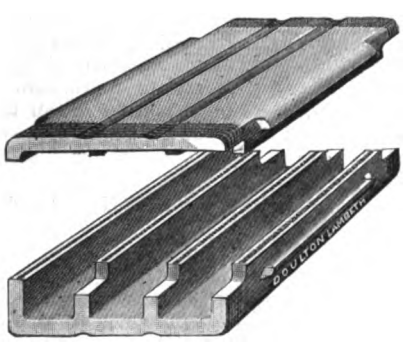

FIG. 3.

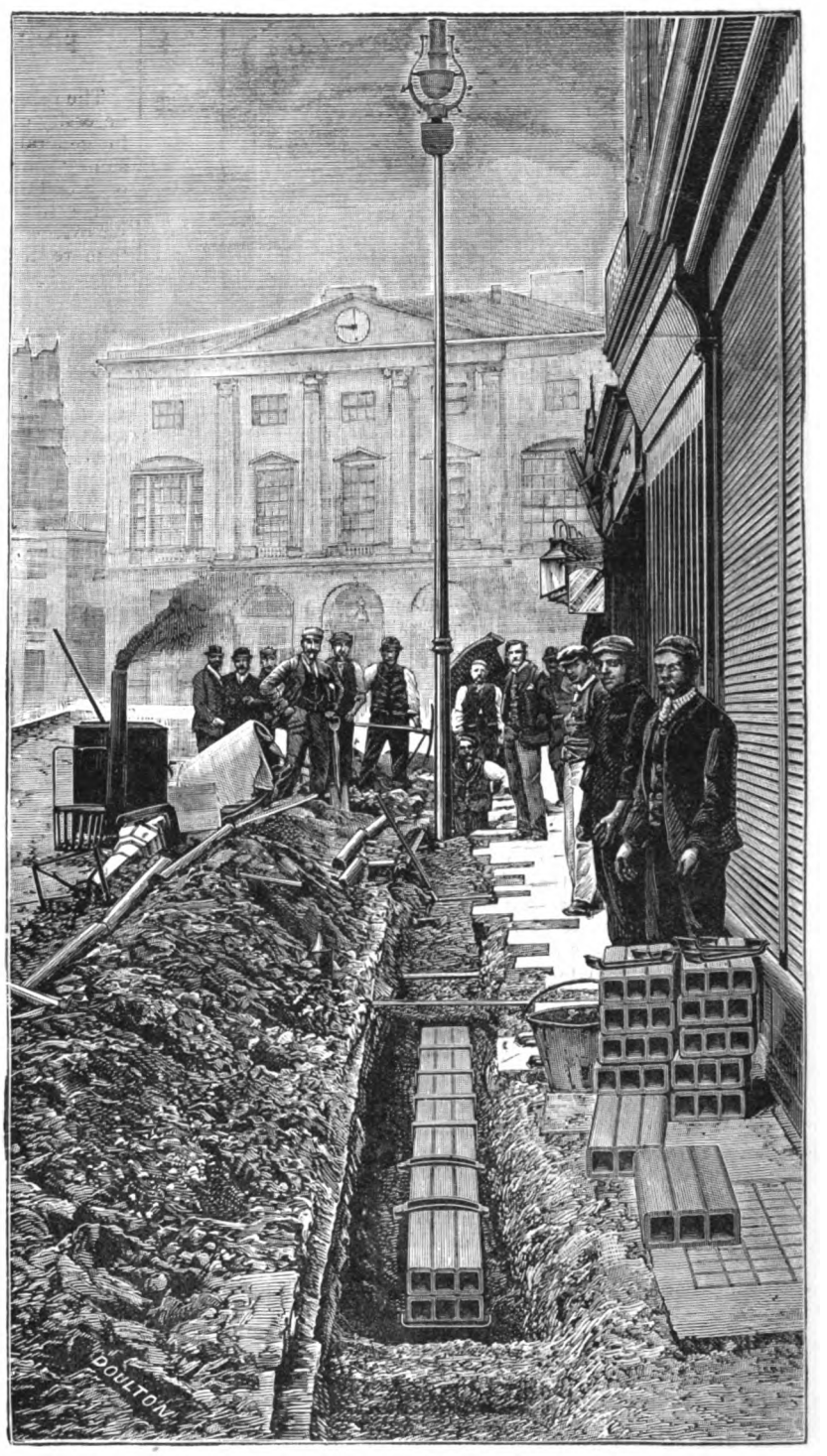

FIG. 4.

are accurately centred one with the other. The operation of drawing cables in or out is therefore performed with the minimum of labour and risk. Glazed stoneware, as a material for use in underground electrical work, possesses two important qualities—viz., it is a non-conductor of electricity, and it is incorrodible and imperishable. Further, it has the advantage of being cheaper than metal or other materials in use. The Doulton casing gives every facility for making house connections. For this purpose stoneware boxes may be introduced into the line at the time of laying the conduit, or there is no difficulty at any subsequent time in cutting out a portion of

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PLUME SHADES.

We illustrate herewith some incandescent lamp shades which are being brought out by Messrs. Charles Ingle and Co., 157, High Holborn, the designs being mainly by Miss Beatrice Devonport. The material employed is swan's feathers, which lend themselves to artistic treatment, and various tints are employed, such as cream white, dark green, light green, salmon pink, rose pink, terra-cotta, amber, blue, and lilac. Provision

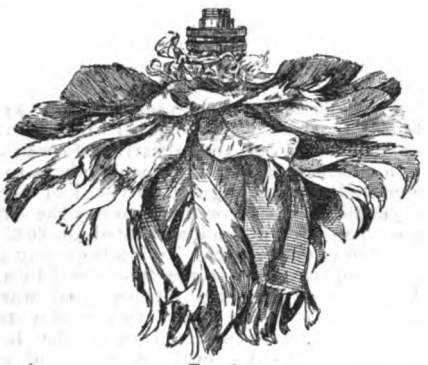

FIG. 1.

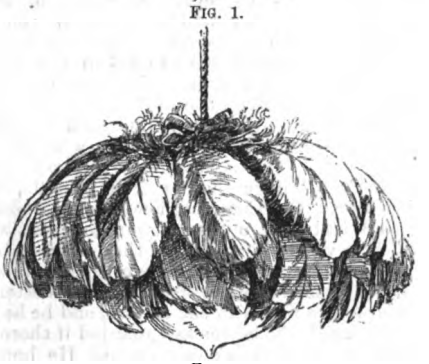

FIG. 2.

FIG. 3.

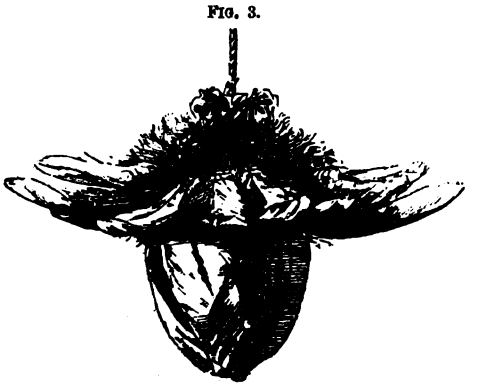

FIG. 4.

is made for an air space between the incandescent lamp and the shade. The designs which we illustrate are entitled: Fig. 1, rose; Fig. 2, water-lily; Fig. 3, tulip; and Fig. 4, fuchsia.

Bedford.—A requisition signed by three members of the Town Council has been handed to the town clerk, calling for a special meeting of the Town Council for the purpose of adopting or rejecting a resolution that application be made for a provisional order to supply electricity for public and private purposes within the borough. In compliance with the requisition, and with the sanction of the Mayor, the town clerk has already issued summonses for a special meeting to be held on Monday, November 19, in the Council-chamber.

NEWCASTLE-ON-TYNE TRAMWAYS.

Messrs. Siemens and Co. have made the following reply to the borough engineer's report on the above tramways:

On June 13th, 1894, the city engineer presented a report to the Town Improvement Committee of Newcastle-on-Tyne on the best system of tramways for that town. The report deals with three systems: (*a*) horse-traction system; (*b*) conduit electric system; (*c*) cable system; and advocates strongly the adoption of the last-named.

A considerable portion of the report is taken up with adverse criticisms of the conduit electric systems which are actually in operation at Blackpool, Lancashire, and at Buda-Pesth, in Hungary. A perusal of this portion of the report cannot fail to prejudice any body against the conduit electric system; and it is desirable to reply to some of the objections made, and to correct the more striking inaccuracies which have crept into the report. In the first place no comparison is possible between the lines at Blackpool and at Pesth, as the systems adopted are essentially different; consequently the following remarks are confined to the Buda-Pesth system.

The objections raised in the report fall under the following headings: (1) width and gradients of streets; (2) speed for the service; (3) width of the slot; (4) form and construction of conduit; (5) interruption of service from climatic causes; (6) working expenses; and it may be well to take them in order.

The report states that while the conduit electric system is very suitable for the very wide and flat streets of Pesth, it would not answer in the narrow and hilly streets of Newcastle. Though it is quite true that Pesth possesses some magnificent streets, not unfrequently 150ft. to 200ft. wide, in which there is ample room for the ordinary traffic to run alongside the tramway, yet this is not the whole truth; for the electric tramway passes through many streets which at least approximate to the narrowness of those in Newcastle, without any disturbance to the ordinary traffic. Thus the conduit electric tramway runs: through Szechenyi-street, which is 48¾ft. wide; through Woll-street, which is 47½ft. wide; through Calman-street, which is 47¾ft. wide; and through Baross-street, which is 39ft. wide. In these streets there is a single track, but a double track runs through König-street, the width of which is 47¾ft. Nor can it be said that Pesth is flat; for on the course of the tramway there are inclines as steep as 1 in 50 for some length. In this connection reference may be made to the statements in the report that the electric system of tramways has not yet been introduced into the neighbouring town of Buda, on the opposite side of the Danube, because it is hilly, and that the authorities are enquiring into the possibility of introducing the cable system. The real cause why tramways have not been introduced in Buda is that while Pesth is a busy commercial town, its sister Buda had an amount of traffic which was not sufficient to warrant the introduction of the tramway. Plans for a conduit electric system have been got out and laid before the authorities of Buda, whose decision on them is now being waited for; but they have never even contemplated using cable traction.

The statement that the average speed of the electric cars in Pesth is 12 miles an hour, a speed inadmissible in Newcastle, needs correction. The maximum speeds at which the cars may travel, and beyond which the driver dare not go, are as follows: in the suburbs, 11¼ miles an hour; in the wider streets, 9¼ miles an hour; in the narrow streets, 6¼ miles an hour; at street crossings, 3¾ miles an hour; so that the average speed is about that of Newcastle—viz., eight miles an hour.

It is true that the width of the slot at Pesth is 1¼in., but it must be borne in mind that the slot was not made 1¼in. wide to accommodate the electric collector; but the electric collector was arranged to work in the slot which already existed for the wheel flanges, and that it was owing to the wheel flanges having to run in the slot that the latter was made so wide. There was no need to provide a slot 1¼in. wide for the electric collector, and there is no difficulty whatever in contracting the slot to a width of ¼in., equal to that used for a cable grip, at a depth of about 1in. below the surface. Indeed, the working drawings of a conduit electric tramway with a contracted slot of this nature have been got out, and would be followed in the construction of any new line. Even though a bicycle wheel should drop through the slot, it could not short-circuit the conductors, since these are not placed vertically below, but to either side, and consequently the wheel would not touch them.

The construction of the track is stigmatised as "flimsy," and yet costing £1,000 per mile more than the cable traction system. The report gives the cost of construction of the Pesth tramway as £12,000 per mile, which sum has apparently been deduced from the total capital of the company. The actual cost of construction was one-third of this—viz., £4,000 per mile—as was stated by Dr. John Hopkinson in his evidence before the Hybrid Committee in 1893 on the Protective Clauses to be introduced into Electric Tramway Bills. A few figures will serve to refute the charge of flimsiness: rails, fish-plates, etc., weigh 180lb. per yard; supports and fittings, 150lb. per yard; conductors, 30lb. per yard; or a total weight of iron and steel of 360lb. per yard. Such a construction would satisfy the mind of any engineer as to its power of supporting heavy loads. The Hungarian Ministry of Commerce prescribes that the calculations for such constructions are to be based on the assumption that they will have to bear two-axled wagons of 24 tons weight. It is quite incorrect to say that the rails of the Pesth tramway rest on "loose brickwork"; on the contrary, the rails rest on and are securely bolted to cast-iron frames of square shape, which are embedded in the concrete

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conduit at distances apart of about 4ft. The brickwork referred to in the report is simply used to make up the level above the concrete conduit, and does not support the rails at all; and it is not "loose," but properly bonded brickwork laid in Portland cement. In case of its being necessary to gain access to the conductors, a rail has not to be taken up, but only a few granite setts.

It is possible that snow may have stopped the electric tramway at Blackpool for days together, but nothing of the kind has ever been the case at Pesth, where the service on the electric tramway has never yet been interrupted for a whole day. As a rule, the electric tramway was stopped no longer than the horse tramways to allow of the snow being cleared away. To give some idea of the cost of clearing the snow, it may be mentioned that in the winter of 1893, when the snow was very heavy, it only amounted to 1·2 per cent. of the receipts. The suggestion in the report that the traffic might be interrupted by a piece of damp paper being blown into the slot and coming into contact with the conductors, is of course utterly groundless, and can only have originated in some total misconception of the nature of the electric currents used. Indeed, "short-circuiting" seems to be held up rather as a bogey in the report, possibly because it was not quite understood. The moister English climate need not be feared in connection with a conduit electric system, since the conduit can always be efficiently drained, and the conductors are well placed to the sides out of the way of moisture.

The reasons which are given as accounting for an increased cost of working in England are fallacious. Thus it has been shown here that the average speed in Pesth is not more than in Newcastle, but the same, and therefore the car mileage is not increased. It is true that labour is cheaper in Hungary than in England, but labour is a smaller proportion of the working charges than coal, oil, and all stores, and all these are certainly far cheaper in Newcastle than in Hungary. The difficulty of surmounting inclines can be especially attacked with electric trams, for each axle of the car can be made to drive, and consequently the whole weight of the car can be utilised for adhesion. At Buda-Pesth an experimental incline of 1 in 10 was tried, and it was found that an ordinary car of the electric tramline with a single 16-h.p. motor driving on to both axles could surmount it easily at a speed of 5½ miles an hour.

The above remarks are based on information received direct from the Buda-Pesth Tramway Company, to whom a copy of the engineer's report had been sent.

COMPANIES' MEETINGS.

WESTMINSTER ELECTRIC SUPPLY CORPORATION, LIMITED.

An extraordinary general meeting of this Company was held on Wednesday at Eccleston-place, Belgravia, to consider a resolution for increasing the capital by £100,000. Lord Suffield occupied the chair.

The **Chairman** explained that the proposed increase was rendered necessary by the very large growth of the business. It was not the intention of the directors to apply the extra capital asked for in erecting new buildings or in extending the area of supply, but it would be expended in the purchase of plant, meters, cables, etc., to meet the demand of the present district. On December 31, 1893, the lamps on circuit numbered 131,565 of 8 c.p.; now there were 158,000 lamps and about 9,000 more were waiting to be connected, while applications were still coming in at the same rate. It was proposed to offer the new shares to existing shareholders, but he ought to point out that it was not intended to issue the whole or any large part of the additional capital at once. After the resolution had been passed, the Board would consider the amount it was at present advisable to issue, and then communicate with the shareholders as to the terms, and invite them to subscribe to the first instalment. He then moved a resolution for increasing the capital from £300,000 to £400,000.

Mr. E. Boulnois, M.P., seconded the resolution.

In reply to a **Shareholder**, who enquired if the Board could not see their way to issue the shares at par, the **Chairman** said it was deemed prudent to charge a small premium with which to commence the nucleus of a reserve fund.

The resolution was agreed to.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.

The general meeting of the shareholders of the Brazilian Submarine Telegraph Company was held at Winchester House on Wednesday, Sir J. Pender being in the chair.

The **Chairman**, in moving the adoption of the report, stated that the receipts of the half-year ended June were £94,679, those of the previous half-year having been £96,262, showing a decrease of £1,583. The receipts from messages showed a decrease of £1,393, and from miscellaneous receipts, including interest, rents, and transfer fees, a decrease of £190. The decrease in the amount of interest was due to the low rates allowed by the Bank of England on deposits. Having regard to the further fall in the value of the Brazilian currency, the decrease in the receipts from messages would have been much greater but for the fact that the Company's lines had carried some 40,000 more words in the previous half-year. This showed a satisfactory growth of traffic in South America. News telegrams had increased, and the Company was desirous of affording facilities for fostering that traffic. As compared with the corresponding half-year of 1893, the income from messages showed a decrease of £12,181, but this decrease was fully accounted for by the difference in exchange. In the half-year of 1893 the average rate per milreis was 12½d., whereas in the half-year now under review the rate was only 9½d. During the current half-year the rate had reached 12⅜d., and was now 11⅜d.—an improvement due to the more settled state of affairs in Brazil and to a splendid coffee crop. The working expenses during the half-year amounted to £20,269, those of the previous half-year having been £24,284. The decrease of £4,015 was due to the fact that their cables had been, fortunately, free from interruption. The working expenses at the stations were £13,026, as compared with £13,064 during the previous half-year. The interim dividend of 1½ per cent. paid in June absorbed £19,500, £15,000 had been transferred to the reserve fund, and the directors now recommended a final dividend of 3s. per share, making, with the interim dividends, a total dividend of 6 per cent. for the year, and also the payment of a bonus of 1s. 2d. per share, which together will amount to £26,000, leaving a balance of £1,501 to be carried forward. That, he thought, was a most satisfactory statement to have to make. All interests connected with foreign countries had been sufferers, more or less, yet that company was able to pay the same dividend in bad times. The reserve fund amounted to £692,269, contributions during the past 18 months having been only £42,000, but with the interest on investments the fund stood in a satisfactory position. A large and growing reserve fund was absolutely necessary, seeing that there were two cables to maintain, and, sooner or later, to renew. During the half-year the directors had caused to be made 90 miles of cable, at a cost of £16,000. Since they had undertaken the working of the Pacific and European Telegraph Company they had more than doubled the traffic. They had also £40,613 in the European and Azores Telegraph Company, and though he was not in a position to make any definite remarks on the subject, the Eastern Company had secured a concession from Germany which would give their Company not only special advantages but a subsidy from the German Government. The Brazilian Government having held that the Company's privileges had expired in 1892, had imposed a tax on their traffic. The Company held that the concession had not expired, and had sent out an agent to assist at a friendly arrangement. The visit was made at a time of civil disturbances, and their agent was sent out in the hope of coming to some understanding with the Brazilian Government. The Western Brazilian Company was equally affected in the matter, and he held that their common interests might be better safeguarded if there could be a closer alliance between these two companies. He hoped that the time was not far distant when this question would be fairly considered by both bodies of shareholders.

Mr. Brodrick, M.P., seconded the motion for the adoption of the report and the declaration of a dividend.

The motion having been agreed to, Sir J. Pender and Mr. Brodrick were re-elected directors, and the proceedings closed with a vote of thanks to the chairman.

VENEZUELA TELEPHONE COMPANY, LIMITED.

The ordinary general meeting of the Venezuela Telephone and Electrical Appliances Company, Limited, was held on Tuesday at the offices, 37, Lombard-street, E.C.

Sir Douglas Fox presided, and stated that the report the directors presented was unmistakably the most satisfactory one that had been submitted since the initiation of the Company. The profit for the year amounted to £7,413, as against £4,143 last year, and the sum actually earned, leaving out of the question balances, was £2,753, which showed that they were now established on a firm basis, and were able to make a fair return not only to the debenture-holders but to the shareholders. Since the present manager (Mr. Wallis) was appointed there had been a considerable reduction in the operating expenses on the other side of the water, while the business had increased from £18,444 last year to £21,284 this year. He believed that, owing to the efforts Mr. Wallis was making, they might fairly hope for a further reduction in the operating expenses. At present they stood at 56 per cent., as against 60 per cent. last year. Their capital, which amounted to £152,900, exactly represented the sum which had been expended—that was to say, cost of the property, stores, and material at Caracas. He attributed the present satisfactory financial position of the Company to the businesslike arrangements made by Mr. Philipps when he visited the property recently. He concluded by moving the adoption of the report and accounts.

Mr. J. W. Philipps seconded the motion.

Mr. E. A. Wallis (the manager) stated that during the year the subscribers had increased in Caracas by 195, in La Guaira by seven, in Valencia by 21, and in Puerto Cabello by 16, making a total increase of 239 subscribers over the year 1893.

The motion was agreed to.

After the re-election of the retiring director and auditors, a vote of thanks was given to the chairman and Board.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

London, W.C.—To-day is the last day for the delivery of tenders for the electrical plant wanted by Mr. John Annan, manager for Mr. Samuel Wheeler, "Official Receiver in Companies Liquidation," acting as liquidator of J. W. Hobbs and Co., Limited, for the hotel in course of completion on the Salisbury Estate, Victoria-embankment.

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Hapton (Lancs.).—Tenders are invited for lighting with electric light the village of Hapton and so much of the township of Hapton as the lighting inspectors may think necessary. Full particulars may be had of the work required to be done by applying to Mr. Henry Cunliffe, chairman of the Lighting Inspectors, Post Office, Hapton, to whom tenders are to be delivered by 27th inst.

Sunderland.—The Corporation require tenders for wiring the Town Hall, including the supply and fixing of all cables, casings, switch and fuse boards, lamps, etc. Copy of specification, etc., may be obtained at the office of the borough electrical engineer on the deposit of £1. 1s. Further particulars are given in our advertisement columns. Tenders must be delivered at the office of Mr. Fras. M. Bowey, town clerk, not later than November 8.

London, E.C.—Tenders will be received until noon on Wednesday, 31st inst. (*a*) for supply of red fir telegraph poles, to be delivered in London, King's Lynn, or Sutton Bridge, and at Northumberland Dock (River Tyne), West Hartlepool, Hull, or Grimsby; and (*b*) for creosoting the poles with 10lb. or 12lb. of creosote to the cubic foot as may be directed. The poles to be felled between November 1, 1894, and February 28, 1895 and to be delivered during the following summer at the port at which the creosoting is to be performed. Butt sections from not less than three poles, to show the quality of timber offered, must precede or accompany the tender of any person who has not already supplied the Postmaster-General with poles. The Postmaster General does not bind himself to accept the lowest or any tender. Forms of tender, containing all particulars, may be obtained on application to Chas. E. Stuart, controller of stores, Telegraph-street, E.C.

RESULTS OF TENDERS.

Tonbridge.—The Board of Guardians have accepted the tender of Mr. E. Powell, of Grove Hill-road, Tunbridge Wells, to erect and maintain a complete telephonic system in the house for seven years at £12 per year.

Cardiff.—The Corporation have received the following tenders for wiring the Town Hall and market buildings for electric lighting purposes, including the supply and fixing of all cables, casings, switch and distributing boards, etc., but not lamps and fittings:

	Town Hall.	Market.
Maunsell Mercier and Co.	£264 0 0	£198 0 0
Fergus and Co. (accepted)	338 0 0	185 0 0
Clay Bros. and Co.	318 0 0	245 0 0
Fowler, Lancaster, and Co.	493 15 0	232 10 0
F. W. Ball and Co.	553 5 7	507 18 9
W. and T. Robinson, Limited	636 10 0	480 17 0
J. B. Saunders and Co.	678 0 0	483 0 0
S. Walker and Co.	705 0 0	610 0 0
Knapman, Hodder, and Co.	994 18 6	740 7 6

BUSINESS NOTES.

Derby.—The Assembly Rooms have been lighted electrically.

Colchester.—The new public library, which was opened yesterday, is lighted electrically.

Western and Brazilian Telegraph Company.—For the past week the receipts were £3,215.

York.—The electric light has been installed in the buildings of the York Steam Laundry Company.

Bristol.—The Corporation are being asked to extend the electric light mains to the Croft and Arley Chapel.

Cheltenham.—Messrs. Weyman, Hitchcock, and Co.'s new engineering works are to be lighted electrically.

Coventry.—The Town Council have decided upon 6d. per Board of Trade unit as the charge for the electric light.

Cadley Hill.—Messrs. Hewes and Geary have lighted the colliery of Messrs. Hall and Boardman at Cadley Hill by electricity.

London Electric Supply Corporation, Limited.—The offices of this Company have been removed to 25A, Cockspur-street, S.W.

Leeds.—The Theatre Royal is to be altered, and among the improvements to be introduced is the installation of the electric light.

Nottingham.—There have been 54 applications made for current, and at present 35 consumers are connected with the mains.

Worcester.—The Union Club is to be lighted electrically, the work being carried out by the New British Electrical Contractors, Limited.

Chiswick.—Good progress is being made by Messrs. Bourne and Grant in preparing the ground for the engine-house for the central electric light station.

Indo-European Telegraph Company.—The directors have declared a half-yearly interim dividend at the rate of 5 per cent. per annum, payable on November 1.

London, W.—Messrs. Rashleigh Phipps and Co., of Oxford-street, are carrying out an electric light installation on the premises of Mr. Anderson Critchett, Harley-street, W.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 21st inst. amounted to £888, as compared with £611 in the correspondingweek of last year.

Brechin.—At a special meeting of the Police Commissioners it was agreed to accept the offer of the House-to-House Electric Light Supply Company to provide electric light for the burgh.

Edinburgh.—Messrs. Adair and Co., South Bridge, have introduced into their premises electric lighting by arc lamps. Their premises are the first in the city to adopt this method of illumination throughout.

Burton.—Messrs Hewes and Geary have fitted up the office of the *Burton Chronicle* with the electric light. The same firm have obtained a contract for an installation at the potteries of Messrs. Cash, Massey, and Co., Limited.

Hall Electrical Company, Limited.—This Company has been registered, with a capital of £4,000, to acquire and carry on the business of an electrical engineer as hitherto carried on, under the style of A. Hall and Co., at Liverpool.

Bournemouth.—The Roads Committee of the Town Council recommended that plans be passed for a transformer pit in Beckford-road, and an extension of the main in Sea-road, Boscombe. The report was adopted.

Whitechapel.—The District Board have given permission to the City of London Electric Lighting Company to lay a main from the south-western corner of the Minories to the Dock House for the purpose of supplying electricity to one of the company's warehouses in St. Katharine's Docks.

North Staffordshire.—The Duke of Sutherland has just commenced some important improvements on his Trentham estate in North Staffordshire. The hall itself is to be lighted by electricity, power being obtained from the River Trent, which will be specially deepened for the purpose.

Eastern Telegraph Company, Limited. — This Company announces the payment by warrants on November 1 of interest for the half-year ended October 31 on its 4 per cent. mortgage debenture stock. The transfer books will be closed from October 27 to November 1, both days inclusive.

Charles Joyner and Co., Limited.—This Company has been registered, with a capital of £35,000, to acquire as a going concern the business of manufacturers of fittings connected with lighting with oil, gas, or electric light carried on by Charles Joyner and Co., of Icneild-square, Birmingham.

Beverley.— Mr. J. Scarr, shipbuilder, of Grovehill, has been the first to adopt the electric light in Beverley. The whole of his works have been fitted up by Mr. S. P. Wood, of Hull, whose electrical engineer, Mr. Ernest M. Parsons, has carried out the details in a very satisfactory manner.

St. Saviour's.—The Board of Works for the St. Saviour's District have completed the construction of a large underground lavatory, etc., at the junction of the Borough High-street and Southwark-street, near the commencement of the approach to London Bridge. It is lighted by electricity.

City and South London Railway.—The receipts of the Company for the week ended October 21 were £932, against £810 for the corresponding week of 1893, or an increase of £122. The total receipts for the current period of the present half-year amount to £13,863, as against £12,956 in the corresponding period of 1893, an increase of £907.

Agency.—Mr. L. Barrière, 22, Rue St. Sabin, Paris, informs us that he has appointed as his sole agent for Great Britain and the Colonies Mr. G. Straus, 130, Queen Victoria-street, London, E.C. He also calls attention to his works fitted with all the latest labour-saving machinery for producing metal screws, terminals, and all kinds of metal turning.

London, E.C.—Messrs. Strode and Co., of St. Paul's-churchyard, are installing the electric light at 3, Fenchurch-avenue. At Tuesday's meeting of the City Commission of Sewers, on the motion of Mr. Gordon, it was referred to the Streets Committee to consider the advisability of including Finsbury-circus among the main streets for electric lighting purposes.

Change of Firm.—The electrical light business of Mr. W. E. Hayne, 29, Western road, Brighton, has lately been acquired by Mr. Thos. King, of Maidstone, and will be carried on under the management of Mr. Chas. Rawlings. Owing to ill-health Mr. W. E. Hayne has been compelled to retire from practical work, but will act as consulting engineer at Ebor House, Bexhill-on-Sea.

Blackpool.—The report of the Blackpool Winter Gardens and Pavilion Company, Limited, for the year ending September 30 states that the installation of the electric light throughout the buildings has been carried out at the cost of £3,307, which has been paid out of the reserve, leaving a balance at the credit of that fund of £193. Complaints have been made as to a smoke nuisance at the electricity works.

Monmouth.—The Council in committee have reduced the number of proposed sites for the works required for the combined drainage and electric lighting scheme to two—viz., the Osbaston farm and Brooksholme. Negotiations with a view to a final decision are now to be opened up. The engineers stated that they would be able to complete the works in about a year from the time of commencement, which would be undertaken immediately the sanction of the Local Government Board had been obtained.

Monte Video Telephone Company.—The accounts for the year ended July 31 last show a net profit of £6,902. 15s. 11d. After making provision for all working expenses in Monte Video and London, depreciation of stock of materials in Monte Video, and writing off the final amount of preliminary expenses, there remains an available balance, including the amount of £775. 2s. 9d. brought forward from last year, of £7,677. 18s. 8d. The directors recommend the payment of a dividend of 4 per cent. on the preference share capital, absorbing £5,600, which, after placing £1,000 to reserve account and £500 to reserve for bad and doubtful debts, leaves the sum of £577. 18s. 8d. to be carried forward to next year.

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British Electric Light Company.—Mr. Justice Stirling, on Wednesday, heard a motion asking, on behalf of the holders of a series of debentures, for the appointment of a receiver and manager of the British Electric Light Company, Limited. Counsel stated that under the terms of the debentures, if the principal money was not paid on July 31, 1894, the whole of the Company's undertaking and property should become specifically fixed and charged therefor, and that principal and interest should forthwith become payable. Payment of the principal had been demanded and had not been made, and the interest had been in arrear for a year. The Company did not appear, and his Lordship said there would be the usual order.

Bath.—The Surveying Committee of the Town Council have received a letter from the Rev. G. C. Clarke, of St. John's Priory, with reference to the lighting of South-parade. It appeared that the sub-committee had proposed to move the electric light standard from one position to another, but to this the residents objected. Mr. Clarke suggested that another gas lamp should be erected midway between the two electric lights by the side of the asphalte walk under the trees. Alderman Bright believed it was proposed by the sub-committee to cut down some of the trees. It would be an act of vandalism to remove one of them. He moved that the extra lamp asked for be erected. Alderman Sturges seconded, and the proposition was carried.

Bacup.—The report of the Health and Baths Committee of the Town Council stated that the chairman submitted a communication from Messrs. Richardson and Herbert, electrical engineers, of Manchester, with reference to lighting the baths by electricity, using the steam from the present boilers for the engine. They estimated (roughly) the lights required as two arc lamps of 2,000 c.p. each for the second-class bath, two of 3,000 c.p. each for the first-class bath, and 29 incandescents, equivalent to 30 16-c.p. lights, for the remainder of the building, and the cost of the installation, including steam-engine and dynamo, but exclusive of foundations, at about £180. It was resolved that the matter be left over for the next meeting of this committee to deal with.

St. Pancras.—The Electricity Committee of the Vestry have reported that the chimney shaft had been completed, and that the work connected with the erection of the central electric station buildings and destructor buildings on the King's-road site was being steadily proceeded with. It was deemed desirable to acquire the freehold of the site, and for this purpose, as well as to meet the contracts let in connection with the destructor buildings and appliances, the central electric station buildings, electrical machinery, and mains, a sum of £65,000 was required. Hence the committee recommended that application be made to the London County Council for a loan of £65,000, repayable by equal instalments of principal and interest combined in 42 years. The report of the committee was adopted.

Paddington.—The Infirmary Committee of the Paddington Board of Guardians recommended that steps be taken to light the wards of the infirmary with the electric light. The Rev. C. Dent moved the adoption of the recommendation. Dr. Felce seconded it. Mr. Sherrard moved that the administrative block of the infirmary be included in the recommendation. Colonel Blair seconded this. General Whish, Mr. Empson, and Mr. Jephson spoke in favour of the proposed addition. Messrs. Dent and Swift, Mrs. Charles, and the Chairman argued in favour of the recommendation as sent up by the Infirmary Committee. It was in the end decided by eight votes to six to adopt Mr. Sherrard's proposal. The recommendation as amended was then carried. St. Saviour's Church has been lighted electrically.

Electric Fittings.—Messrs. B. Verity and Sons inform us that they are exceedingly busy in their fittings and electrical accessories departments, being obliged to extend their works at Aston and put down additional machinery in order to cope with the pressure of orders. Among the principal contracts in hand for fittings are the following: Southport Municipal Buildings, assembly hall, etc.; Worcester Guildhall and Municipal Buildings; Burton Town Hall and Municipal Buildings, Church Institute, etc.; and Cardiff Town Hall and Municipal Buildings, St. Mary's Markets, etc. They have also some large trade orders for switches, lampholders, general sundries, etc., the switch factory especially having to work overtime in order to keep pace with the heavy demand, the output of their new key sockets alone having been doubled within the last month.

New Mains in London.—Permission has been granted by the London County Council to the Westminster Electric Supply Corporation to lay a service main across North-row, North Audley-street; to the London Electric Supply Corporation to lay distributing mains in Heddon-street and court, Regent-street; to the Vestry of St. Pancras to lay mains in Gloucester-road and across Regent's Park-road; to the House-to-House Electric Light Supply Company to lay mains in Scarsdale-villas from Marloes-road to Allen-street; to the Notting Hill Electric Lighting Company to lay mains across Chepstow-villas and in a part of Holland Park; to the County of London and Brush Provincial Electric Lighting Company to lay mains across Rosebery-avenue at six places, and on both sides of that thoroughfare from Farringdon-street to St. John-street-road; and to the Kensington and Knightsbridge Electric Lighting Company to lay mains in Bute-street, Pelham-street, Harrington-road, and Glendower-place.

Lancaster.—A letter has been read at a meeting of the Rural Sanitary Authority from Mr. Sydney Moore, secretary of the Windermere District Electric Supply Company, asking for the sanction of the Authority to the application of the company for a provisional order to enable them to supply electricity within the Authority's district, and, in the event of the Board declining to sanction the application, that an interview be granted to the directors. It was stated that the Authority had given permission to the Morecambe Electric Company to supply electricity to the Sandylands district of Heysham, and that it was necessary to give notice of motion for a future meeting that the application should be considered. Mr. Stephenson gave the requisite notice, stating that he did not think the Authority should discourage anything of the kind. It was subsequently pointed out that if the Authority consented to the application it would prevent any other company supplying electricity in the district, whereupon Mr. Stephenson said he would oppose the application.

Cambridge.—The Paving, Drainage, and Lighting Committee of the Town Council have reported that they have had several interviews with Mr. W. M. Fawcett, architect, with reference to the amount to be paid to him in respect of the preparation of the plans and specifications for the electric lighting station which the Corporation proposed to erect, when it was intended that they should carry out the electric lighting installation themselves, and finally Mr. Fawcett had agreed to accept the sum of £250 in discharge of all claims against the Corporation for services rendered and for disbursements made by him on their behalf in connection with the electric lighting, and the committee recommend that his offer be accepted. Councillor S. L. Young moved, and Alderman Deck seconded, the adoption of the report. Councillor H. M. Taylor, in supporting the motion, stated that he thought Mr. Fawcett in accepting the sum of £250 in respect of the electric lighting station had behaved in a most liberal and most generous manner. The motion was carried.

Reading.—The Callender Bitumen, Telegraph, and Waterproof Company, Limited, of London and Erith, who are the manufacturers and contractors for laying the underground mains of the Reading Electric Supply Company, Limited, have commenced their operations. The type of mains adopted is concentric lead sheathed and armoured, the dielectric itself being jute fibre, impregnated with bitumen under heavy pressure. With this system of mains, which are complete in themselves, as despatched from the manufactory, no further protection in the way of pipes or brick culverts is required. The mains are laid direct into the ground, the cables possessing sufficient mechanical strength necessary to withstand all ordinary rough usage and heavy traffic without injury. Amongst the various towns at present supplied by this system are Richmond, Tunbridge Wells, Brighton, Ealing, Pontypool, Cheltenham, Worcester, Oxford, Wolverhampton, Ayr, and Glasgow. The underground mains of the South Staffordshire and Douglas and Laxey Tramway Company are also on this system.

Chester.—A special meeting of the Chester Town Council has been held to discuss a recommendation submitted by the Boating and Baths Committee to the effect that the Hop-pole Paddock should be selected as the site for public baths. The Council had many months ago adopted the Hop-pole Paddock, which is their own property, as the site for baths and electric light generating station, it being felt that the joint scheme could be worked more economically than two separate undertakings. A strong opposition developed against the proposal, however, in which the Duke of Westminster, Bishop Jayne, and the dean and chapter joined, the contention being that the proximity of the electric lighting station to the city walls and cathedral would be dangerous, a nuisance, and an eyesore. Recently, the Council decided to place the electric lighting works on Corporation property known as the Water Tower Gardens, whereupon the Boating and Baths Committee decided to urge the Council to select the Hope-pole Paddock as the site for the public baths alone. The recommendation has been adopted.

Windsor.—On the recommendation of the Electric Lighting Committee, the Town Council have decided that the town clerk be requested to publish the statutory notices of intended application for a provisional order to supply electrical energy to Windsor and Eton. A new electric installation company is about to be started at Windsor, in the High-street, under the style and name of the Windsor Electric Installation Company, engineers and contractors. They have secured the services of Mr. A. E. Farrow, late manager of the Windsor branch of Roger Dawson, Limited, as their engineer and manager. Mr. Farrow has in Windsor laid down the electric light plant at the White Hart Hotel, and was consulting engineer during the installation of the light at the Manor Hotel, Datchet. While with Messrs. Dawson he carried out the electric lighting at The Priory, Datchet, at the Bracknell Supply Stores, and at Clewer Park, the residence of Sir H. D. Gooch. Electric lighting is about to be adopted at Bourne End for Mr. R. C. Lehmann and Mr. Spencer Brunton, and for Mr. G. F. Adcock at Riversdale, Bourne End.

Eastern Extension, Australasia, and China Telegraph Company.—The gross receipts, including Government subsidies, have amounted in the half-year to £247,681. 2s. 4d., against £257,986. 13s. 5d. for the corresponding half-year of 1893. The working expenses, including £21,295. 16s. 5d. for cost of repairs to cables and expenses of ships, absorb £80,295. 3s. 10d., against £78,229. 19s. 3d. for the corresponding period of 1893, leaving a balance of £167,385. 18s. 6d. From this is deducted £3,940. 2s. 7d. for income tax, £32,488. 13s. 9d. for interest on debentures, debenture stock, contribution to sinking fund, and revaluation of currency balances, leaving £130,957. 2s 2d. as the net profit for the half-year. Two quarterly interim dividends of 1½ per cent. each, amounting to £62,500, have been paid for the half-year under review, leaving £68,457. 2s. 2d. to be carried forward. The loss resulting from the third year of working, ended April 30 last, under the Australian tariff guarantee arrangement, amounted to £12,384, half of which was borne by the guaranteeing Governments and the other half by the associated cable companies in

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terms of the agreement. The general meeting of the Company will be held at Winchester House on Wednesday afternoon next.

Glasgow.—A beginning will be made early next month with the lighting by electricity of the Glasgow Corporation tramcars. Each car is to be provided with a couple of accumulators, weighing about 40lb. apiece, placed at either end of the vehicle. There will be four lights on every car, each of 8 c.p., two being placed inside and two outside. The inside lamps are to hang from the ceiling, while the outside lights will be poised on poles above the heads of the passengers. These outside lamps will be placed at the ends of the cars, and will serve the purpose of the bullseyes presently used, as the glass facing outwards will be coloured to correspond with the name board. The accumulators will only require to be charged once a day. The contract has been given to the Froggat Electric Lighting Company, London. Dynamos are being laid down at Paisley-road and Coplawhill stations, the two places where the electricity is to be generated. It is expected that by the end of the year all the cars will be fitted with the light. The Glasgow and South-Western steamer "Minerva" has been fitted with a search-light of 1,000 c.p. The object is to assist the steamer in taking the piers on the late runs.

Poole.—At a recent meeting of the Council the promoters of the Poole and Bournemouth Tramways wrote asking the Corporation to consent to an extension of the time in which the proposed trams were to be commenced. The Council, however, did not accede to the request. The Board of Trade, on being appealed to, granted the promoters three months' extension to enable them in the meantime to again approach the Town Council. This has been done at a meeting of the Corporation, when Mr. James Gordon Smith and Mr. D. Onslow, of London, representing the promoters, attended as a deputation. Mr. Smith reminded the Council that it was intended to have electric trams, and with the tramways to incorporate a scheme for the lighting of the town with electricity. Therefore, in asking the Council to reconsider their decision, the promoters felt that they were not doing anything detrimental to the interests of the town in any way, as they hoped to commence laying down the trams in January next. After a short discussion, in the course of which the Town Clerk pointed out that it would be necessary to rescind the resolution now on the books, it was decided that on the next agenda notice would be given that inasmuch as the promoters have given an undertaking that the work shall be commenced at the Poole end, and the construction of the trams to be commenced in January, the Council will consider the desirability of rescinding their former resolution. The town clerk is to write to the promoters and get the terms of their undertaking in writing before the next Council meeting.

Huddersfield.—Mr. Thomas Bland, at a meeting of the Town Council, called attention to the refusal of the Central Wards Committee to allow the Huddersfield Industrial Society, Limited, to carry wires across Buxton-road for the purpose of lighting by electricity the society's premises in John-street. The society, Mr. Bland said, thought they were not being fairly treated, considering that a firm in George-street had been allowed to carry across an overhead wire there. Mr. Inman said that the committee had every desire to meet the wishes of the society as far as was practicable, but he pointed out that the traffic in Buxton-road was greatly in excess of that in George-street. Alderman Glendinning said that he should move that no overhead wires be allowed in any thoroughfare. Alderman Hellawell said he believed that if the application had been made to lay wires underground there would have been no objection. Alderman Stocks reminded the Council that if the request were acceded to, the Co-operative Society would enjoy a privilege which the Council did not enjoy themselves. The Council were compelled to lay their electric lighting wires underground. It would create a new danger if they were carried overhead. On the suggestion of Mr. Inman, Mr. Bland withdrew his opposition to the committee's record, and the minutes were adopted. The County Council have decided to inform the Central Wards Committee that there is no intention to lay mains along Viaduct-street at present. A supply of 500 3in. and 500 2in. pipes was ordered.

Luton.—At a special meeting of the Highways and Lighting Committee the clerk reported that he had received replies from 51 boroughs to the queries forwarded to them, and that he had sent to each member of the Council a tabulated statement of the queries and answers and also to the town clerks who had so courteously replied to the questions. The clerk also reported that he had had an interview with one of the chief officials of the Board of Trade and a firm of parliamentary agents, and gave full detailed particulars as to the proceedings to be taken and the probable expense of obtaining a provisional order, and generally on the whole question. The committee having very fully considered and discussed the whole question, the Mayor proposed, and Councillor Wilkinson seconded, the following resolution: "That the town clerk be and he is hereby authorised to take all legal and other steps to lead to an application being made to the Board of Trade for a provisional order for the supply of electricity for public and private purposes within the borough of Luton, in accordance with the provisions of the 'Electric Lighting Acts, 1882 to 1890,' and the rules made by the Board of Trade with respect to applications under the said Acts." The committee divided: ayes, 10; noes, 1. It was resolved that the clerk should retain Messrs. Sharpe, Parker, Pritchards, and Barham, of 9, Bridge-street, Westminster, London, as parliamentary agents in the matter of obtaining the provisional order. This report has now been before the Town Council, and has been adopted by a large majority.

Dover.—The Town Ward Lighting Committee of the Town Council have reported on the position of the arc lights from the Monument to the Market-square, and stated they did not approve of them, but as the position had already been settled they had no power to alter them. The Town Clerk said that the surveyor reported in April on the position, and after they had been referred to the Castle Ward Lighting Committee, they had been approved. Councillor Clark said that they were greatly disappointed, as the four lamps from the Monument were not placed in the most advantageous positions. He referred particularly to the lamp in front of the Monument, and thought that it spoilt the appearance of that structure. Councillor G. Mowll said that there were two lamps in the Market-square, one at the corner by the Fountain Hotel, and one by Mr. Igglesden's, but no provision had been made for a central lamp. It appeared that the positions had been selected by the electric light engineer, and submitted to the approval of the Council. The Castle Ward Lighting Committee had approved of the lamps in their district, but the four lamps in question in the Town Ward had been overlooked. The Mayor said that there had been some little misunderstanding, but he thought that they had best leave the lamps as arranged until they were tried, and then if they wished they could be altered. On the motion of Councillor Bradley, the lighting of the new streets on the Folkestone-road was submitted to the Town Ward Lighting Committee. Alderman Pepper also asked that the committee should report on the lighting of Cannon-street, and the question of electric light in these streets was ordered to be considered by them.

Cardiff.—A special meeting of the Lighting and Electrical Committee of the Cardiff Corporation was held at the Town Hall on Monday afternoon, under the presidency of Alderman P. W. Carey. A deputation, consisting of Messrs. John Gunn, Louis Tylor, and Mrs. Viriamu Jones, waited upon the committee upon the question of supplying electric light at the Aberdare Hall. When the application was originally made they understood that the minimum charge for the supply of the light would be £30 per annum, but, according to the draft agreement they were to pay £30 per annum plus the cost of the electricity consumed. If that agreement was adhered to they could not possibly take the light, as the cost would be too great. In the discussion which followed the Chairman pointed out that the Aberdare Hall was 1,200 yards outside the compulsory area, and the cost of laying the mains would be £600. Under the provisional order the Corporation were authorised to charge 5 per cent. on first cost of works outside the compulsory area. Mr. Riches stated that when the wires were once laid a number of people in Park-place would use the light, and the guarantee of the Aberdare Hall authorities could be reduced in proportion. Mr. Gunn said they were quite prepared to pay for all electricity above £30, but they could not afford to pay the two sums. Mr. Harpur here stated that in this district not a single application had been received for the light. Ultimately the deputation agreed to pay a minimum rate of £40 per year, plus the cost of electricity used beyond that amount, and on the motion of the Mayor, seconded by Mr. Gerhold, it was decided to lay the matter before the town clerk, in order to ascertain whether the suggestion could be carried out. A number of applications were read for the position of foreman of the electrical machinery and plant at the central station. The position is worth £3 a week. After going through the qualifications of the various candidates, Messrs. J. T. Elliott, J. E. Teesdale, J. Wits, and C. A. Hibbert were requested to appear before the committee yesterday. At a meeting of the Chamber of Commerce, the president announced that the Exchange Company were going to introduce the electric light for the convenience of the members of the Chamber.

Hanley.—Four 1,000-c.p. arc lamps are now employed to light Elphinstone's Circus. The Corporation met on Tuesday, when it appeared from the minutes of the Electric Lighting Sub-Committee that an application had been received from Messrs. McIlroy Bros. for electrical energy to supply 219 electric lamps at their premises in Miles Bank and Lamb-street, but the engineer reported that if the markets were lighted all the available energy would be taken up. The committee recommended that the application of Messrs. McIlroy Bros., also one from Mr. Handforth, Piccadilly, for a supply of 16 lamps, be complied with. It was further resolved: "That this sub-committee having found the existing plant and machinery insufficient to supply the demands for energy for electric lighting, tenders for an additional engine and alternator be obtained, and that the electrical engineer be requested to submit at an early meeting a scheme for the extension of the plant and mains for supplying the electrical energy likely to be required within the area of supply, that part of the scheme relating to the compulsory area being submitted for first consideration." The sub-committee also recommended that the town clerk be requested to write to the Brush Electrical Engineering Company requiring them to forthwith put the electric lighting plant and machinery in proper working order to the satisfaction of the borough surveyor in accordance with the terms of their contract. In moving the confirmation of these minutes, Alderman Shirley said the extent to which electrica energy had been applied for was phenomenal. All the power they were at present able to supply had been asked for, and the committee were, therefore, compelled to take steps with the view of providing additional plant and increased energy. The Board of Trade required them to retain surplus energy to the extent of 20 per cent., so that it was compulsory for them to provide extra power if they wished to meet the demands upon them. Mr. A. Wood, in seconding the motion, said it would have been better if the committee had got the existing plant out of the hands of the contractors before taking steps to provide additional plant, but, seeing that they had not sufficient power to light their markets now the wiring

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was complete, the committee thought it desirable to proceed with obtaining further machinery without delay. The motion was then agreed to.

Medical Electrical Institute, Limited.—In this concern, which has just been registered, the word "electrical" is being used objectionably, and as the Official Receiver in Bankruptcy has virtually sanctioned the reconstruction, it will unfortunately have an official aspect to many of the lunatics in this kingdom who are not locked up. The title of the Company is the "Medical Electrical Institute, Limited," which has been registered by Jerome and Co., 38, Basinghall-street, E.C., with a capital of £75,000, divided into 25,000 7 per cent. preference shares of £1 each, and 20,000 ordinary shares of £2. 10s. each. Object: to purchase or otherwise acquire all the business, goodwill, rights, privileges, contracts, copyrights, trade-marks, patents, assets, and property of the Medical Battery Company, Limited; to adopt and carry into effect an agreement, made October 16, 1894, between the Medical Battery Company, Limited (in liquidation), of the one part, and H. Banyard, on behalf of this Company, of the other part; to provide for and carry out, under the control and superintendence of a duly qualified medical man, the treatment of diseases by means of galvanic, electric, and magnetic appliances, batteries, baths, medical and other apparatus, and by massage, hydrotherapic inhalation, mechanical exercise (Dr. Zander's, or any other system), chemical, dental, and other processes; and to carry on the business of manufacturers of and dealers in all kinds of galvanic electric, magnetic, therapeutic, gymnastic, and other appliances; as chemists and druggists, dentists, chiropodists, Turkish and other bath proprietors, etc. The first signatories to the memorandum of association are:

	Shares.
A. Cowen, clerk, 12, Charter-buildings, Goswell-road, E.C. ...	1
T. S. Smith, clerk, 80, Mallinson-road, Battersea-rise, S.W. ...	1
C. L. Quin, clerk, 64, Basinghall-street, E.C.	1
W. Brittain, clerk, 126, Windsor-road, Forest Gate, E.....	1
P. Jerome, solicitor, 7, Boutflower-road, Handsworth	1
T. J. Horrocks, merchant, 17, Goldhurst-terrace West, N.W...	1
A. Lienard, accountant, Newport Villa, Muswell-hill	1

There shall be six first directors. The first are C. G. Elers and J. Oliver (nominated by the ordinary shareholders), A. L. Poulter and L. J. Greenberg (nominated by the preference shareholders), and W. B. Jones and A. Fleet (nominated by the second mortgage debenture-holders). Qualification, 100 ordinary or 50 preference shares, or £100 second mortgage debentures. Remuneration, £600 per annum, or 5 per cent. of the net dividend profits, divisible. We can only hope that the money required will not be raised, and that the capital will be limited to the £17. 10s. put against the names of the signatory dummies. It is a pity that the concern in question has not been allowed to go into oblivion.

Whitehaven.—Mr. Rienzi Walton, one of the inspectors of the Local Government Board, has attended at the Town Hall, Whitehaven, for the purpose of making local enquiry in respect to the application of the Trustees of the Town and Harbour for sanction for further borrowing powers for the purpose of electric lighting. Among those present were Mr. J. G. Dees (chairman of the Trustee Board), Mr. J. Jacques, Mr. J. L. Paitson, Mr. J. Pattinson, Mr. T. K. Metcalf, Mr. J. Collins, Mr. J. Tyson, Mr. J. S. Brodie, Mr. E. Stiven, and Mr. P. J. Watts—all members or officials of the Trust. There were no unofficial ratepayers present. Mr. Brodie, the borough surveyor, gave evidence in support of the application, which was for power to borrow £6,304. About half of this was for works already executed, and the other half for works to be executed. The works already done were extras on the original contract, including extra public lamps for Hensingham-road, Arrowthwaite, and in the town, £492; extra domestic main round by Irish-street, £389. 2s. 11d.; three feeders to different points, £1,851. 10s. 2d.; extra domestic services beyond those sanctioned, £260. 5s. 10d.; wiring up of the harbour, £66 5s. 3d.; and cables in stock, £140. 6s. 8d. prime cost. Mr. Brodie explained that these works were urgently required, owing to the fact that the gas company might have charged the Trustees very heavily for the public lighting of the outlying district if they had not included them; and the extra plant was necessitated by the great demand there was for current beyond what it was anticipated there would be for some time. The additional plant now proposed to be acquired consisted of a pair of engines and dynamos, £1,500; water-pipes, £30; switchboards, alterations to connections and instruments, £60; conductors, branches, and house service, £1,750; meters £500; additional batteries, £50; sundries, £20. This was Dr. Hopkinson's own estimate. The whole of the public lighting of the town was now done by incandescent light. This was the only town in this country entirely lighted by electricity. There were 429 street lamps, equal to an average of 465 lamps of 16 c p. each. They had 104 harbour lamps, equal to an average of 172 16 c.p. lamps. There were 63 private installations, the total lamps supplied being 1,395 16 c.p. That brought up the total to 2,032 16-c.p. lamps now installed. The dynamo output at present at the station was 2,000 16-c.p. lamps, with a small battery equal to about 300 16-c.p. lamps for one hour. There were 3,400 lineal yards of domestic cable laid, and there was a lamp connection of one lamp to every 2·4 lineal yards. Applications had been received from 18 additional consumers These they could not accommodate without this further plant. They would equal 116 16 c.p. lamps. But he himself knew of many others that were pending. The applications were not sent in because it was known that they could not be met at present. Mr. Brodie gave the particulars of the financial position of the works that were submitted at the last trustee meeting. The Inspector remarked: It is satisfactory, I think, so far. Mr. Dees: I think so. Mr. Dees added that he need hardly say the Trustees were anxious to get sanction from the Local Government Board as early as possible.

Stafford.—The foundation-stone of the electric light station was laid last week by the Mayor (Councillor G. Wormal). The matter was first mooted by the service of a notice on the Corporation by the Electric Supply Association to the effect that they proposed to apply for power to supply the borough. As the owners of the gas-works, for which undertaking they had paid a considerable sum, the Corporation felt that they could not acquiesce in the application, and that if electricity was to be supplied in the borough they ought to supply it. Consequently, they applied for powers to do so, and obtained them in 1890. A canvass of the town was taken as to the demand for electric light, but there was not sufficient demand as to warrant the Council in spending some £15,000 capital outlay. The Board of Trade was apprised of these facts, and the matter lay in abeyance. On the erection, however, of the new County Council Hall the matter was reopened by the County Council applying to be supplied with the electric light for the hall and also for the technical schools now being built. On this a second canvass of those likely to require the electric light was made, and more favourable replies being received, Dr. Hopkinson, F.R.S., electrical engineer, was called in to advise the Council on the whole case His opinion was favourable to taking the work in hand. A Local Government Board enquiry was held, the result being that borrowing powers to the extent of £20,000 were granted by the Local Government Board. Of this sum it is proposed to spend only £15,000 at present. The contract for the main buildings was let to Mr. H. Lovatt, Wolverhampton, who is also the contractor for the county hall and the county technical buildings. The main buildings will be of red pressed bricks with Hollington stone facings, the interior of the dynamo-house being lined with glazed bricks. The dynamo-house is to be 82ft. by 45ft., and there will be three 120-h.p. condensing horizontal steam-engines, each to drive a dynamo, calculated to produce 300 amperes at 200 volts, with a speed of 600 revolutions per minute. Adjoining the dynamo-house will be a boiler-house, in which there will be erected three Lancashire steel boilers, 7ft. 6in. diameter and 28ft. long. Space is left in the dynamo-house for two more engines if necessary, and in the boiler-house for four more boilers. The chimney stack will be 135ft. high, with sufficient capacity to accommodate eight boilers. The cables will be enclosed in earthenware pipes. The supply will be on the three-wire system of Dr. Hopkinson. The stone-laying ceremony was performed in the presence of the members of the Town Council and a few spectators. Mr. J. F. Bell, gas engineer, presented a silver trowel and mallet wherewith to perform the ceremony Having done so, the Mayor declared the stone well and truly laid. Alderman W. H. Peach, chairman of the Electric Lighting Committee, proposed a vote of thanks to the Mayor for performing the ceremony, and gave a history of the undertaking.

Hampstead.—The Electric Lighting Committee of the Vestry reported that they had insured the electric station building and plant in the Norwich Union Fire Insurance Society as follows: buildings, for £6,000, at 5s. per cent.; plant and other contents (exclusive of dynamos), £7,000, at 5s. per cent.; dynamos, £2,000, at 21s. per cent. without warranty; that they had insured the four boilers against explosion with the Boiler Insurance Company for £2,000 each at the annual premium of 40s. each, and the economiser also against explosion with the same company for £300; that they had considered applications for the supply of electric current in Heath-street, High-street, and Gayton-road, and they recommended that mains be laid from the sub-station No. 6 in Arkwright-road along Fitzjohn's-avenue and Heath-street to a new sub-station at the junction of Heath-street and High-street, and from thence along High-street and Gayton-road, at an estimated cost of £726; that the request of the committee of the Metropolitan Asylums Board to be supplied with electric current at their North-Western Hospital, at a reduction of 33 per cent. off the present price, be agreed to, provided the Board enter into a three years' agreement to take annually a supply of not less than 70,000 units; that the engineer be authorised to obtain certain tools, etc., required at the station, as set forth in a list submitted to the committee at a cost of £105. 4s. 7d., such amount to include the sum of £19. 18s. 8d. already expended on account of tools (as previously authorised); and that the engineer be authorised to obtain the necessary meters, etc., for customers' connections, at a cost not exceeding £300. In reply to the chairman, Mr. Thwaites, chairman of the Electric Lighting Committee, said that the price to be charged to the North-Western Hospital would be a little over 4d. per unit. Mr. Sharpe said that some time ago the Vestry decided that 20 per cent. was to be the highest discount allowed. Why was 33 per cent. to be allowed in this case? Mr. Underwood replied that this deduction was in strict accordance with the scale already agreed upon. Twenty per cent. was to be allowed on an amount of £500. Here it was expected that the sum of £1,100 would be received from the hospital. Mr. Greenhill thereupon moved, as an amendment, and Mr. Payne seconded, that the clause be sent back to the committee with instructions to them to negotiate with the hospital committee for the supply of the light on the basis of 4d. per unit. Mr. Thwaites expressed his willingness to accept this amendment. The recommendations of the committee were adopted, with the exception of this clause referring to the supply to the hospital, which was referred back in accordance with the terms of Mr. Greenhill's amendment. A cheque was drawn for £300 in favour of Mr. W. H. Preece, C.B., F.R.S,, the consulting engineer, for commission on the sum of £6,000 certified on account of Messrs. Siemens's contract. The consideration of the following recommendation of the Electric Lighting Committee, submitted on July 26,

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was resumed—viz., "That application be made to the London County Council to advance to the Vestry the sum of £24,400 for electric lighting purposes under the terms of their order, dated June 26, 1894." The motion was agreed to. The Works Committee reported that they had instructed the surveyor to remove the 38 gas lamps superseded by the electric arc lamps in the Finchley-road, upon receiving an intimation from the electrical engineer that they are no longer required. Approved.

Birmingham.—The installation of the electric light at the Market Hall was brought into use on Tuesday evening, when the current was turned on by Councillor Parkes (chairman of the Markets and Fairs Committee) in the presence of a large company of persons interested in the improvement. Among them were Councillors Jarvis, Bowkett, Nixon, Moore Bayley, Marsh, and S. Lloyd; Mr. Henry Lea (Messrs. Lea and Thornbury), and Mr. Vaudrey (manager of the Electric Supply Company). The installation consists of 42 arc lights and three incandescent lamps for the superintendent's office. The lamps, with the exception of those illuminating the entrance, are suspended over the gangways of the hall, at a height of 14ft. from the floor, and the light, amounting in the hall to about 50,000 actual candle-power, is well distributed throughout the entire space. The capital outlay amounts to £900, which will be repaid by annual contributions for 10 years of £100 per annum. The cost of running the electric lamps will be £507 for energy and £25 for carbons, as compared with £522 at present paid for gas. The gas lighting hitherto has been very unsatisfactory, and upon enquiry it was found that to improve it would involve a materially greater cost than the employment of electricity from the mains of the Electric Supply Company. The turning on and off of the lamps is effected by a switchboard in the superintendent's office. This board contains 23 switches, each of them governing two lamps, and these are turned on slowly, one after the other, so as not to make too sudden a call upon the supply company's mains. Councillor Parkes, having turned on the light, addressed a few remarks to those who were present. He said it was 61 years since the foundation-stone of that hall was laid, and at no period of its history had it been so brilliantly illuminated as at the present time. When the Markets and Fairs Committee decided upon the employment of electricity they were subjected to some severe criticism, but he thought they would agree with him that they were right in the course they had adopted. He quite admitted that gas was a most useful illuminant under some circumstances, but for a building of that kind the electric arc light was certainly very much the best. The nominal candle-power that he had now lighted was something like 100,000 candles, but the actual candle-power was little more than half that in consequence of the medium through which the light came. He only wished he could turn on good trade as easily as he turned on the new lights. Unfortunately, that was not in his power, but he thought that by providing improved illumination for the hall they would render it additionally attractive, and that an increased business would be done there. The wish of the committee was to make the building as well adapted to the business of the tenants as they possibly could, and he felt sure the tenants would be pleased with the improvement. He believed the Birmingham Market Hall would always command a large amount of attention from buyers, not only resident in Birmingham, but also from visitors from the surrounding districts. He wished success to the market, and to all who did business in it. Councillor Jarvis (chairman of the General Markets Sub-Committee) said that the committee thought it well to bring the market up to date in respect to its illumination. The electric installation had been most successfully carried out by Messrs. Lea and Thornbury, and the Council were specially indebted to Mr. Henry Lea for the attention which he had devoted to it. He also mentioned that they had been met in a most generous manner by Mr. Vaudrey, on behalf of the Electric Supply Company, and also by the Walsall Electrical Company in respect to the necessary fittings.

Ulverston.—The following report has been brought before a meeting of the Rural Sanitary Authority: At a conference of representatives of the Ulverston Union Rural Sanitary Authority, the Dalton, and Grange, and Ulverston Local Boards held on the 4th inst., Mr. James Hodgson presiding, the clerk of the Ulverston Rural Sanitary Authority laid before the committee notice of the Windermere and District Electric Supply Company, Limited, of their intention to make application to the Board of Trade in pursuance of the Electric Lighting Acts, 1882 and 1888, for a provisional order authorising the company to supply electrical energy for public or private purposes within the area of the jurisdiction of the local authority as defined by the above Acts for the district of the Ulverston Union Rural Sanitary Authority. The Grange and Ulverston Local Board representatives intimated that their respective Boards had received a similar notice. The Dalton representatives stated that no such notice had been served upon their Board, and withdrew from the conference. Moved by Mr. Haines, seconded by Mr. Tosh, and resolved, "That the committee consider that it would be reasonable that the Windermere and District Electricity Supply Company, Limited, should have the power to supply electrical energy for public or private purposes to such portion of the Ulverston rural sanitary district as extends to Haverthwaite, including the watershed of the Leven on the west as far as Greythwaite, and the portion of the rural sanitary district on the east side of the River Leven, and the district of the Grange Local Board, should the before-mentioned portions of the said district and the Grange Local Board consider it desirable to have the use of the electric light within the said districts, and that the Ulverston Rural Sanitary Authority oppose the application of the order to the rest of their district, along with the Ulverston Local Board, and that if the part of the Ulverston Rural Sanitary Authority district to the north and east of Haverthwaite and the Grange Local Board do not desire to have electrical energy supplied by the said company, they be requested to join in opposing the proposed application. The committee also consider that it is desirable to appoint a sub-committee of seven members of this committee to meet and discuss the matter with electric supply company in the interests of all the parties concerned, and report to this committee." Mr. Haines, in the absence of Mr. Hodgson, moved the adoption of the report. Mr. Dove dwelt upon the importance of an assurance being given that the company did not intend to interfere with the waters of Coniston Lake. He did not think that any private company should have a monopoly in regard to that watershed. The Clerk: That is really what the committee propose to oppose. They wish to keep the company out of the Coniston district altogether. Mr. Mason seconded the motion. Mr. Harrison asked why the committee did not propose to oppose the company in regard to their powers on both sides of the Leven? Mr. Haines said there were two reasons. The first was, that if they entered a general opposition to everything the company asked for, the probability was the company would also oppose the Authority, and it was thought better to give the company a certain area, as defined in the report. The second reason was that the people of Haverthwaite, Cartmel, and Grange might wish to have the electric light, and they thought they should allow them this opportunity of getting it if they wished. Mr. Harrison did not think they should give a monopoly to any company without due consideration. The people of the places mentioned might be able to supply themselves on easier terms than they could obtain from a company with a monopoly. Mr. Haines: The committee came to the conclusion there was no other source of supply except the water power which this company has already purchased at Backbarrow. The Chairman said if the Cartmel and Grange Boards should upon consideration decide to oppose the application of the company, there was nothing to prevent the committee's report being modified accordingly. He suggested that the report should simply be read, and that the Authority should await the report of the conference with representatives of the company. This was agreed to.

Aberdeen.—Prof. Kennedy reports as follows to the Town Council with reference to the necessity for an extension of the electric lighting plant: "In July, 1892, I reported to you on this matter, and in March of this year the electric lighting works, carried out on the lines of my report, were opened. You may remember that in my report I estimated the total cost of the works, so far as the supply of the eastern district was concerned, at £24,400. I find from particulars furnished to me that the capital cost of the works, including all sums contracted for but not yet paid or due to the contractors, and including also the purchase price of the site in Cotton-street, the cost of connecting up consumers and of meters and every other matter covered by the estimate, along with the engineer's commission, amounts to about £23,900. The total cost is thus well within the estimate. Being exceedingly anxious not to give you too sanguine an estimate of the rate at which the lamps would be connected, I only put down the total number at 7,000 (in the eastern district) after two years of working, and provided plant for this number, although the station and the mains were so arranged that demands for increased power could easily be met as they arose. It must be most gratifying to you to find that the demand for lighting has increased far more rapidly than I ventured to suggest, and that already nearly 7,000 lamps are connected to your mains, although the station has only been at work for six months. It is not possible, from the running power of the summer months only, especially in a place so far north as Aberdeen, to estimate the probable income per lamp per annum. In my report I put it at 9s., assuming that you charged 8d. per Board of Trade unit. With your actual charge of 7d. per unit, this figure would be more nearly 8s. per lamp per annum, and I see no reason to suppose that this is an over-estimate. It corresponds to an average consumption of only 13·5 units per lamp per annum, as against 18 in Glasgow, 16·5 in Birmingham, 16·7 in Hull, and over 20 in Newcastle. From Mr. Murray's weekly station reports, of which I have sent you an analysis month by month, there seems every reason to think that even in your first full year of working the enterprise will fully pay its way without making any call on the rates, although it was hardly to have been expected that so favourable a result should be so soon obtained. It is undesirable that lamps should be connected in excess of the number for which the existing plant will safely provide current without use of the reserve plant, and this limit is now practically reached in the Aberdeen station. I have, therefore, to advise you that tenders should be obtained as soon as possible for the next instalment of the plant for which the station was schemed. This addition should consist of two engines and dynamos, each of about 200 h.p., placed on the existing engine-block in the places already provided for them. By this extension the total horse-power of the station will be raised from 316 to 716, and the net power (with one larger engine in reserve in each case) from 236 to 516. At present the maximum number of lamps (8 c.p.) which can be lit at one time (without use of reserve) is about 4,000, which is as many as there is any likelihood of being lit at once out of 7,000. The new plant would increase this to about 8,600, which would represent about 15,000 wired, or more than double the capacity of the present plant, besides allowing a larger reserve power. The present boiler power is sufficient for this extension, so that no new boilers would be required. Nor would any addition or alteration to the buildings have to be made—the present engine-house being large

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enough to hold easily 400 h.p. more than this first extension, or still more if it should be found advisable later on to adopt a larger size of machine. With the new plant there will of course be required additions to the existing steam and exhaust pipes, etc., as well as additions to the instruments on the switch-board. In each case the existing work has been schemed so that further plant can be added without alteration to that which already exists. The present chimney, which is an old one, with some addition made to its height, will suffice for the new plant. I estimate the total additional cost of the two engines and dynamos, with all steam and exhaust pipes, switchboard instruments and connections, erected complete in the station ready for work, to be not more than £3,500. It would be advisable at the same time to increase the amount of copper in the feeders, as they will have to carry current increased in proportion to the increased power of the station. Provision was made when the mains were laid for making this increase as far as possible without lifting the road or foot-ways, so that it will be hardly anywhere necessary to disturb the surface of the streets. The cost of this additional copper, including the cost of pulling it into the culverts and connecting up, should not exceed £350. My estimate for the total cost of the extension to plant and mains is therefore £4,350. This, added to the amount already expended or contracted for, would bring up the total capital cost of the electric lighting scheme to about £29,000. In cases of this kind, the cost of the first instalment of buildings, foundations, plant, roadwork, and mains is, of course, far greater in proportion than the cost of extensions, so that the capacity of plant and mains is in this case more than doubled by an addition of less than 20 per cent. to the original cost. I have not entered into the question of the extension of the distributing mains—*i.e.*, the extension of the area to be lighted. This is an important matter of policy in which you must, no doubt, be guided very largely by the feelings of the inhabitants of the districts concerned. I have no doubt whatever that before long it will become necessary for you to extend the mains into at least as much of the western district as was shown on the map accompanying my original report. Whether this should be done in the summer of 1895 or not is a matter of which I am not able to advise you at this moment, as I have no information as to the existing or probable demand for current in the residential part of Aberdeen." In a note, Prof. Kennedy adds, "The maximum number of lamps which have as yet been alight at one time is about 3,500, on the 11th inst."

PROVISIONAL PATENTS, 1894.

OCTOBER 15.

19560. **Improvements in the means of transmitting power from gas-engines, steam-engines, and the like for driving dynamos and other apparatus.** Frederick Henry Royce, 53, Arcade-chambers, St. Mary's Gate, Manchester.

19585. **Improvements in electric arc lamps.** Pierre Adolphe Mougin, 28, Southampton-buildings, Chancery-lane, London.

OCTOBER 16.

19603. **Improvements in ceiling roses, cut-outs, and such like for electrical purposes.** Charles Leigh Clarke and William Paul Theermann, 7, South-parade, Manchester.

19605. **Improvements in electrical conductors and joints therefor.** Bond Andrews, 12, Batoum-gardens, Brook Green, London.

19654. **Improvements in telephone receivers.** Francis George Bell and Max Binswanger, 73, St. Stephen's-road, Upton Park, London.

19668. **Improvements in carbons or electrodes used in arc lamps for electric lighting.** Alfred Francis Bilderbeck Gomess, 9, Warwick-court, Gray's Inn, London.

19681. **Improvements in coin-freed telephonic apparatus.** William Miller, 28, Southampton-buildings, Chancery-lane, London.

19702. **Improvements in accumulators.** George Edward Heyl, 23, Southampton-buildings, Chancery-lane, London.

19710. **Improvements in dynamo-electric machines and motors.** Illius Augustus Timmis, 2, Great George-street, Westminster.

OCTOBER 17.

19733. **An electric clock.** Walter Hearn and Charles Robert Gatehouse, 32, Bow-street, London.

19742. **Improvements in electrical switches.** William Paul Theermann, 70, Deansgate, Manchester. (Complete specification.)

19764. **Charging electric accumulators.** John Hopkinson, 5, Victoria-street, Westminster.

OCTOBER 18.

19807. **Improvements in and connected with electric door contact.** Hermann Oppenheimer, 55, Redcross-street, London.

19842. **Improved electric storage fuse distribution box, also relating to single and double pole fuses or cut-outs.** Leon H. Cline, Buddle-street, Wallsend-on-Tyne.

19868. **An improvement in electro-deposition of an alloy of zinc and cadmium.** William Arthur Thoms and William Henry Burgum, 58, Lombard-street, London.

19889. **Improvements in electric arc lamps.** Charles Tyringham Praed and Percy Ruskin Allen, 46, Lincoln's-inn-fields, London.

OCTOBER 19.

19924. **Improvements in the combination of electric light with metallic bedsteads.** John William Hoyland and Wilson Henry Sturge, 12, Cherry-street, Birmingham.

19966. **Improvements in means or apparatus relating to the supply of electrical energy to portable electric lighting apparatus.** Henry Birnbaum, 55, Chancery-lane, London.

OCTOBER 20.

20017. **Improvements in the regulating mechanism of electric arc lamps.** Anthony George New and Arthur James Mayne, 55, Chancery-lane, London.

20043. **Improvements in arc electric lamps.** William Geipel, 73, St. Stephen's-road, Upton Park, London.

20059. **Casting by means of electric current.** Petro Scheidt and Jan W. Tideman, 26, Luisenstrasse, Berlin.

20081. **Improvements in rapid telegraphic transmission.** Charles Langdon-Davies, 24, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1893.

15971. **Electromagnetic motor.** Anders and Kottgen.

18150. **Secondary battery lamp for mines, etc.** Doubleday. (Sussmann.)

21435. **Electric heating bodies, etc.** Schindler.

21966. **Electrical drop indicator.** Beal.

22519. **Clips for electric conductor casings.** Darrah and Metcalfe.

22960. **Controlling electrical devices.** Wilkinson and Penson.

11973. **Electrolysis of water.** Siemens Bros. and Co. and Obach. (Second edition.)

1894.

4849. **Supporting and protecting electrical conductors.** Day and Allmark.

14634. **Galvanic battery.** Buell.

16400. **Generating and applying electricity to the body.** Newton and others.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	5	5½-6
Bournemouth Electric Company	—	—
Brush Company, Ordinary	2	2½-2⅝
—— Nom. Cum , 6 per cent. Pref.	2	2½-2⅝
—— 4½ Debenture Stock	100	111-114
Charing Cross and Strand	5	4½-5½
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	13-14
—— 6 per cent. Cumulative Pref.	10	14½-15
—— 5 per cent. Debenture Stock	115	131-133
City and South London Railway, Consolidated Ordinary	100	36-38
—— Debenture Stock	100	121-123
—— 5 per cent. Pref. Shares	10	13-14
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	94-99
Electric Construction, Limited	2	½-⅝
—— 6 per cent. Debentures	—	87-92
—— 7 per cent. Cumulative Pref.	2	1½-2
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1⅛-1⅜
Elmore's French Company	2	3/16-5/16
Elmore's Wire Company	2	1⅛-1⅜
Fowler-Waring Cables	5	½-1½
W. T. Henley's Telegraph Works, Ordinary	10	8-9
House-to-House Company, Ordinary	5	1-1½
—— 7 per cent. Preference	5	5½-5¾
India Rubber and Gutta Percha Works	10	24½-25½
—— 4½ per cent. Debentures	100	102-104
International Okonite, Ordinary	—	—
Kensington and Knightsbridge	5	4⅞-5½
—— 6 per cent. Pref.	—	6¼-6⅝
Liverpool Electric Supply, Ordinary	5	6 11/16-6 15/16
—— Pref.	—	—
Liverpool Overhead Railway	10	7 15/16-8 1/16
—— Pref.	10	13-13½
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric	5	½-1½
Metropolitan Electric Supply	10	9½-9¾
—— 5 per cent. Reg. Debentures, 1-10,000 in Bonds of £10, £20, and £40	—	—
National Telephone, Ordinary	5	4½-5½
—— 6 per cent. Cum. First Pref.	10	15-16
—— 6 per cent. Cum. Second Pref.	10	14-15
—— 5 per cent. Nom. Cum. Third Pref.	5	5½-5¾
—— 4½ per cent. Deb. Stock	—	110-113
Notting Hill Company	10	5½-6½
Oriental and Electric Company, £1 shares	1	1-1½
—— £5 Shares	—	6¾-7½
—— £4½ shares	—	5½-6¼
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7½-8
—— 7 per cent. Pref.	5	8½-9½
Swan United	—	—
Telegraph Construction and Maintenance	12	41-43
—— 5 per cent. Bonds	100	106-109
Westminster Electric Supply, Ordinary	5	6½-7
Yorkshire House-to-House	4½	4½-4¾

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NOTES.

Personal.—Sir David Salomons has accepted the mayoralty of Tunbridge Wells.

Telegraphy in India.—A line of telegraph is to be laid from Chittore to Oodeypur.

Telephony in France.—A telephone line has been inaugurated connecting Angiers with Paris *viâ* Saumur and Tours.

Cardiff Exhibition.—The council of the proposed exhibition have decided to postpone the holding thereof until 1896.

"Horncastle's Manual."—The sixth annual issue of this work will appear on January 1, and will deal with all matters relating to joint-stock enterprise in 1894.

Electric Towing.—According to the *Bulletin International de l'Electricité*, the experiments made on the Bourgogne Canal with electric towing have proved very successful.

Electric Traction in France.—A line of tramway between St. Georges-de-Didonne and Pontaillac, with a connection to Royan, has been declared of public utility.

Electric Cranes.—A description appears in the current issue of the *Bulletin International de l'Electricité* of a 15-ton electric crane which has been erected in the works of the Société Bollincx.

Electric Transmission in Germany.—The machinery of the Herzogl. Anhalt. Maschinenbau Anstalt und Giesserei, at Bernburg, is to be worked entirely by means of electric motors.

Southport Electricity Works.—The central electric light station established by the Southport Corporation will be opened by the Mayor (Alderman James Wood) on Friday next, the 9th inst.

Telegraphy on the Caspian Sea.—The Russian Government are establishing telegraphic communication between Astrachan and the so-called "12ft. roadstead," the anchoring place of vessels.

Electric Traction in Italy.—The Società Generale di Elettricità are asking the Milan Municipality for a concession for various lines of electric tramway through the main streets of the city.

Economy in the Use of Current.—A self-regulating switch has been devised for the purpose of automatically switching off in half an hour a lamp in case it is left alight when not required, a matter of importance to hotel keepers and others.

A Substitute for Indiarubber.—According to the *Echo*, whose "news," as a rule, is more extensive than accurate, "bolata, the product of a tree in Sumatra, is becoming the rival of Indiarubber and guttapercha." We never heard of it.

Royalty and Electric Light.—An electrical engineer crossed to Calais on Tuesday evening by the cargo boat with apparatus with which to light by electricity the special saloon in which the Prince and Princess of Wales are travelling across the Continent to Livadia.

The Electric Barber.—An American contemporary says that an ingenious citizen of Tacoma has devised an apparatus in which the principle of the electric fan is utilised to blow a current of warm air through the locks of a customer who has been having his head shampooed.

Telephony in Germany.—Delays have taken place in connection with the erection of the telephone line between Berlin and Vienna owing to difficulties which have been met with in Austria due to the nature of the ground. However, the line will, it is expected, be completed about the middle of the month.

Electric Lighting in Italy.—Experiments in connection with the electric lighting of the Milan streets having proved very satisfactory, the Società Generale di Elettricità are erecting a number of 500-c.p. arc lamps. The Municipality of Eboli, a small town in the Campagna, have decided to introduce the electric light there.

Electric Traction in Russia.—A decidedly novel project has been put before the St. Petersburg Municipality by the Finland Passenger Steamboat Company. They propose during the winter to run an electric tramway on the ice on the Neva, from the Palace Quay to the Mytninski Quay. Each car is to carry 20 passengers, the rate of speed being 20 versts per hour.

New Ink Slinger.—"Oh, my dear young man," remarked an old lady at an electrical exhibition, "what beautiful ink-bottles!"—pointing to some dry batteries. "Madam," observed the attendant, "these are indelible ink-bottles." "I thought so," rejoined the old lady. "If I had only heard of them in my younger days I should have been a millionairess."

Siemens-Halske Cyanide Process.—It is reported from South Africa that the Siemens-Halske cyanide process is being adopted by the Metropolitan, May Consolidated, and New Crœsus, and the first results, apart from those already obtained at the Worcester works, may be expected in a month or two. The royalty has been definitely fixed at 3 per cent.

Cost of Indian Telegrams.—A proposal to considerably reduce the cost of telegrams between India and the United Kingdom has been received by the Government of India, says the *Indian Engineer*, but it is impossible for any answer to be given, as the matter is one in which the cable companies are mainly concerned, and the Government can take no action without their sanction.

Society of Engineers.—The next ordinary meeting of this society will be held at the Town Hall, Westminster, on Monday, November 5, when the adjourned discussion of Mr. T. W. Baker's paper on "The Utilisation of Town Refuse for Generating Steam," will be resumed and concluded. The annual dinner will be held at the Holborn Restaurant on Wednesday, December 12 next.

Telegraphic Communication with Alderney.—The island of Alderney is now isolated from the rest of the world so far as telegraphic communication is concerned, a rupture having taken place in the cable connecting Alderney with Guernsey. The break is about mid-channel, and it is said will not be repaired until next spring. This will be unfortunate for the inhabitants, as during the winter months the mail steamer "Courier" goes there only twice a week.

Presentation.—On Wednesday last, on the occasion of Mr. E. Putland's retirement from his position on the technical staff of Messrs. Johnson and Phillips, he was presented by his late colleagues and friends with a handsome gold watch and other smaller items to mark the esteem and the goodwill which he has so well earned during his 10 years' connection with the firm. Great regret was expressed amongst all Mr. Putland's colleagues, and he is followed by their very best wishes.

Electric Traction in Austria-Hungary.—The Municipality of Budapest have approved in principle of the proposal of the local horse tramway company to convert their lines into electric tramways. The plans which they have prepared have also been accepted as a basis of the scheme to be carried out. The company will increase its capital to carry out the work. Steps are being taken in order to convert the Prague tramways, which belong to a Belgian company, into an electric system.

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Electric Light on the Cheap.—According to the *Elektrotechnischer Anzeiger* of Berlin, a M. V. Jeanty has arrived in Berlin from Paris to exploit his "galvanic element, 'Fulgar.'" The cost per hour is stated to be for a 6-c.p. incandescent lamp ·0024 of a penny; for a 10-c.p. lamp, ·004 of a penny; and for a 16-c.p. lamp ·0064 of a penny. Our contemporary satirically enquires why anyone should now build a dynamo or construct accumulators.

Meldrum's Forced-Draught System.—The system of forced draught as applied to boilers, and to which reference is made in the article describing the Bolton electricity works, consists in the delivery of air under pressure into the closed ashpit beneath the firebox by means of a steam jet and carefully-designed blower, which is illustrated in the article in question. The appreciation of the system is shown by the fact that in over 2,000 cases this method has been adopted with successful results.

Flexible Couplings.—In our issue of October 12, reference was made in the description of the electricity works at Worcester to the Snyers clutch used in the driving of two of the alternators simultaneously by both turbines and engines. At that time we were unable to give an illustration of this coupling, but a view of it will now be found in another column, in the article on "Gas-driven Alternators." The working of this form of clutch at Worcester will be watched with interest, especially as regards the cost of maintenance or renewals.

Lectures on Polyphase Currents.—A short course of lectures on polyphase-current working will be given at Finsbury Technical College, by Prof. Silvanus P. Thompson, on Mondays, at 8 p.m., through the month of November. The first lecture deals with polyphase generators; the second with the history and development of the rotatory-field motor; the third is devoted to the theory of non-synchronous motors; and the series concludes with some account of the tests on modern types of alternate-current motors, their construction, and methods of starting and regulation.

"Technical Education Gazette."—We have received from the London County Council a copy of No. 1 of *The London Technical Education Gazette, being the official circular of the Technical Education Board of the London County Council*, which, it is stated, has for its object the publication of the official announcements of the Board. With the impudence characteristic of the Council, the secretary of the T. E. B. touts for advertisements for this circular. No information is afforded as to whether this sheet with the brief title is to be published weekly, monthly, quarterly, or annually.

Vulcanised Fibre.—A new price-list of the vulcanised fibre supplied by Messrs. Mosses and Mitchell and Co., Chiswell-street, E.C., has been issued. This fibre is largely used for mechanical and electrical purposes. The hard vulcanised fibre is a good insulator in all dry positions. Among the variety of applications of this fibre may be mentioned in dynamos for commutators, magnet heads, etc., for switchboards and switch plugs, wall insulators, bases of telegraph and electrical instruments, press buttons, electric gas-lighting appliances, electric fire and burglar alarms, electric lamps, etc.

French Cable Companies.—The *Journal des Débats*, says a Reuter's telegram, makes the following announcement: "The Minister of Commerce, Posts, and Telegraphs, with the sanction of the Council of Ministers, has signed a decree, dated October 27, which authorises the French Paris New York Telegram Company to transfer to the French Submarine Telegraph Company the rights and charges of the concession granted to it on January 7, 1879, for the establishment of a submarine Transatlantic cable. This decision officially confirms and renders definite the amalgamation of the two companies agreed upon by the meetings of their respective shareholders."

Bankside Station.—Messrs. Willans and Robinson, of Thames Ditton, have received an order from the British Thomson-Houston Company for several large engines for the Bankside station of the City of London Lighting Company, which is one of the most important orders for electric lighting engines ever received in this country at one time. There are eight engines of 700 i.h.p. each, coupled direct to Thomson-Houston alternators, and we understand that the Thomson-Houston Company have received a complete order, of which they form a part, for engines, dynamos, boilers, pipes, exciter plant, etc. They have already at this station put down four Willans engines of 300 i.h.p. each coupled direct to their alternators.

Electric Lighting for Hospitals.—The use of the electric light in public buildings and institutions gains ground steadily, if slowly. In all new buildings of any size and importance it is becoming a matter of course that the system shall be installed from the beginning; but when it is a question of adaptation to existing institutions the balancing of expense against convenience, says the *Hospital*, gives matter for much deliberation, and too often hospital authorities are frightened to embark upon improvements, however important, when a very large initial expenditure is entailed. With the money difficulty once overcome, there cannot be two opinions as to the enormous advantages to be gained by its adoption.

Electric Lighting in France.—Good progress is being made by Mr. Andrieu in connection with his central electric light station at Capdenac, where the water power of the Lot will be utilised. Current will be supplied to the Capdenac railway station, to the Municipality, and to private consumers. Thomson-Houston dynamos and Fontaine turbines will be used. The gas company at Laval intend to offer the Municipality a proposal to erect a central electric light station. They have been authorised to use the Avesnières waterfall for motive power. A report has been submitted to the Lille Municipality with respect to the scheme proposed by the gas company for lighting some of the streets of the town by electricity.

Lancashire Jokes.—During the process of construction and equipment of a certain Lancashire central electric light station, some of the workmen on the job became curious about the electrical plant, and it was decided to give them a fright and those in the know a little pleasure. One instance was the painting on a large wooden box containing water of the words, "Danger: this box is charged with alternating currants" (currents). Another was the labelling of the words, "Beware of danger: this machine is being charged," on an alternator which was not run for some weeks afterwards. A third trifle was the advice given to "keep away from the engines [which were not running], or they would pull your watch out of your pocket."

Institution of Electrical Engineers.—The first of the meetings of the Institution during the session of 1894-95 will be held on Thursday, 8th inst., when the following papers will be read: "Notes on Electric Tram ways in the United States and Canada" (supplementary paper), by Mr. H. D. Wilkinson, member, and "Electric Traction, with Special Reference to the Installation of Elevated Conductors," by Mr. R. W. Blackwell, foreign member, and Philip Dawson, associate. These papers will be discussed, together with Mr. Wilkinson's original paper, "Notes on Electric Tramways," etc., published in Part 113

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of the *Journal of Proceedings*. The annual dinner, as we have already stated, will be held at the Freemasons' Tavern on November 21.

Association of Municipal and County Engineers. A meeting of the Incorporated Association of Municipal and County Engineers will be held to-morrow (Saturday) for the purpose of inspecting the Colne Valley Water Company's works at Bushey, and also the Hampstead electric lighting station, which has been recently opened. The programme of the meeting will be as follows: 11.40 a.m.—train leaves Euston for Bushey, arriving 12.20; 12.30 a.m.—short paper describing the water company's works now in progress will be read by Mr. Brough Taylor, M.I.C.E.; 1 p.m.—lunch; 1.30 p.m.—inspection of pumping station and water-softening works; 2.34—train from Bushey to Hampstead (change at Willesden Junction); 3.30 p.m.—short paper upon electric lighting installation by Mr. W. H. Preece, C.B., F.R.S., etc.; 4 p.m.—inspection of electric lighting station and works.

Electric Torpedo Boat.—According to a Reuter's telegram from Melbourne, Mr. Seymour Allan, a resident of Sydney, has invented a submarine torpedo boat capable of sinking to any depth, and of travelling under water as quickly as on the surface without revealing its presence. A working model of the boat has been tried in the public baths in the presence of the Earl of Hopetoun, the Governor, the naval commandant, and a number of naval and military officers. The experiments were a complete success, the model rising or sinking stern or bow, turning, reversing, or remaining stationary in obedience to the electric current by which it is worked. The inventor claims that a full-sized boat would be capable of remaining under water for three days, and would carry torpedoes on the bow and stern decks. When fired the projectiles would be magnetically attracted to the bottom of an enemy's ship. What next!

Bordeaux Exhibition.—A meeting will shortly be held at the London Chamber of Commerce for the purpose of ascertaining to what extent British manufacturers and others are disposed to actively participate in the thirteenth National, International, and Universal Exhibition to be held in Bordeaux from May to November, 1895. With the object of making the meeting thoroughly representative, the secretary of the London Chamber will be pleased to forward a formal invitation to any interested persons who will intimate their wish to be present. Meanwhile, the full regulations and other information as to the exhibition may be obtained on application at the offices of the Chamber, Botolph House, Eastcheap. Should the meeting come to a conclusion in favour of British participation, it will be part of the business to nominate the members of a British committee, on lines similar to those pursued in regard to the Antwerp Exhibition of this year.

Berlin Electricity Works.—The Electrical Company, of 122 and 124, Charing Cross-road, inform us that the report for the year 1893-94 of the Berliner Electricitätswerke contains the following figures up to the end of September, 1894: Consumption of current supplied to the cable network, 97,287 amperes; additional consumers to the extent of an output of 9,313 amperes will be shortly connected to the mains. The consumption of current during the year 1893-94 was equal to 92,055,000 normal lamp-hours for private customers, and 424,290 for street-lighting; and for motors, 570,421 kilowatt-hours were used. At the end of June, 1894, 360 motors were connected with an output of 1,364 h.p., and orders for 70 more motors, with an output of 300 h.p., are in hand. The total capacity of the station is over 13,000 kilowatts. The Berliner Electricitätswerke were designed and constructed by the Allgemeine Electricitäts-Gesellschaft, of Berlin, whose sole agents for Great Britain are the Electrical Company, Limited.

The Mica Mines of Chota Nagpur.—The mica mines worked in this part of India are all situated in the Giridih sub-division of the Hazaribagh district. The majority of these are in the Kodarma Government estate, both inside and outside the Government reserved forests, and the rest are scattered over portions of *gadis* Gawan, Domchanch, Khesmi, Musnudih, Byrea, Doranda, and Satgawan. The majority of the mines situated within the above-mentioned *gadis* are worked by Messrs. Christian and Company. During the past year 15 new mines, covering an aggregate area of 22·57 acres within the Kodarma Government estate, were settled by the deputy commissioner of Hazaribagh at an aggregate rental of Rs.1,252 per annum. The aggregate current demand of the rent due to the Government amounted to Rs. 9,692, out of which Rs. 9,554 was realised, and only Rs. 137 remained due from one lessee. The total output of all the mines, whether situated within the Government estate of Kodarma, or in the estates of private zemindars, was 3,086 maunds 25 seers, against 2,236 maunds in the previous year.

The Pacific Cable.—A Reuter's telegram from San Francisco, dated October 27, says: "Mr. Mercer, of the British Colonial Office, and Mr. Sandford Fleming, the representative of Canada, have returned from Hawaii, where they have been negotiating with the Government of that country for the concession of a landing-place and telegraph station for the projected Pacific cable. Mr. Fleming was interviewed on arrival here, and said that the Hawaiian treaty with the United States precluded the concession of any land or any special rights to any country other than America. The British commissioners had agreed not to fortify the cable station nor to create a naval station. Mr. Fleming added that it was understood Hawaii would appeal to Washington for permission to grant the privilege asked for by Great Britain in respect to the land concession. The commissioners, while on their journey, inspected Bird Island, and made the necessary soundings in the vicinity. They will proceed from San Francisco to Washington to urge their case with the United States Government."

Engineering, Electrical, and Allied Trades Sections.—A meeting of these sections of the London Chamber of Commerce, and others interested in the construction of light railways and of steam and electric tramways, will be held at the offices, Botolph House, Eastcheap, E.C., to-day (Friday), at 2.30 p.m., to consider the following agenda: "(1) to consider a circular letter [which is given in another column] received from the Railway Department of the Board of Trade in reference to 'a movement recently set on foot with the object of obtaining further powers and facilities for the construction of light railways and steam or electric tramroads,' and to 'the requirements which are imposed by the Board of Trade upon new railways'; (2) to appoint two members to attend a conference at the Board of Trade on an early date with the object of discussing (*a*) 'how far the usual requirements of the Board of Trade as to constructing and working new railways may fairly be relaxed, especially in the case of lines built through sparsely-populated and agricultural districts'; and (*b*) 'whether additional legal facilities for obtaining powers to construct tramroads and light railways are necessary or desirable.'"

The New Decimal Association.—A general meeting of the members of the New Decimal Association will be

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held at the offices of the London Chamber of Commerce on the 20th inst. It is intended, as soon as possible after Parliament reassembles, to move the appointment of a Select Committee, and it is chiefly for supporting this action that the meeting now called is to be held. It is also proposed that endeavours should be made to secure energetic action in the United States. The following resolutions will be submitted: "Resolved, that this association learns, with great satisfaction, that the Government no longer oppose the appointment of a Select Committee to enquire whether any, and what, changes in the present system of weights and measures should be adopted, and the executive committee is hereby authorised to take such steps as it may consider best for promoting the adoption of the metric weights and measures." "Resolved, that Mr. William L. Wilson be informed of the position of the movement in this country for adopting the metric weights and measures, and that he be urgently invited to use his influence to secure such legislation as may provide for the adoption of this system of weights and measures in the United States."

Use of Micanite.—The Mica Insulator Company, of New York, have issued the following concerning the use of micanite: An important point in making or refilling commutators is the necessity of applying heat during the process of building, and from long experience we will guarantee the following method to give perfect satisfaction, and be a cure for such ills as loose bars, cement oozing out, or oil soaking in, if micanite segments or rings are used. After assembling the commutator, heat it to about 200deg. F., or just enough to make micanite pliable, then tighten the bars or rings as much as possible. The pliability of the micanite will allow the distribution of unequal strains and will counteract to a great extent irregularities in the dimensions of other parts of the commutator. Then continue the heating, but this time let it reach 400deg. F., or until the shellac, which will have oozed out here and there, has become dry. In fact, the shellac may be partially carbonised with no bad results. Then retighten the commutator either hot or cold, but preferably in both states. Do not tighten during the progress of this second heating, but wait until the shellac is baked dry. When no proper arrangements are provided for heating, the commutator can be put for a few minutes inside a boiler-furnace door, or on a gasoline stove, or on a plate placed over a blacksmith's forge.

Calcutta Tramways.—The regularly recurring hot season, says *Indian Engineering*, brings in its train a list of casualties among the tramway company's horses in Calcutta, as well as other places where this system of locomotion is in vogue, which is heartrending. But apart from this, which is practically rather a shareholder's point of view, there is much to be advanced from the point of view of the public against relying upon beasts of burden for the regularity and certainty of their reaching their places of business, considering the value and increasing importance of every moment of time. In such centres as Calcutta, Bombay, Madras, etc., nothing short of mechanical power should be insisted upon for the working of tramways, since such power is unaffected by weather, and journeys may be timed with fair accuracy, which it is impossible to do when animal power is relied upon. The daily traveller by tram in Calcutta knows only too well by the stoppages which result from the use of too fresh or too stale horses just when pressed for time, or by the snail pace rendered necessary in the hot weather, what the inconveniences of the present system are, and he is fully entitled to have a grumble when he reads of electric and cable tramways adopted in places where nearly everything is in favour of animal power. There seems to be no potent reason why the tramways in Calcutta should not be converted into cable, if not into electric, tramways to the much greater convenience of the public using them.

Electric Traction in Germany.—A commission was sent by the Elberfeld Municipality to Paris to inspect the accumulator electric traction system there in connection with a proposed line at Elberfeld running north and south. The Railway Commission in consequence were in favour of arranging with Messrs. Mather and Platt, of Manchester, to carry out an accumulator project, but the Municipality at a private meeting have decided not to do so, but to give the work to the Elektricitäts-Gesellschaft "Union," of Berlin. Yet another scheme for an electric railway in Berlin has been laid before the Municipality, this time by Messrs. Kramer and Co., railway contractors. The line in question is intended for the purpose of establishing communication between the western and north-western districts, starting from the Genthinerstrasse and terminating at the Weinendammer Bridge. The local authorities of Berlin have granted a 40 years' concession to the Charlottenburg Horse Tramway Company for electric traction on their lines from the Alt-Moabit-strasse to the Lindenstrasse, *viâ* Paulstrasse and the Luther Bridge. The Grunderwerbs und Baugesellschaft, of Berlin, propose to construct an electric tramway on the trolley system between Landsberger Platz, Berlin, and Hohen-Schönhausen. It is proposed, when the central electric generating station is established in Dresden, that the three eastern lines of the Dresden Street Railway Company in Blasewitz, Striesen, and Strehlen, shall adopt electric traction on Messrs. Siemens and Halske's system. Mr. Th. Wulff has acquired the Bromberg horse tramway, with the object of converting it into an electric line. The work will be carried out by the Allgemeine Elektricitäts-Gesellschaft, of Berlin.

The "Intense" Cat.—A widening circle of admirers is loud in the praise of the cat. When the secretary of the National Cat Show assures us, says the *Lancet*, that the animal is "intense" it is quite possible to agree with him. When he adds the suggestion that gently rubbing a cat's back may "have a beneficial effect on persons in bad health" it is scarcely safe, in view of all that is known of "suggestion" and the effects of peripheral stimulation on nervous centres, to absolutely differ from him; but when it becomes evident that he deduces the above from what "everybody who has studied cats must know," that "the animal is full of electricity," it becomes difficult to repress a more or less emphatic request to him to "stop." The electrical effect produced by rubbing a cat's back is, of course, well known; it is also well known that this is frictional electricity, or, perhaps more correctly, the electricity of contact—that it is a surface effect produced by the rubbing, that it does not point to pre-existing electricity stored in the body of the animal, and that the person who, having concluded a massage, sinks into a chair declaring that his exhaustion is consequent on the loss of "the living galvanism" which he has imparted to the patient is a charlatan. It is to be remembered that friction between any dissimilar substances always produces electricity, and in illustration of this the electrical effect sometimes produced in a dry atmosphere when the hair is combed or the body quickly divested of a flannel jersey may be instanced, or the classic experiment of rubbing a stick of sealing-wax on a rabbit's fur may be called to mind. Those who are accustomed to rely on the curative effect of stroking a cat's back may find consolation in the last-named experiment, inasmuch as it teaches them that when their "feline favourite" is no more health and strength may still be secured by gentle friction on its skin.

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Electricity in Australia.—An Australian correspondent writes to us that an electrical conference was to be held in Melbourne about the end of September for the purpose of drafting a code of rules governing the erection of overhead light and power wires. Mr. P. B. Walker, of the Telegraph Department, and Mr. Jas. O. Callender, were appointed to represent New South Wales. The North Sydney electric tram has broken down, the armature of the generator being burnt out. In the interim a small dynamo (which also broke down) was put in to run one car during the hours of light load, the heavy load being taken up by the trailers of the cable tram drawn by horses. The Telegraph Department have been considering the advisability of extending the Moore-street tunnel as far as the exchange. As this is rather an expensive undertaking, the Callender-Webber conduit was proposed. The result has been that nothing is to be done till the subject has been discussed by the conference to be held in Melbourne. The Hillgrove Electric Light and Power Company have at last started their installation at Hillgrove. The power is generated six miles from Hillgrove at Gara Falls, and the distribution is on the three-wire system. The company's programme includes the lighting of the town and motive power to the mines. Mr. W. Harcourt Palmer is the hydraulic engineer, and Prof. Threlfall, of the Sydney University, consulting electrician to the company. The contractors to the electrical portion are the Crompton Company, under the supervision of Mr. O. W. Brain. The Railway Commissioners have had an experimental accumulator tramcar built, which has been running between the Sydney railway station and the city since May last. The car carries 80 passengers, and is exceptionally heavy, weighing about 17 tons loaded. So far it has evidently been successful, and the Commissioners have ordered two more to be built on the same lines.

New Swindon Junior Engineering Society.—A successful meeting of this society was held in the Mechanics' Institution on Thursday last, when Mr. G. B. Clifton, M.I.Mech.E., read a practical paper on "Ship-Lighting by Electricity," to a large attendance. Mr. Clifton commenced with an enumeration of the advantage of installing the engine and dynamo in such a position that the heat of the boilers and the accumulation of coal dust, rolling of ship, etc., would have the least effect on their running. A distributing-board was described from which the mains are led off to the respective compartments of a ship, and special attention was given to the efficient connection between the compartments. As an example of this an ingenious type of stuffing-box which not only renders the joint watertight, but at the same time insulates the cable from the bulkhead, was submitted. Mr. Clifton emphasised the great necessity for providing good protection of the wires from the action of salt water, and their careful jointing, using resin as the flux, and also pointed out the advisability of the co-operation of the shipbuilder and the electrical engineer to facilitate the wiring of a ship under the best conditions. Mr. Clifton concluded his paper with an exhaustive description of the fittings on a ship, where they differed appreciably from those used in house-lighting. In the discussion, the chairman, Mr. H. G. Cotsworth, gave a short review of the introduction of the electrical lighting of ships, and mentioned the great influence the contracts of the Admiralty and other private firms had on the final establishment of the electrical engineering industry. He also enquired as to the objections to the use of arc lamps in the cargo-holds of ships. Mr. Leader, with some remarks on the development of ship-lighting, Mr. Stephens, with the suggested use of portable lamps in the engine-rooms, and Mr. Tincknell, with an enquiry as to current-carrying capacity of the cables used, also contributed to the discussion, which was concluded with some further remarks by Mr. Clifton on the points raised.

"The Electric Lady."—In the early years of the eighteenth century, whilst Du Fay and the Abbé Nollet watched with astonishment "the first sparks that were ever drawn from the living body," and long before Kruger had conceived the idea of electro-therapeutics, or Kratzenstein had given that idea form, electrical phenomena, says the *Lancet*, were attracting much attention. Many earnest experimenters were investigating the "thing" which, since the days of Gilbert, had come to be called "electricity"; philosophers were gaining a first insight into its possibilities; a new science was quietly winning its way. At the same time the less serious portion of the society of the period, aware of the newly-discovered phenomena, was amusing itself by "drawing sparks" as "electric rain," or "the electric star," or, perhaps, occasionally in the form of the "electric kiss." At the end of the nineteenth century electrical science has made an amazing progress—a progress, however, with which its more frivolous developments seem scarcely to have kept pace. They have, it is true, got beyond the stage of the frictional machine, but it cannot be said that the entertaining young man of the period yet knows how to conjure playfully with currents of "Teslaic" frequency or to amuse an audience by a skilful adaptation of the Hertzian wave. The "penny shocker" is, from the electrical standpoint, a painfully coarse experience of a coil current, and even "the electric lady" of these latter days is, on the whole, a very poor thing. "She is found to be so highly charged with animal electricity that when she immerses her hand in water anyone placing a finger in the bowl at the same time experiences a shock." About the latter there can be no question; the sensation is that of an unmistakable induction current. Neither is it to be denied that she is "charged with electricity." In other words, she is connected with one pole of a large coil kept carefully out of sight and hearing. She places her hand in water; a second person, standing "to earth," and doing the same, offers a passage to the current through the body, and a fall of potential is the result; but there is no obvious means of completing the circuit. This may surprise those who work only with the ordinary medical coil, but anyone accustomed to larger coils and to so-called "idle pole" work is aware that under such circumstances no metallic connection with the other pole is necessary. The circuit is completed *viâ* the body of the second person through the ground and so back to the second pole; and the more effectively the latter is "earthed" the more palpable will be the effects in question. This unpolar method is from its medical aspect something more than a mere experiment. It affords a very serviceable method of electrisation. If a person lightly insulated and holding an ordinary moistened electrode attached to one pole of the secondary of a large coil be touched on the forehead by a person standing "to earth," the former will experience a not unpleasant electrical sensation—an effect, however, scarcely perceptible on the arm. But if the "operator" places his foot upon the firegrate (thus making a better earth) the effect is stronger. If, however, the idle pole itself be well "earthed" by being connected to a gas or water pipe, then, if the person holding the electrode as above be insulated on glass and be touched as before on the arm, a distinct effect just short of muscular contraction is produced. By altering the amount of the insulation and varying the "earthing" of either pole a variety of electrical effects are obtainable. Muscular contractions of a widely varying strength and cutaneous stimulation of every degree of intensity may be thus secured,

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MECHANICAL TRACTION FOR TRAMWAYS.

(Continued from page 447.)

Turning from questions of theory, construction, and working to those of cost—both initial outlay and operating expenses—our author considers, first, the conductor system, whether overhead or underground; second, the central station; and, third, the car equipments.

With regard to the expenditure necessary for the line, he estimates the average cost of network proper—that is, the poles, span wires, trolley wires, and all accessories—at from £640 to £770 per mile of single line, and from £1,024 to £1,280 per mile with iron poles as against the cheaper ones of wood. For a double line these prices will require increasing by £200 to £250 per mile. A bare copper return conductor, buried in the soil, will cost when in position from £150 to £200 per mile. The expense entailed by feeders will, of course, vary according as they are carried overhead or underground.

When the line does not exceed 2½ miles in length the cars may be run directly from the trolley wires, but for any length over and above this distance feeders become essential. If their size is but small, not exceeding that of the trolley wires, they may be carried overhead; but as the demand for current increases when the line is extended or developed, either their number or size must also be increased, and in such a case it becomes almost necessary to put them underground. Their price then is, of course, higher, as they must be well insulated and protected by a lead and metal covering, or by being carried in earthenware or metal pipes. Their cost will average from £750 to £1,000 per mile, laid in position, for a section equal to carrying 125 amperes at ordinary current density. Their lengths will vary, as a rule, from one-third to one-fifth of the network, according to the relative position of the latter with the central station. The total cost of an overhead system will therefore reach an average of from £1,300 to £2,000 per mile.

The expenditure necessary upon an underground or trolley system is much more costly, and the electrical work alone, it is said, may even involve an outlay of £12,000 per mile, not counting any sums spent upon the permanent way.

Taking next the central station, it is usual to calculate upon 1,000 to 1,200 square feet of heating surface in the boilers per car on the line, and similarly from 18 i.h.p. to 20 i.h.p. in the engines. [This seems far too high; from 10 h.p. to 15 h.p. in the engines per car on line being ample allowance on ordinary lines without excessive grades.] This gives about 14 or 15 kilowatts dynamo output per car, without the reserves, which, of course, must be also allowed for. The outlay upon plant of this capacity for a line employing from eight to twenty cars will average £450 per car, divided up thus: £250 for boilers, engines, and steam accessories; and £200 for dynamos and electrical details. Buildings, estimated on a basis of £3 to £4 per square yard, will come to about £120 per car. An extra allowance of 35 per cent. at least should be made in all these prices to cover the cost of reserve plant, so that the total outlay upon the central station will range from £720 to £800 per car in service.

With regard to the cars and their motor equipment, the author states that at first the tendency was to make these too light for efficient working under rough usage, and the more modern types are much heavier than those formerly built. Cars to hold 50 passengers, designed by the Thomson-Houston Company, weigh from seven to eight tons empty, and those for 30 passengers about five or six tons. The cost of the former are given as varying from £800 to £1,000 complete. They replace smaller cars weighing 3½ to 4 tons each, and costing from £200 to £280, so that the excess in weight to be really taken into account is from 3½ to 4 tons, and the extra cost from £600 to £720 per car. The smaller electric cars, with a seating capacity for 28 to 32 passengers, cost about £600 to £700 each complete, of which £450 to £480 represents the electrical equipment over and above what an ordinary horse-car would require.

Speaking generally, an allowance of 25 per cent. in the number of cars must be made by way of reserve stock and cars under repair, so that the outlay for the large cars will vary from £720 to £800 per car in service.

The total expenditure may now be summarised thus:

Overhead line: £1,300 to £2,000 per mile of line.
Underground line: about £6,000 per mile of line.
Fixed plant and rolling-stock: from £1,450 to £1,600 per car in service.

From these data the author prepares a simple table to show comparison between the overhead and underground, or conduit system; assuming the cost of rolling-stock, fixed plant, and material at, say, £1,520 per car in service, he obtains the following results, which may be left in francs and kilometres as they merely give comparisons:

PER CAR IN SERVICE.

	Cost of line			Total cost		
	1 car per km.	2 cars per km.	3 cars per km.	1 car per km.	2 cars per km.	3 cars per km.
Overhead	25,000	12,500	8,300	63,000	50,500	46,300
Conduit	100,000	50,000	33,000	138,000	88,000	71,000

In support of the figures herein quoted, the sums expended on the Marseilles-St. Louis Electric Tramway on the overhead system, are set forth; this line has a length of nearly four miles, and was erected by Messrs. Sautter and Harlé:

Permanent way		£14,400
Overhead system, etc.		10,000
Buildings	£3,400	
Fixed plant, etc.	7,800	
		11,200
Eighteen cars, complete		14,560
Offices, etc.		5,800
Miscellaneous		1,840
Total		£57,800

or about £15,000 per mile, and £3,200 per motor car.

The line at Brussels, running from the Place Roupe to La Petite Espinette, with a length of 6¼ miles (rather less than one quarter of which is double track) cost about £2,750 per car in service, or £4,500 per mile. The number of cars usually employed is about 10; the company owns 12 cars, two being in reserve. These cost in all £10,560, and have seating capacity for 35 passengers. The electrical plant cost £16,960, so that the entire outlay was £27,520.

(To be continued.)

EFFICIENCY OF DIRECT-CURRENT MOTORS.

Writing in the *Electrotechnische Zeitschrift*, Mr. A. Müller, Vienna, deals with the subject of calculating the power given off by direct-current motors. He states that the direct experimental determination of the performance of an electric motor necessitates the use of the Prony brake or of another form of measuring the work done by the machine. When we have such an appliance and the ordinary current and pressure meters at our disposal, we can ascertain by means of direct tests the relation between the mechanical energy given off and the electrical energy conveyed to the motor—that is to say, the efficiency for different loads. When that has been done we can, by means of tabular or graphically arranged results of tests, read off the electrical energy to be employed for a given load, and at constant pressure the current strength. The use of the Prony brake, the author states, means a loss of time, and, particularly with large motors, it is costly. With a view to to overcome these disadvantages, Mr. Müller cites the following indirect method of determining the mechanical work performed. When running without a load, we regulate the pressure at the terminals of the motor so that the latter runs at its normal speed. Thereupon we measure the necessary pressure and current required to maintain the motor at this speed. From the products of both we deduct the calculated loss in watts from the ohmic resistance of the armature, and we thereby obtain that particular work at no load which corresponds to the hysteresis of the armature iron, eddy currents bearing friction, and air resistance. The author then gives mathematical examples of this method, which he concludes yields more reliable results than the employment of the Prony brake.

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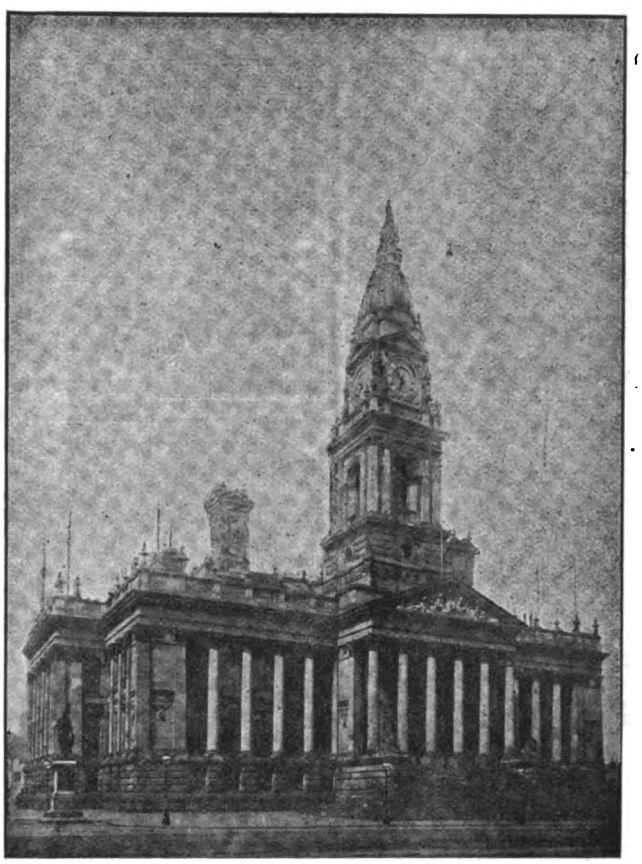
THE ELECTRICITY WORKS AT BOLTON.

General Remarks.

When one hears the name of Bolton, his mind always runs towards the manufacture of cotton, for is not this the staple trade of the town, where it has existed for several centuries. Its manufacture is, however, not of so ancient a character as that of woollen goods, which date back at least 700 years ago. Bolton is not Manchester, but through the inventions of Richard Arkwright and Samuel Crompton, it has largely—very largely—contributed towards the development of cotton manufacture in Lancashire. It is, however, not only for cotton spinning and manufacture that the town is celebrated, but engineering works and machine-constructing shops, together with bleaching and dyeing works, and iron and steel production, have made the town famous. The town has a population of some 116,000 persons, and its cotton manufactures and engineering and machine productions are to be found in all parts of the world.



BOLTON TOWN HALL.

The members of the Corporation are progressive, and they believe in concentration and municipalisation. In 1850 the authority of the Corporation was consolidated, and in 1864 an Act was obtained authorising extensions in the water supply and the provision of a public park and town hall. Bolton Park was opened in 1866, and the handsome Town Hall, of which a view is annexed, was inaugurated by the Prince and Princess of Wales in 1873. Not content with dealing with the water supply of the town, the Corporation in 1872 acquired the undertaking of the Bolton Gas Company. Sewerage works have been constructed at Burnden, and many important street improvements have been carried out. The town is provided with a market hall, wholesale market, free library, and an important technical school, whilst 17 miles of tramways, owned by the Corporation and leased to a company, are laid in the town and adjacent districts.

Another important step was taken when the Corporation, resolving to keep abreast of the times and not to be behind other corporate bodies, decided to municipalise the supply of the electric light, and the works for this purpose are now being set in operation. It will be subsequently seen that a new departure has been made, in so far that the capital outlay on the works has as far as possible been restricted to local firms. In fact, it is doubtful whether there is another town in the country where so much money has been spent locally on an enterprise of this character. However that may be, the Bolton Corporation were well advised in resolving to institute municipal electric light works, and were fortunate in securing Mr. John H. Rider, M.I E.E., as their electrical engineer.

As far as the adopted system is concerned there seems to be little that is novel, the method being high-pressure generation and low-pressure distribution on the three-wire system. It is, however, in the details which have been carefully thought out by Mr. Rider that some interesting and new features are to be found. As, however, these points will be considered further on, we may as well pass on to consider the early steps taken with a view to the introduction of a public supply of electricity. Why, it may be asked, should the Bolton Corporation establish electric light works? Let us see.

Preliminary Steps in Electric Lighting.

The Gas Committee of the Corporation in June, 1889, appointed a sub-committee to consider the subject of electric lighting, and subsequently notices were received from several companies intimating their intention to apply for parliamentary powers for the supply of electricity in the borough. As a result, it was determined, in view of the possibility of the Corporation themselves undertaking such a supply, to oppose the acquisition of powers for this purpose by any outside company, a fact upon which the Corporation are to be congratulated. In May of the following year, after obtaining information as to the action taken in the matter by other important municipalities, the Corporation decided to apply for a provisional order. A provisional order for this purpose was obtained, and this was confirmed by the Electric Lighting Orders Confirmation (No. 1) Act, 1891.

Consequent upon thus securing the requisite powers, the Gas and Lighting Committee, in November, 1891, appointed a sub-committee to carry them out. This sub-committee consisted of Alderman Miles (chairman), Alderman Broughton (vice-chairman), and Councillors W. Cooper, Finney, Tootill, Horridge, and Horrocks.

The first report of this sub-committee, presented in May of the following year, detailed the information sought and obtained by them on the subject, and recommended that contractors should be invited to furnish the Corporation with specifications and tenders for the installation; the generating station to be erected on land belonging to the Corporation in Spa-road; the area of supply in the first instance to be the compulsory area prescribed by the provisional order, but regard to be had to such further extensions as might be required to any other part of the borough. As a result, specifications and tenders were received from six firms, with estimates of the cost of the necessary plant, each firm recommending a system to be introduced. The sub-committee then visited towns where the systems recommended were to be seen in operation, but before coming to a final decision they appointed Mr. J. H. Rider as electrical engineer, and requested him to examine the specifications and advise the Corporation thereon. A report was then presented setting forth the conclusions of the sub-committee, and recommending the adoption of the alternating-current high-pressure system

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with transformers, the engineer submitting a scheme for that purpose.

This report was approved by the Council, and the town clerk was directed to apply to the Local Government Board for permission to borrow £40,000 for electric lighting purposes. A Local Government Board enquiry into the matter took place on August 2, 1893. The detailed estimate of cost submitted at the enquiry showed that for initial requirements the sum of £22,695 would be needed, and that for prospective requirements further amounts would be necessary making a total of £41,650.

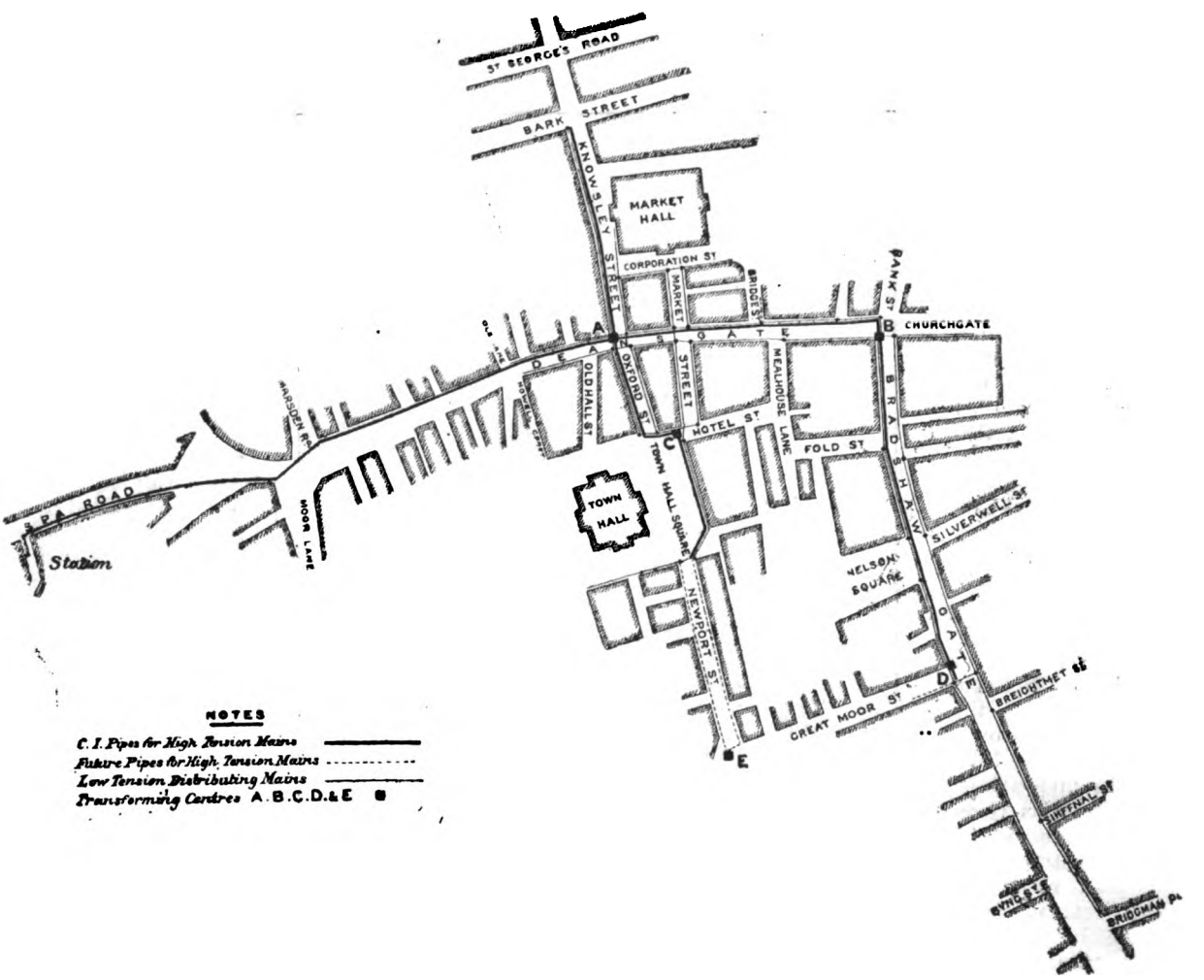
The sanction of the Local Government Board for the borrowing of £22,700 was given on October 6 of last year. This amount was allowed for the initial installation, leaving the Corporation to apply for further sanction when necessity arose. Messrs. Hinnell and Murphy, of Bolton, were appointed architects for the erection of the generating station buildings, and plans submitted by them having been approved of, tenders for the erection of the buildings were invited. Tenders were received both from firms within and outside the borough. As, however, the Corporation considered it desirable to entrust the work to ratepayers, and as the complete tenders received from those in the borough were not satisfactory, it was decided to obtain separate tenders for the various kinds of work. Finally, the work was let in the following contracts with Bolton tradesmen :

Excavating and concreting, Mr. G. S. Goodlad	£440	0	0
Bricklayer's work, Mr. Jas. Bradbury	2,058	5	0
Stonework, Messrs. Gregson and Smith	2,060	0	0
Carpentry and joinery work, Messrs. W. Burrow and Son	1,045	0	0
Slaters' work, Messrs. Warr and Co.	124	0	0
Plumbers' work, Messrs. Rd. Cuerden and Son	99	6	1
Painter and plasterer's work, Mr. Henry Critchley ..	96	0	0

It was contemplated, in accepting the above tenders, that the carrying out of some portion of the work as designed should be deferred, but it having since been determined to complete the buildings, an additional further outlay beyond the above sum has been incurred, amounting to about £1,000.

The contracts for the steam and electrical plant, according to the plans and specifications of Mr. J. H. Rider, were placed with the following firms :

Steam-engines and crane, Messrs. J. and E. Wood, Bolton	£2,113	10	0
Boilers, pipes, pumps, etc., Messrs. Hick, Hargreaves, and Co., Limited, Bolton	3,525	0	0
Alternators, dynamos, and transformers, Brush Electrical Engineering Company, Limited, London ...	2,808	5	6
High and low tension cables, Messrs. Siemens Bros. and Co., Limited, London	2,645	0	0
Switchboards, Manchester Edison-Swan Company, Limited, Manchester.....	930	0	0
Accumulators, Crompton-Howell Company, Limited, London.....	231	12	0
Cast-iron pipes, Staveley Iron Company, Limited ...	247	10	0
Transformer-chambers, Mr. W. Pollitt, Bolton	258	4	0



Bolton.—Map showing District Supplied.

The work of erection was commenced under the general supervision of Mr. Rider, with Mr. D. Lee as clerk of works, and on December 13, 1893, the chairman of the committee (Mr. Alderman Miles, J.P.) laid the memorial-stone in commemoration of the commencement of the buildings the Mayor (Mr. Alderman Nicholson, J.P.) presenting to him for the purpose of the ceremony a silver trowel, the gift of the members of the committee, and the architects a mallet. During the progress of the work several enquiries came for electric light outside the compulsory area, and the committee therefore decided to extend the mains into Corporation-street, Newport-street, and Mawdsley-street. An additional transforming-chamber has also been provided at the junction of Newport-street with Great Moor-street.

The System Adopted.

The scope and features of the undertaking as already carried out, and in prospect, are more fully detailed in the following particulars. The electricity works have been designed with a view to ultimately supply the whole of the borough, although at the present time mains are

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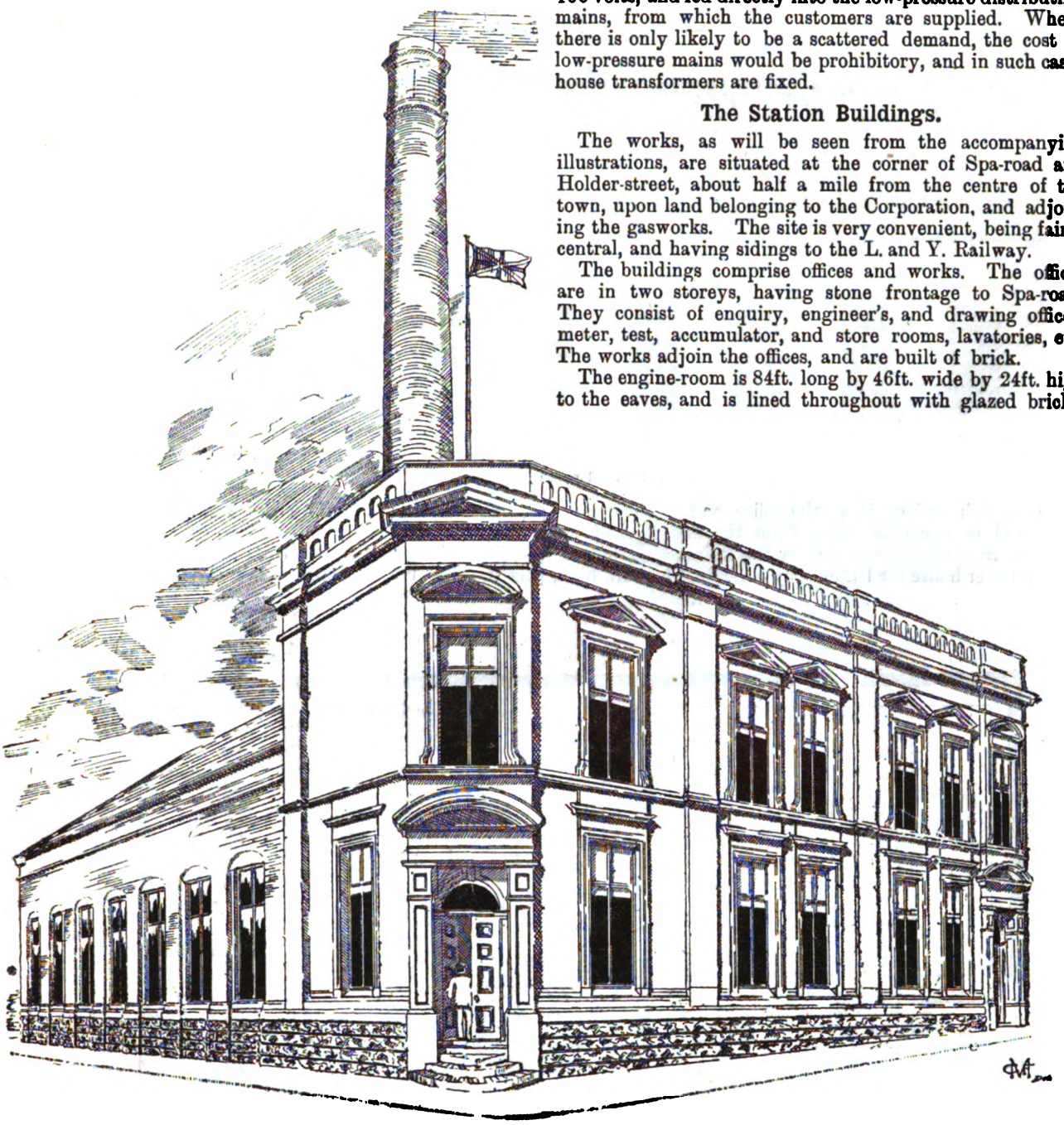
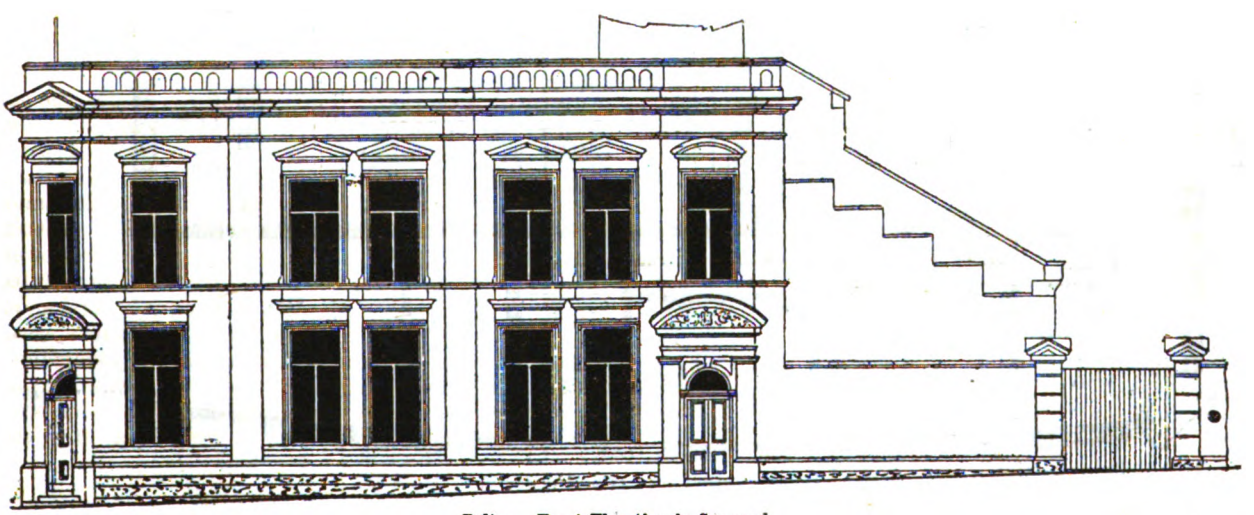
only laid in the centre of the town, as indicated in the annexed map.



Bolton.—External View of Station Buildings.



Bolton.—Front Elevation in Spa-road.

The system adopted may be briefly described as follows: An alternating current of 2,000 volts pressure is generated at the works, and sent through separate feeder cables to transformer sub-stations. Here it is transformed down to 100 volts, and fed directly into the low-pressure distributing mains, from which the customers are supplied. Where there is only likely to be a scattered demand, the cost of low-pressure mains would be prohibitory, and in such cases house transformers are fixed.

The Station Buildings.

The works, as will be seen from the accompanying illustrations, are situated at the corner of Spa-road and Holder-street, about half a mile from the centre of the town, upon land belonging to the Corporation, and adjoining the gasworks. The site is very convenient, being fairly central, and having sidings to the L. and Y. Railway.

The buildings comprise offices and works. The offices are in two storeys, having stone frontage to Spa-road. They consist of enquiry, engineer's, and drawing offices, meter, test, accumulator, and store rooms, lavatories, etc. The works adjoin the offices, and are built of brick.

The engine-room is 84ft. long by 46ft. wide by 24ft. high to the eaves, and is lined throughout with glazed bricks. The roof is of varnished pitch-pine, and the floor is laid with wood blocks. It will be observed that ample room

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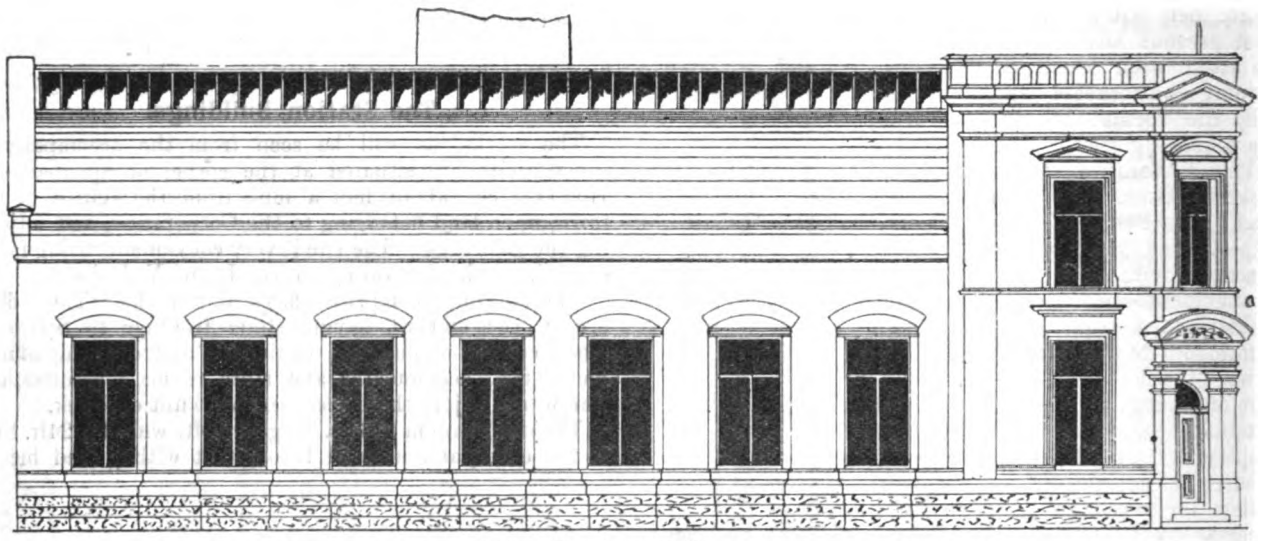
is provided for any extensions of the machinery which may be required, whilst at the same time there is space available for further extensions of the buildings.

mounted by an ornamental cap of terra-cotta. Facing the boilers is a row of bunkers, into which the fuel is shot from the yard overhead.



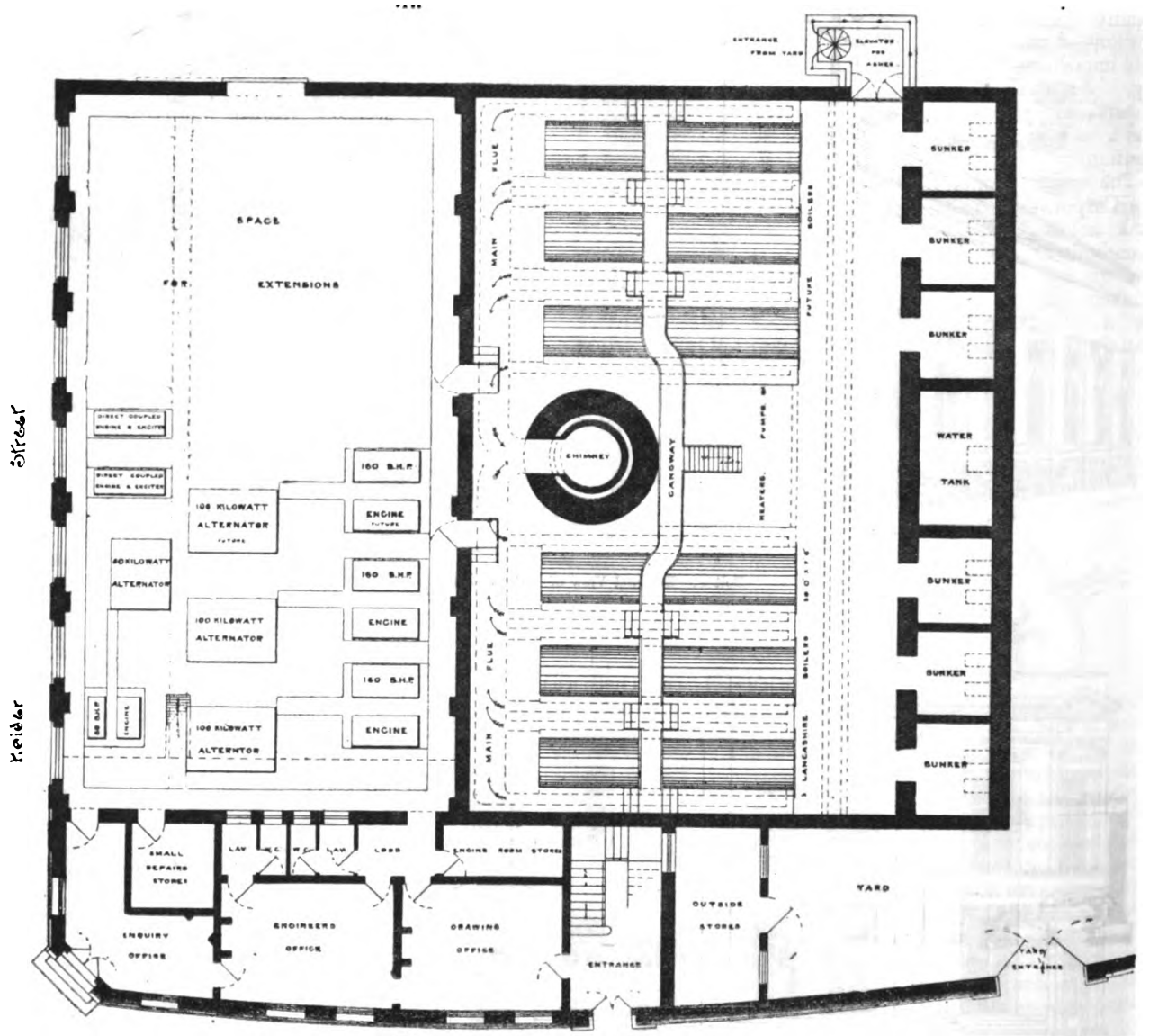
Bolton.—Elevation in Holder-street.

The switch gallery is at the office end of the engine-room, and is accessible either from the first floor of the offices or from the engine-room by the staircase, as shown.

The boiler-house is 84ft. long by 50ft. wide by 32ft. high,

The Boilers.

Three boilers, of the Lancashire type, are at present fixed, although accommodation is provided for another



Bolton.—Ground Floor Plan of Electricity Works.

and lies parallel with the engine-room, but some 6ft. below its level. The chimney is built within the boiler-house, there being space for three boilers on either side. The chimney is 158ft. high from flue bottom, and is sur-

battery of three boilers, as shown. The boilers have been made by Messrs. Hick, Hargreaves, and Co., Limited, of Bolton, and are 30ft. long by 7ft. 6in. diameter. Each boiler has two internal flues, 3ft. diameter,

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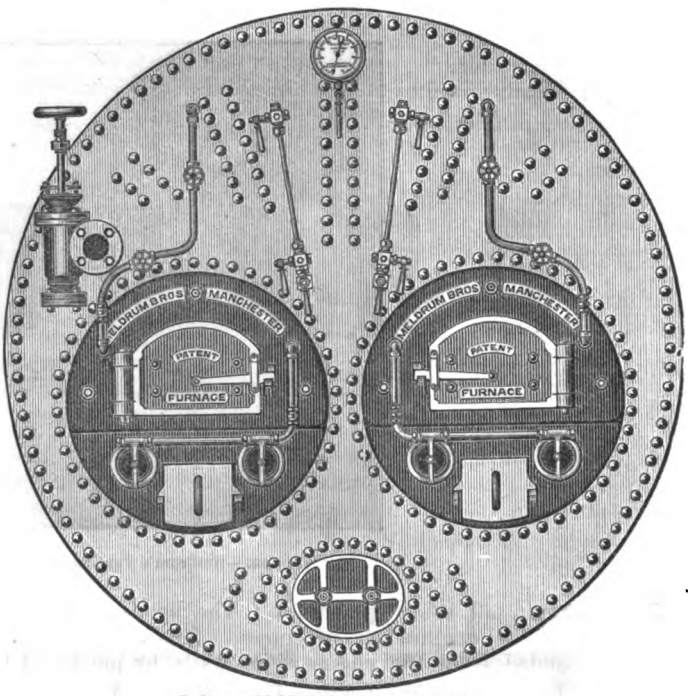
with five Galloway tubes in each. The boiler mountings throughout are by Messrs. Hopkinson, of Huddersfield. The boilers are of steel, and are made for a working pressure of 120lb. per square inch. Hand firing is at present adopted, and the furnaces are fitted with Meldrum's furnace for burning coke breeze, and other waste fuel, the former being obtained from the adjoining gasworks.

This system, which is due to Messrs. Meldrum Bros., of Atlantic Works, City-road, Manchester, is based upon the employment of forced draught in con junction with firing by hand. The arrangement not only allows of the utilisation of cheap fuels of the kinds mentioned, but it also permits of the power of the boilers being increased in case of emergency to much beyond that obtainable where natural draught is employed. This fact, the makers show, renders it possible to put down fewer boilers for meeting the maximum load, whereas additional boiler power is required to cope with this particular load where this method has not been introduced. Another feature of this kind of furnace is that in the emergency of a fog or other sudden demand for steam, the furnaces are capable of rapidly increasing the rate of combustion—a matter which is of considerable importance in central-station working. Annexed are illustrations of Messrs. Meldrum's Lancashire boilers and a back view showing the blowers in position.

The water supply is obtained from the Corporation mains, and a storage tank holding about 5,000 gallons has been built in the position indicated on the ground floor plan between the bunkers. From this the water is drawn by a Worthington vertical marine-pattern pump, provided by the Worthington Pumping Engine Company, of Queen Victoria-street, E.C., and fed into the boilers through a Berryman exhaust steam heater. The arrangements for feeding the water, as shown on the elevation of the boilers, have been duplicated throughout.

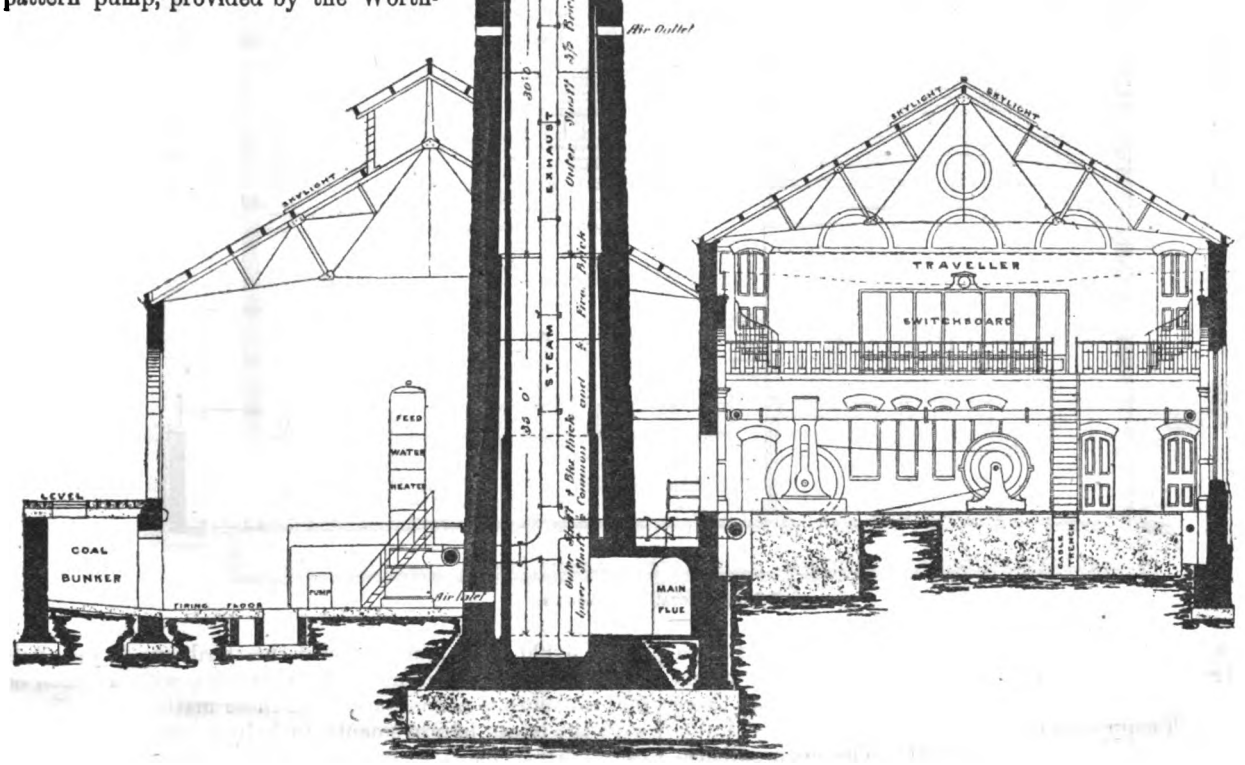
The Steam-Engines.

The main engines are three in number, by Messrs. J. and E. Wood, of Bolton. They are of the compound vertical type, having the novel feature, at least for central-station work, of grooved flywheels between the cylinders.



Bolton.—Meldrum's Lancashire Boiler.

The two larger engines are for 160 b.h.p., having cylinders 13in. and 21in. diameter and 15in. stroke, and run at 180 revolutions per minute. The smaller engine is for 80 b.h.p., having cylinders 10in. and 15in. diameter and 12in. stroke, and runs at 220 revolutions per minute.



Bolton.—Cross-section through Boiler-house and Engine-room

Both high and low pressure cylinders are fitted with expansion valves, those on the high-pressure cylinders being controlled directly by the governors. The governors

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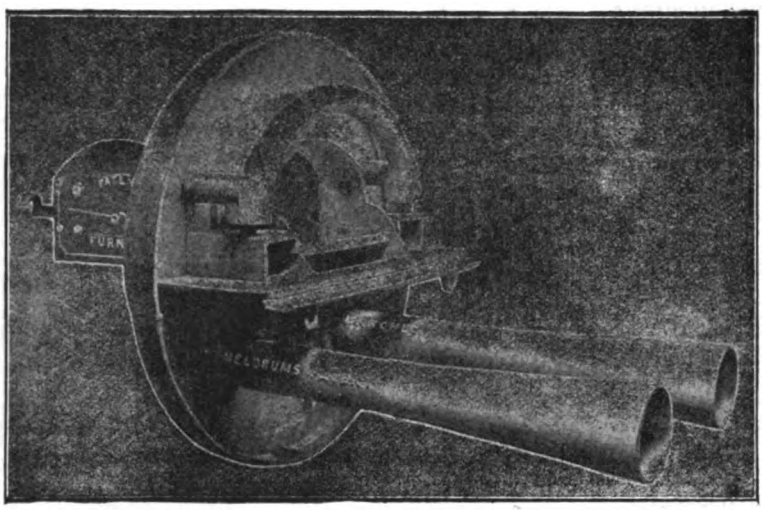
are driven by wheel gearing, and are adjustable while running. In addition to these engines, there are two small vertical engines of 15 b.h.p., by Messrs. Robey and Co., Limited, of Lincoln, these being coupled direct to the exciters.

The steam-pipes, as shown in the general arrangement of steam mains, are in the form of a ring main, and are of wrought iron with wrought-iron flanges. The main ring is 9in. diameter, and the supply pipes from the boilers are heaters, as desired. This arrangement will be evident from the plan of steam and feed pipes. The whole of the pipe work, including pumps and heater, has been supplied and erected by Messrs. Hick, Hargreaves, and Co., Limited.

We must not omit to mention that the engine-room is equipped with an overhead traveller, having a span of 46ft., and supplied by Messrs. J. and E. Wood, of Bolton the makers of the engines. The traveller is worked by hand, and arranged for both slow and fast speeds.

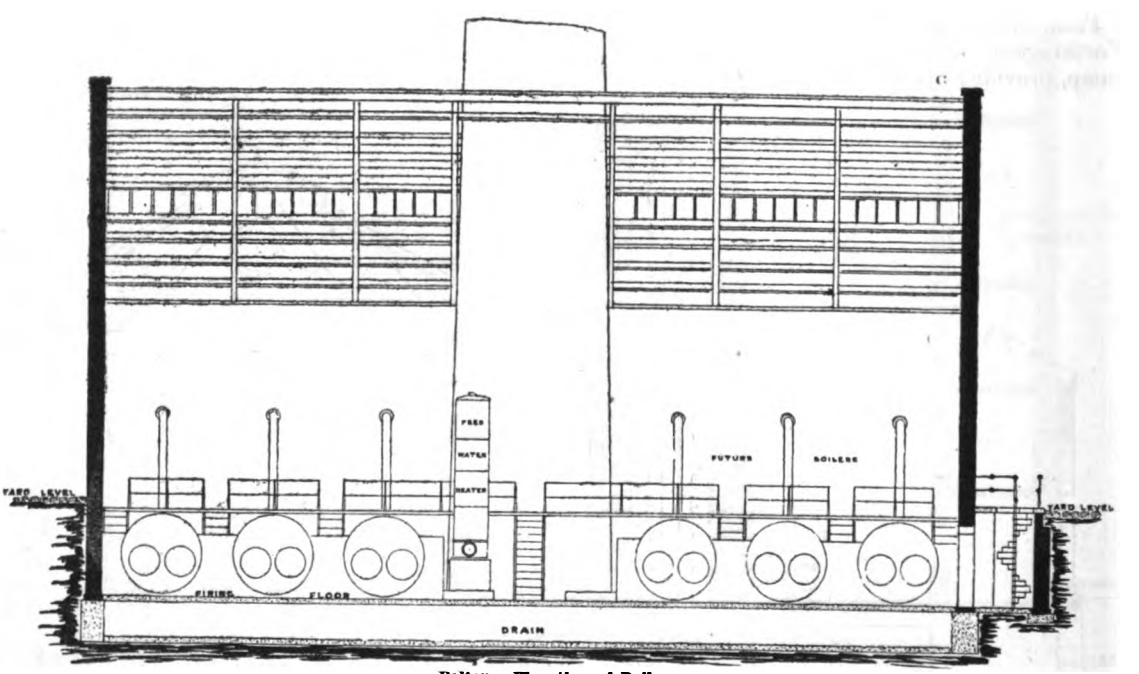


Bolton.—Meldrum's Furnace. Back View, Showing Blowers in Position

7in. diameter, all being $\frac{3}{8}$in. thick. The bends and the branches to the engines are of copper. The steam-pipes are suspended from the engine-room walls by means of brackets and rods, so as to allow freedom for expansion. McDougall separators are fixed in each branch, and by means of Hopkinson's parallel slide valves any section of the main ring may be cut out. The pipes are drained through a McDougall steam-trap into the water-tank. Hopkinson's back-pressure or "isolating" valves are fixed in the branches from the boilers.

The Alternators and Exciters.

At present only three alternators are installed, but in the ground floor plan a fourth machine and engine are shown. These will, of course, be put in as occasion arises. The three alternators are of the Mordey Victoria type supplied by the Brush Electrical Engineering Company, Limited. Two of these machines are of the 100-kilowatt size, capable of giving 50 amperes at 2,000 volts, with a speed of 430 revolutions per minute, sufficient to light



Bolton.—Elevation of Boilers.

The exhaust-pipes are of cast iron, and vary in size from 4in. to 18in. diameter. They are laid in a trench round the engine-room. The engines exhaust directly into these pipes through copper bends and cut-off valves. The drains from the engines are also connected. The main exhaust-pipe is 18in. diameter, and is carried, as will be observed from the cross-section of boiler and engine house, to a height of about 85ft. inside the chimney. It is supported by means of collars and radial rods. The exhaust steam may be led directly into the chimney or round by the feed-water

about 3,500 8-c.p. lamps; whilst the third one is just half the size, giving 25 amperes at 2,000 volts, with a speed of 600 revolutions per minute. All these machines are fitted with the latest improvements, including continuous lubricating arrangements, and are driven from the engine flywheels by cotton ropes, the larger ones by 10 of $1\frac{1}{4}$in. diameter, and the smaller one by eight of 1in. diameter. The alternators are mounted on strong slide rails, fitted with tightening screws and ratchet levers, so that the ropes may be readily tightened whilst running. The armatures

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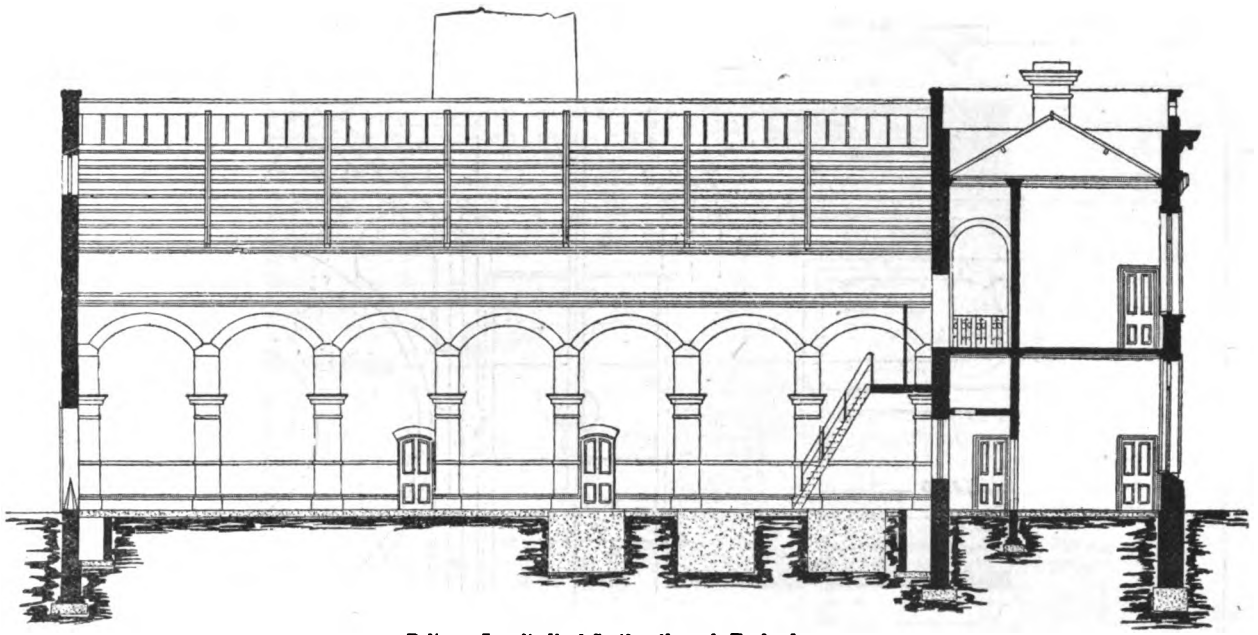
are so arranged that any defective coil can be replaced in a few minutes, each coil, in fact, being independently held, and the machines work perfectly in parallel at any load.

with the Brush Company's improved brush-holders, and with automatic lubrication in the form of chains running in baths of oil formed in the pedestals of the bearings.

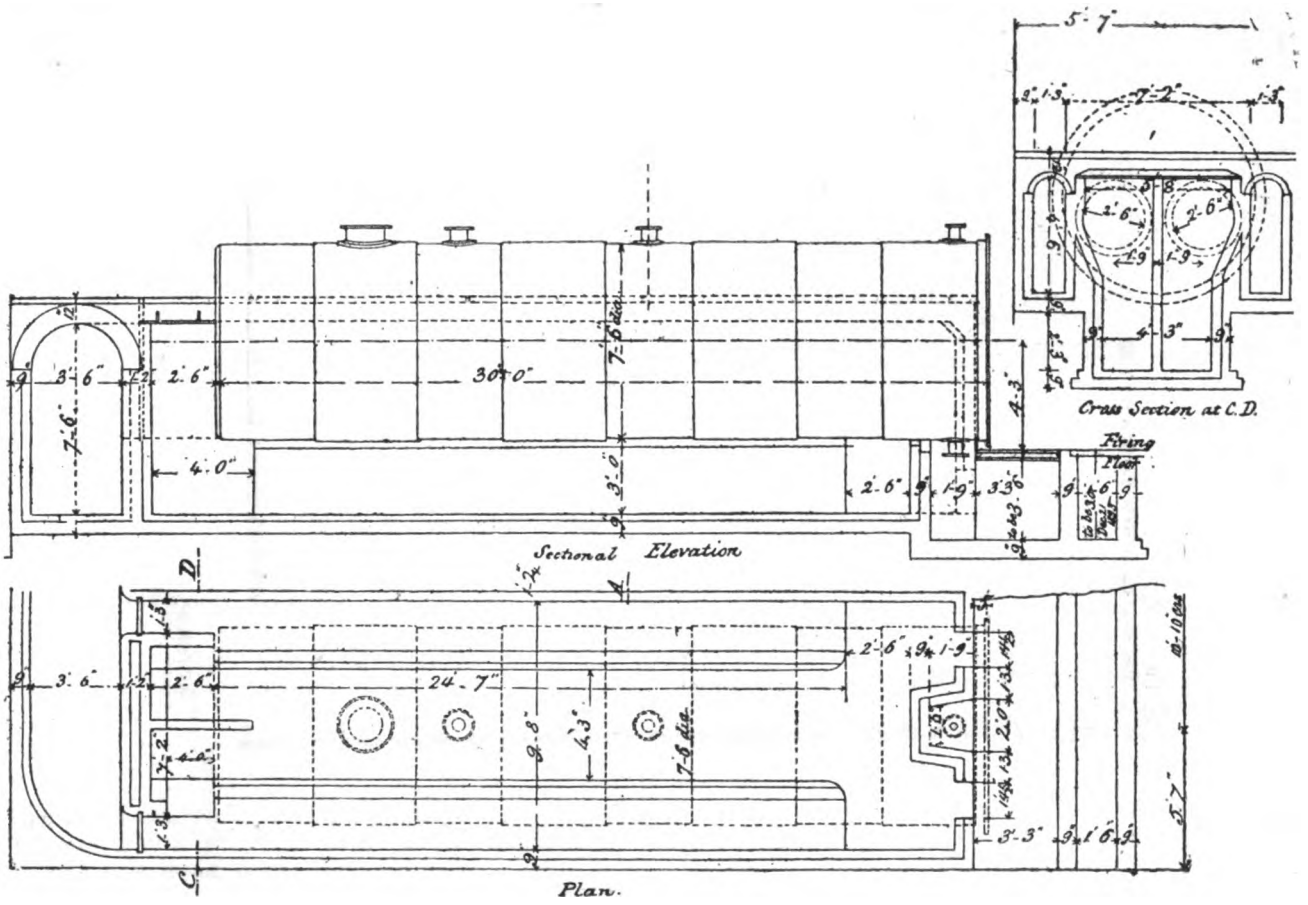
In addition to the exciters, a set of 55 Crompton-Howell



Bolton.—Longitudinal Section through Engine-house

The excitation of the alternators is effected by two Brush-Falcon two-pole dynamos, also supplied by the Brush Company. Each exciter is mounted on a combined bedplate with, as already mentioned, a Robey engine, and designed to run at 270 revolutions per minute. Each exciter is capable of giving 90 amperes

accumulators, supplied by the Crompton-Howell Electrical Storage Company, Limited, of Mansion House-buildings, London, E.C., has been erected. These are of 360 ampere-hour capacity, and may be discharged at any rate up to 130 amperes. The cells are intended for exciting during times of light load, and also to act as a "stand-by." They



Bolton.—Plan, Section, and Elevation of Boiler

at 100 volts, or 70 amperes at 130 volts—in the latter case for charging cells. This output is considerably more than sufficient for the excitation of the whole of the alternators at present installed. These machines have drum armatures, and the fields are shunt wound, being provided with large regulating resistances. They are fitted

are charged from the exciting omnibus bars by raising the pressure of the exciters when required.

The Switchboard Arrangements.

The mains from the various machines are run in a passage under the engine-room floor to the switchboard.

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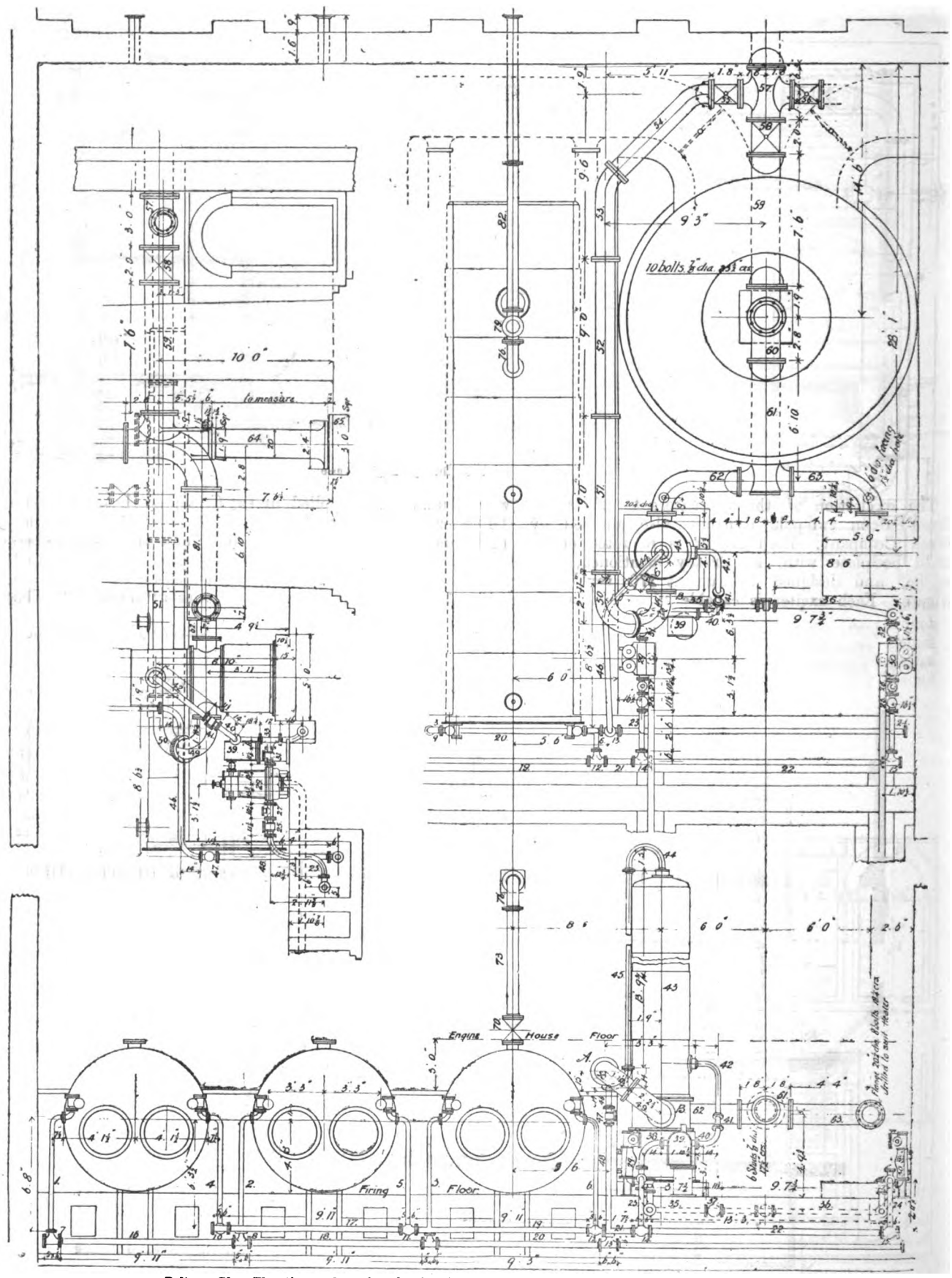
This arrangement, which is illustrated in the cross-section of the engine-house, is very convenient, all the mains being readily accessible at any time. The switchboards, as will be seen from the plan of the first floor, is erected upon a switch gallery, and has been constructed by the Manchester Edison-Swan Company, Limited.



Bolton.—Plan, Elevation, and Section showing Arrangement of Steam and Feed Pipes in Boiler-house.

The general arrangement of the switchboard is represented in the subjoined elevation of the board, whilst the connections are shown diagrammatically. There are six enamelled slate panels, and apparatus is provided for four feeder circuits, two exciters, and one set of accumulators, four alternators, and for synchronising, the board being arranged for extension in either direction. The exciter panel, shown in the centre of the board, carries, for the two exciting dynamos and set of accumulators, two ammeters, two voltmeters, one alternating-current voltmeter, and two double-pole exciter field switches. The two feeder panels, which are shown on the right, contain, for the four feeder circuits, four alternating-current ammeters, four alternating-current voltmeters, four double-pole fault

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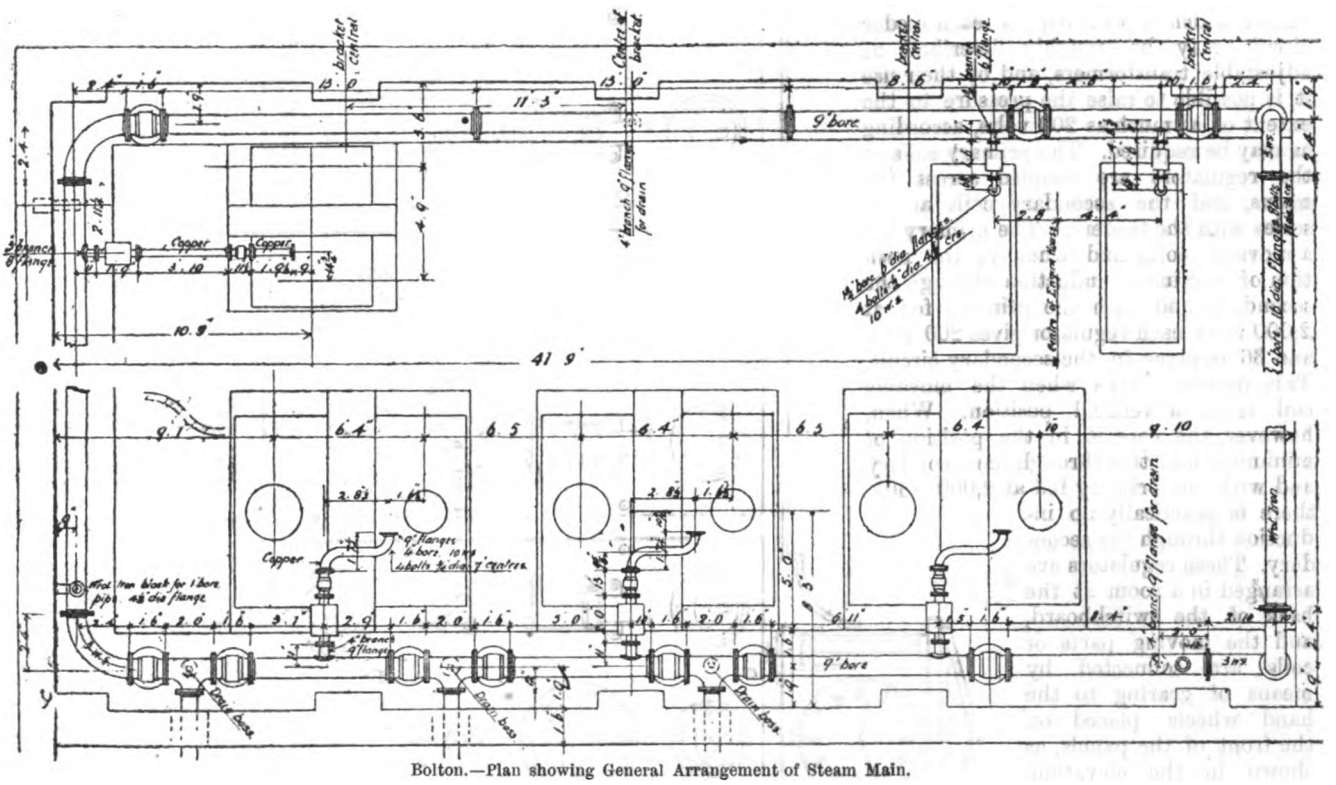
detectors, four feeder regulators, four double-pole feeder switches and fuses.

The two alternator panels for the four alternators are equipped with four alternating ammeters, four direct-current meters, four double-pole alternator field switches, four

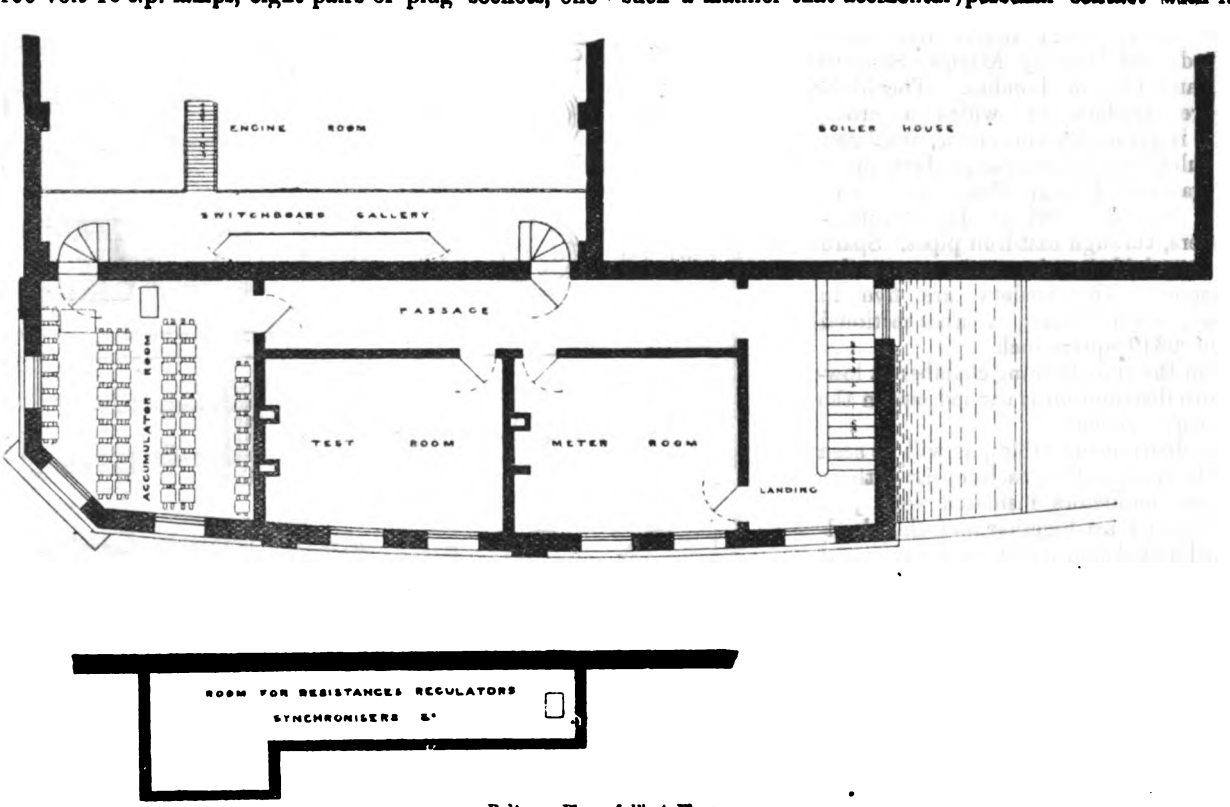


Bolton.—Plan showing General Arrangement of Steam Main.

circular resistance switches for the alternator fields, four double-pole alternator switches, and fuses. To the left is shown the synchronising panel, which carries three alternating-current voltmeters, two bayonet-jointed lamp sockets for 100 volt 16-c.p. lamps, eight pairs of plug sockets, one

meters in the testroom on their way to the switchboard. Pilot wires are run back from the transforming centres and connect to voltmeters on the switchboard, so that the attendant has an actual control over the pressure in any part of the system. The regulation of the station pressure as a whole is done by means of adjustable resistances in the exciter field.

A noteworthy feature of the switchboard is the fact that all apparatus carrying high-pressure current is protected in such a manner that accidental personal contact with it is



Bolton.—Plan of First Floor.

pair of plug cords with plugs, two synchronisers, and two double-pole synchroniser switches. The ammeters are of the Nalder pattern, and the voltmeters are of the electrostatic type by Mr. White for low pressures, and by Messrs. Elliott Bros. for high voltages. The mains from the alternators are connected to Thomson-Houston registering watt-

impossible. For instance, when it is desired to close a circuit the switch is thrown back to the panel, the connection being formed in what may be termed a recessed slot or wedge arrangement in the panel. Similar recesses are provided for the fuse contacts.

An ingenious arrangement has been devised by Mr

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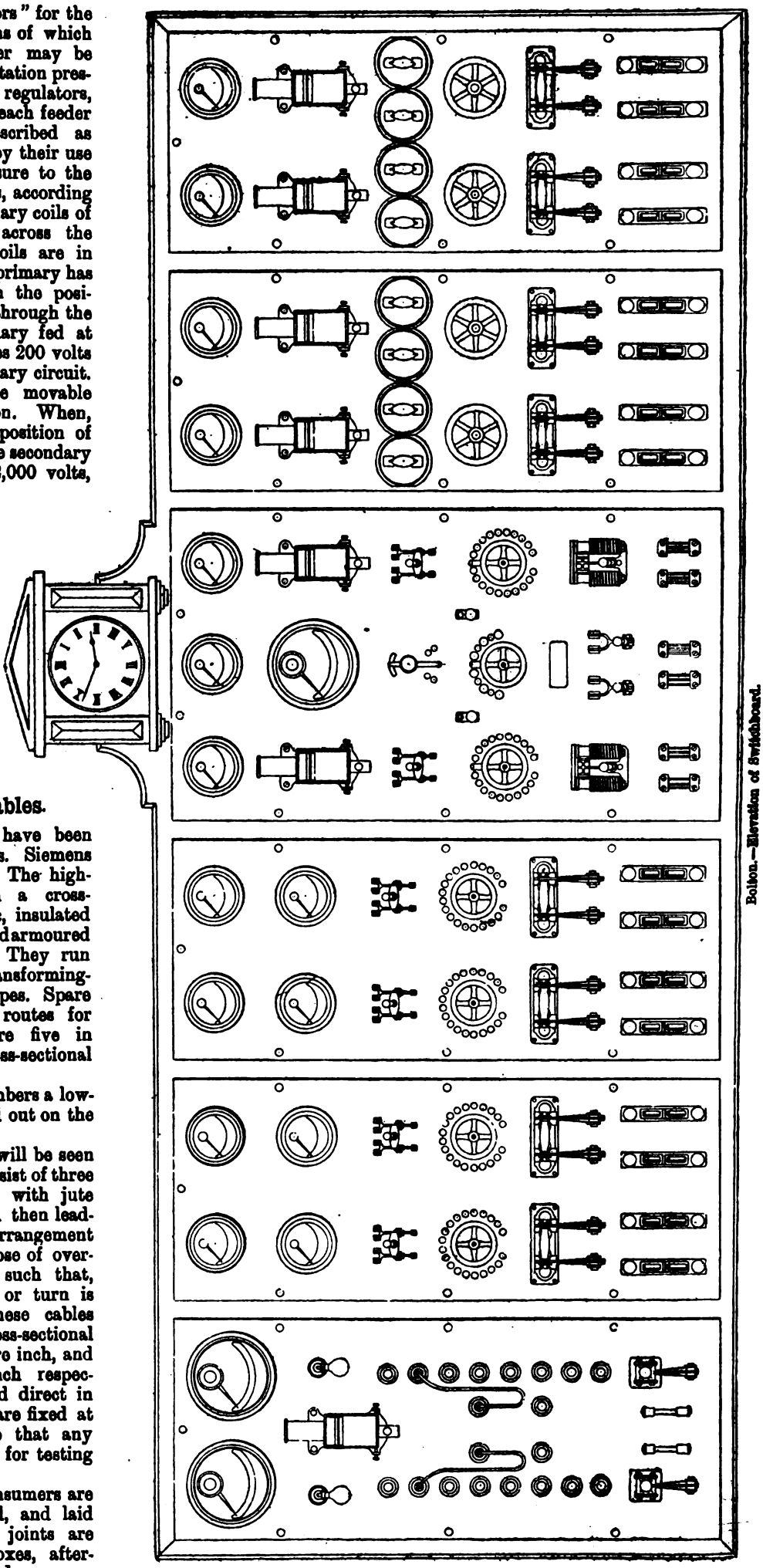
Rider in the way of "regulators" for the feeder circuits, and by means of which the pressure of either feeder may be independently regulated, the station pressure being unaltered. These regulators, one of which is provided for each feeder circuit, may be roughly described as adjustable transformers, and by their use it is possible to raise the pressure to the extent of as much as 200 volts, according as may be required. The primary coils of the regulators are coupled across the mains, and the secondary coils are in series with the feeders. The primary has a movable core, and when in the position of maximum induction through the secondary and with the primary fed at 2,000 volts, each regulator gives 200 volts and 36 amperes in the secondary circuit. This position exists when the movable coil is in a vertical position. When, however, the core is in the position of minimum induction through the secondary and with the primary fed at 2,000 volts, there is practically no induction through the secondary. These regulators are arranged in a room at the back of the switchboard, and the moving parts or coils are connected by means of gearing to the hand wheels placed on the front of the panels, as shown in the elevation. Each regulator is provided with double-pole high-pressure fuses in the primary circuit.



Bolton.—Elevation of Switchboard.

The Underground Cables.

The underground mains have been supplied and laid by Messrs. Siemens Bros. and Co., of London. The high-pressure feeders, of which a cross-section is given, are concentric, insulated with vulcanised indiarubber, and armoured with galvanised steel wires. They run direct to the various transforming-chambers, through cast-iron pipes. Spare pipes are laid in the main routes for extensions. The feeders are five in number, each having a cross-sectional area of ·0349 square inch.

From the transforming-chambers a low-pressure distribution is carried out on the three-wire system.

The distributing cables, as will be seen from the cross-section, each consist of three separate conductors, insulated with jute fibre, twisted up together and then lead-covered and armoured. This arrangement of each strand for the purpose of overcoming inductive effects is such that, practically, a complete twist or turn is made about every 12in. These cables are of two sizes, having cross-sectional areas of ·125, ·0625, ·125 square inch, and ·0625, ·035, ·0625 square inch respectively. These cables are laid direct in the ground. Junction-boxes are fixed at the points of intersection, so that any length may be readily isolated for testing or repairs.

The service wires to the consumers are twin rubber cables, armoured, and laid direct in the ground. The joints are made in special cast-iron boxes, afterwards filled up with compound.

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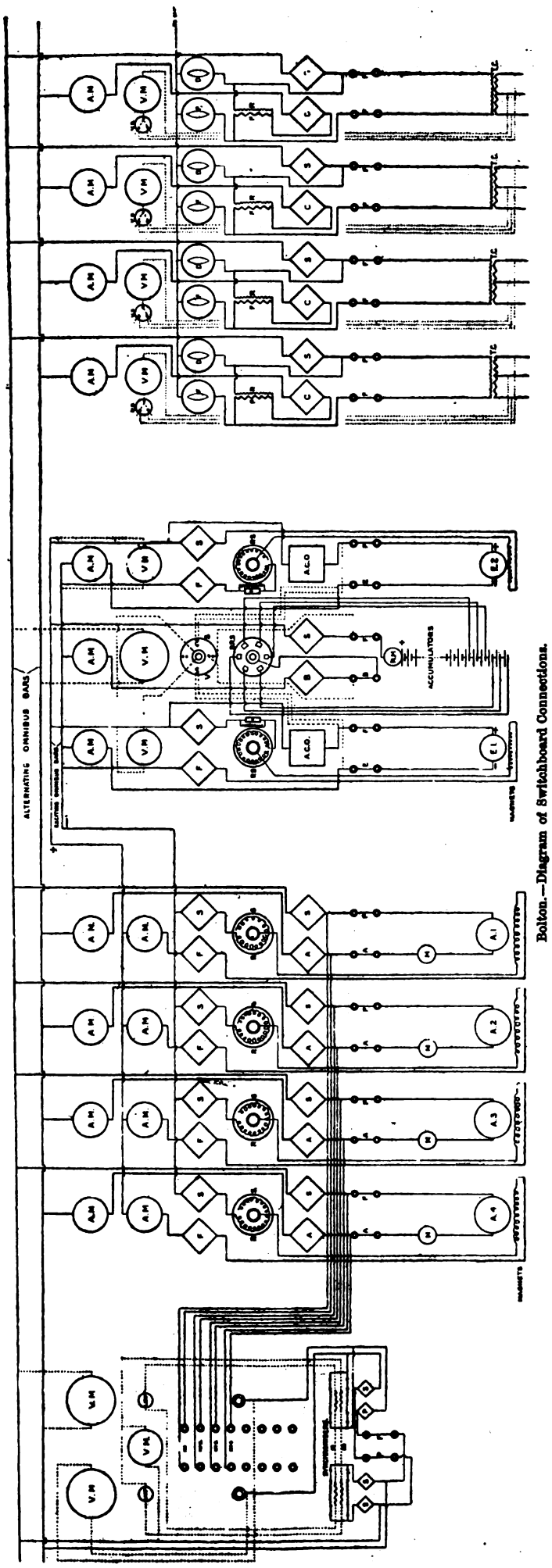

Bolton.—Diagram of Switchboard Connections.

Transformer-Chambers.

The transforming-chambers are built of brick, and are placed in convenient centres under the footpaths, as shown on the map of district supplied. Five chambers are at present constructed, each being 6ft. square and 6ft. high inside. The walls are lined with white glazed brick, and access is gained by means of a double pavement cover. Each chamber will eventually contain five 18-kilowatt transformers, but not more than two are at present fixed in each. High and low pressure switches are provided for each transformer, and the various distributing mains connect through fuses to omnibus bars.

Eight transformers are at present placed in the various chambers. These are by the Brush Electrical Engineering Company, Limited, and are of the 18-kilowatt size, as shown in the illustration. The primaries are for 2,000 volts, and the secondaries for 200 volts, with a middle connection for the three-wire system. The transformers, which have earthed shields between the primary and secondary winding, are fixed in cast-iron cases, which also contain double-pole high-pressure switches and fuses. The low-pressure wires are carried to special switch and fuse boards, where they connect to the distributing network. The arrangement of the low-pressure switchboard is represented in the annexed illustration.

Private Lighting.

Distributing mains have been laid in the following streets—viz., Knowsley-street, Deansgate, Churchgate, Bradshawgate, Oxford-street, Market-street, Town Hall-square, Corporation-street, and Newport-street. Up to the present there have been 35 applications for current in these streets, with a demand equivalent to 3,500 lamps of 8 c.p. Several enquiries have also been received from persons in the main thoroughfares of the town outside the above streets, and immediately a sufficient demand arises mains will be forthwith laid, and additional plant put down to meet it.

Public Lighting.

As far as public lighting is concerned, nothing beyond the erection of an arc lamp in front of the Town Hall in Town Hall-square has been done. This is much to be regretted, for the characteristics of Bolton streets are such as to render advisable the introduction of a better system of lighting than that which at present obtains. Let the Gas and Electric Lighting Committee consider the matter, and bring up some recommendation on the subject before the Town Council. Surely, having sufficient confidence to establish electricity works, as indeed many other towns have done and are doing, Bolton will not be behind. the latter in lighting the main thoroughfares by means of arc lamps. Bolton sadly needs arc lamps, and, owning the gasworks, the Corporation should have no difficulty in deciding to replace gas by electricity. This transformation would brighten the central streets, assist the work of the police, remove the dulness from the town, and rejoice the hearts of the inhabitants.

As already stated, the electricity works of the Bolton Corporation have been designed by Mr. J. H. Rider, M.I.E.E., to whom we are much indebted for the information contained in the foregoing description. The execution of the work has been carried out under his superintendence, Messrs. Hinnell and Murphy have been the architects for the buildings, and Mr. D. Lee has been clerk of works. The undertaking has been under the direction of the Gas and Electric Lighting Committee of the Corporation, the members of which are:

ALDERMAN W. NICHOLSON, J.P., Mayor.
ALDERMAN JOHN MILES, J.P., Chairman.
ALDERMAN WM. BROUGHTON, Vice-Chairman.

COUNCILLORS:

W. BLEAKLEY.	J. HORROCKS.
W. COOPER, J.P.	E. KEARSLEY.
W. EDGE.	J. SHERRY, J.P.
J. FINNEY.	A. H. TAYLOR.
J. HOLT.	R. TOOTILL.
R. HORRIDGE.	

Mr. R. G. Hinnell is the town clerk, and at the request of the committee Mr. Alderman John Miles, J.P. (the chairman), started the supply of current last Wednesday.

(Continued on page 516.)

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

TO ADVERTISERS.

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BOUND VOLUMES.

Vol. XIII. of new series of "THE ELECTRICAL ENGINEER" *can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.*

MORE ELECTRIC TRACTION.

It is just about two years since the first steps were taken by the joint enterprise of the London Chamber of Commerce, the Tramways Institute, the Institution of Electrical Engineers, and other interests involved in the matter to obtain a full discussion by the proper authorities of the situation, both present and prospective, in which electric traction was placed, and everyone at all interested in the subject will remember the results of this enquiry without our needing to recall the circumstances. The road was, without any doubt, cleared in a most effective manner for the adequate promotion of electric street tramways, and the best proof of this lies in the fact that at once there were several projects brought into active vitality, with others ready to follow in rapid succession when the financial world should recover from the shocks it has experienced during the past five years.

There is now every appearance of similar facilities being rendered available for lines which partake more of the character of railways, inasmuch as they are confined to a large extent, if not altogether, to a separate and distinct route, being fenced off from other traffic, just as with an ordinary railroad, instead of using the public roads or highways as earthworks. A line of the type we have in view would resemble very much the Isle of Man electric tramway lately opened between Douglas and Laxey, which travels part of the way along high roads, and for the remainder upon a distinct route or roadway of its own. This is in essence a *light railway*; and it is in connection with such enterprises that we now have to notice with great approval the result of representations made to the Board of Trade. This Department—as will be seen in detail on referring to another page—has requested by circular the attendance of deputies from all the associations and interests concerned in light railway projects at a conference under the auspices of the Board of Trade, when the technical and other difficulties which at present appear to hinder their development may receive careful consideration, with a view to finding out what measures will give suitable relief.

For the purpose of discussing in a preliminary fashion the two chief points raised by the Board of Trade circular, and for appointing deputies to represent the Chamber at the conference, the London Chamber of Commerce has called a meeting of its Engineering and Electrical Trades' Sections, and we congratulate the Chamber on its promptness in dealing with the subject—a promptness which all others interested will probably imitate, if they cannot excel. We make no doubt that prominent and suitable members will be appointed to attend the conference; but it will be useless their doing so, or anyone else, if the entire proceedings are simply to end in resolutions only, of the type with which we have become perhaps too familiar—expressing unbounded approval of the better development of light railways, but not helping in any way to show how this can be achieved.

It would seem very clear that the conference now to be held can only be a first step, a preliminary dis-

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cussion at which the plan of action is to be unfolded, criticised, and decided upon. The points mentioned specifically in the Board of Trade circular are purely technical. They do not involve or introduce in any way the fundamental question of Government support, or contributions from local authorities, parish and county councils, for building and equipping these lines in different parts of the country. Yet it must be confessed that the political or national aspect of successful light railway developments has a primary importance, ranking above questions of gauge, working regulations, or even course of procedure in obtaining parliamentary powers. These are topics which probably even the Board of Trade would not care to discuss with finality, and we shall therefore be disappointed if at the proposed conference no suggestion is made for a full and complete examination into the whole subject, such as can best be done before a joint parliamentary committee, leading on to Government action and a special Bill.

If the Board of Trade itself cannot properly or fittingly make such a proposal, the delegates from the London Chamber of Commerce may well undertake the task. The success already mentioned which attended a similar course of action when electric street tramway development was in danger of strangulation, would prompt a repetition of the plan. Doubtless the Board of Trade would acquiesce, since not only the technical points might be brought out in all their fulness before such a joint committee, but the other topics of a semi-political or statecraft nature might also receive adequate consideration, and these are, as stated, of fundamental importance.

Turning to practical points, we need only express an ardent hope that some effective result will follow on this latest move; there are, we feel sure, large numbers of lines which might very advantageously be worked by means of electric traction, especially where power is cheap or can be stored easily. Again returning to the Manx tramway, its profitable results show clearly that a vast field lies open for light railways worked by electric motors: and if the question is asked why such a line should be possible in the Isle of Man, and not in England, the answer must be that the working conditions imposed by law and authority are different in the two islands. It remains now for the new movement to secure something even better than is possible for Manxland: we want a development of lines on the plan that has worked so favourably in Belgium, if (as we expect) it can be shown that equal scope and similar conditions exist in this country.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TWO-WIRE DISTRIBUTION.

SIR,—Please allow me to correct a slight error which has unfortunately crept into my letter in your last issue. The three lamps shown in the sketch should each be of 16 c.p. This is so obvious that it scarcely needs correcting, but it might possibly mislead some of our friends the beginners. With apologies for troubling you—Yours, etc.,

F. G. ANSELL.

Wickar, Gloucestershire, October 27, 1894.

A SIMPLE FORMULA FOR MAGNETIC WINDINGS.*

BY FRED BRAINARD COREY.

Several methods have recently been presented for the calculation of the windings of magnets, and for the determination of the proper size of wire for each particular case. Perhaps a simple formula, devised by the writer for use in his own work, might be of interest to others who have frequently to calculate the field windings for electrical machinery. The formula is applicable only to shunt or separately excited machines. It is possible that others have followed the same method, but those to whom it is new will find it extremely useful.

Supposing each turn of the winding to be of the same length, the number of ampere-turns depends only upon the cross-section of the wire used, and hence, to obtain a given number of ampere-turns on any core, it is only necessary to select the proper size of wire.

The resistance of one circular mil foot of copper wire at a temperature of 100deg. F. is approximately 11 ohms, and for all ordinary field windings this value may be considered sufficiently accurate. The resistance of any piece of copper wire at this temperature is therefore

$$R = \frac{11 \times L}{\text{circ. mils}},$$

where L is the length of the wire expressed in feet. The current flowing in any such wire is evidently:

$$C = \frac{\text{E.M.F.} \times \text{circ. mils}}{11 \times L}.$$

It is also evident that the number of ampere-turns in any winding is numerically equal to the number of amperes that would result if a single turn of wire were subjected to the voltage to be used; hence,

$$\text{Ampere-turns} = \frac{\text{E.M.F.} \times \text{circ. mils}}{11 \times l},$$

where l represents the mean length of one turn in feet. We now have, by transposition, the cross-section of the wire for the required winding:

$$\text{Circular mils} = \frac{\text{ampere-turns} \times 11 \times l}{\text{E.M.F.}},$$

In case the winding is to be applied to a shunt motor without external field regulation the above is of course sufficient, but in other cases allowance must be made for whatever regulating resistances are introduced into the field circuit.

This, however, is a very simple matter when once we have determined the ratio of the regulating resistance to the resistance of the magnet winding. It is then necessary only to increase the above result in that ratio to obtain the necessary increase in the cross-section of the wire to be used.

Suppose that we have assumed the ratio $r : R$ as the correct value for the required regulation, then our formula becomes

$$\text{Circular mils} = \left(\frac{\text{ampere-turns} \times 11 \times l}{\text{E.M.F.}}\right)\left(\frac{R+r}{R}\right).$$

The mean length of turn can generally be readily estimated with sufficient accuracy to ensure very reliable results.

We can now select the size of wire whose cross-section is nearest to the correct value as found above, and determine the amount of wire to be used by any of the various rules which have been suggested for economy of wire and safe limits of heating.

The question of heating is, of course, a matter of prime importance, and, unfortunately, it is impossible to devise any rule or formula that will, even approximately, give the desired results. The rule is often given to allow one square inch of radiating surface per watt consumed in the coils, but the application of this rule must be governed not only by the shape of the coil and of the surrounding iron, but also by the insulation on the wire, the outer covering of the coils, and the material of the supporting spool. It is, however, a simple matter in the construction of a machine to determine the heating effect of the field current by experiment, and then add or subtract wire as seems best for satisfactory working.

* New York *Electrical Engineer*.

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THE ELECTRICITY WORKS AT BOLTON.

(Concluded from page 513.)

Charges for Current.

A supply of current will be provided at the following charges per Board of Trade unit:

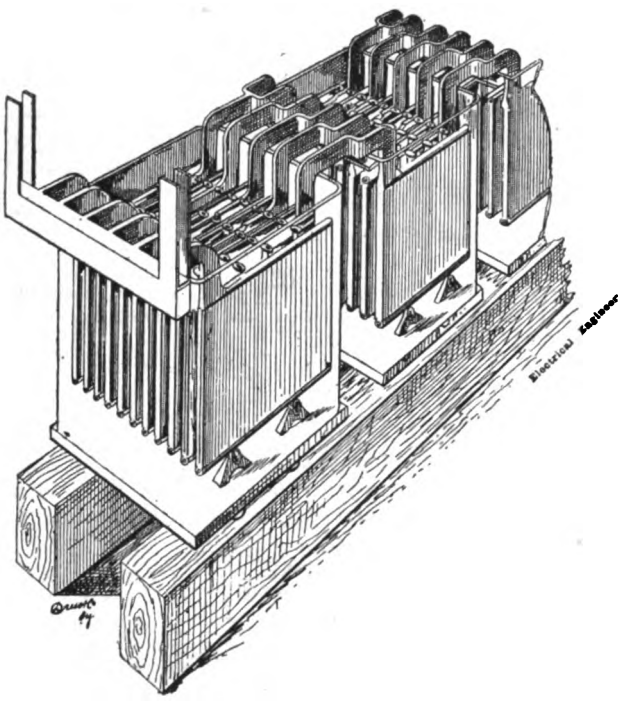
						Per quarter.
Above 12½ B.T.U.	per	16-c.p.	lamp	(or equivalent)	fixed	5½d.
Between 10 and 12½	,,	,,	,,	,,	,,	6d.
,, 7½ ,, 10	,,	,,	,,	,,	,,	6½d.
,, 5 ,, 7½	,,	,,	,,	,,	,,	7d.
,, 2½ ,, 5	,,	,,	,,	,,	,,	7½d.
Below 2½	,,	,,	,,	,,	,,	8d.

The rental of meters will be as follows: for 15 16-c.p. lamps or their equivalent, 2s. per quarter; for 40 16-c.p. lamps or their equivalent, 2s. 9d. per quarter; for 80 16-c.p. lamps or their equivalent, 3s. 3d. per quarter; and for 160 16-c.p. lamps or their equivalent, 4s. per quarter.

A discount of 2½ per cent. will be allowed on all accounts paid within 21 days of the date thereof.

Conclusion.

Mr. J. H. Rider is to be congratulated upon having brought the undertaking to a successful issue, and the Corporation deserve credit for having decided to put down municipal works. Considering the present support, and that in prospect there is every reason to feel confident of the future commercial prospects of the enterprise, which,



Bolton.—Crompton-Howell Accumulators

bearing in mind the extent of the area capable of being supplied, and that indeed from which applications for light are being made, would have rendered extremely injudicious and expensive the adoption of any system other than that now inaugurated.

REGULATIONS OF SUPPLY OF CURRENT BY THE BOLTON CORPORATION.

Application for Supply.—Persons requiring a supply of electricity must fill up and sign an application form, giving particulars as to the number and power of lamps proposed to be fixed, and approximately the maximum number likely to be in use at any one time. Also particulars of any other intended use of the current. Forms of application may be obtained at the office of the borough electrical engineer, and should be returned to him, duly filled up, at least 14 days before the supply is required.

Character of Supply.—The Corporation will supply an alternating current of about 6,000 complete periods or alternations per minute, and at a mean pressure of 100 volts at the main cut-out box.

Three-Wire System.—The Corporation reserves to itself the right of supplying any building containing more than 150 lamps of 8 c.p. (or their equivalent), or requiring an intermittent or varying amount of current, at a mean pressure of 200 volts at the main cut-out box, the circuits being subdivided to 100 volts each, on the three-wire

Bolton.—Section of High-Pressure Cable.

system. In any case such a building must be wired in at least two entirely distinct circuits, and these should be so arranged that as equal a demand as possible will take place on each.

Bolton.—Section of Low-Pressure Cable.

Wiring.—The whole of the internal wiring and fitting work should be carried out by a responsible firm, and must be in accordance with the current rules of the Phœnix Fire Office, and of any other regulations which the Corporation may require.

Bolton.—Mordey-Victoria Transformer.

Conductors.—No conductors used shall carry a current greater than 1,000 amperes per square inch of their cross-section, and the sizes of the conductors must be so proportioned that the fall of pressure between the main cut-out

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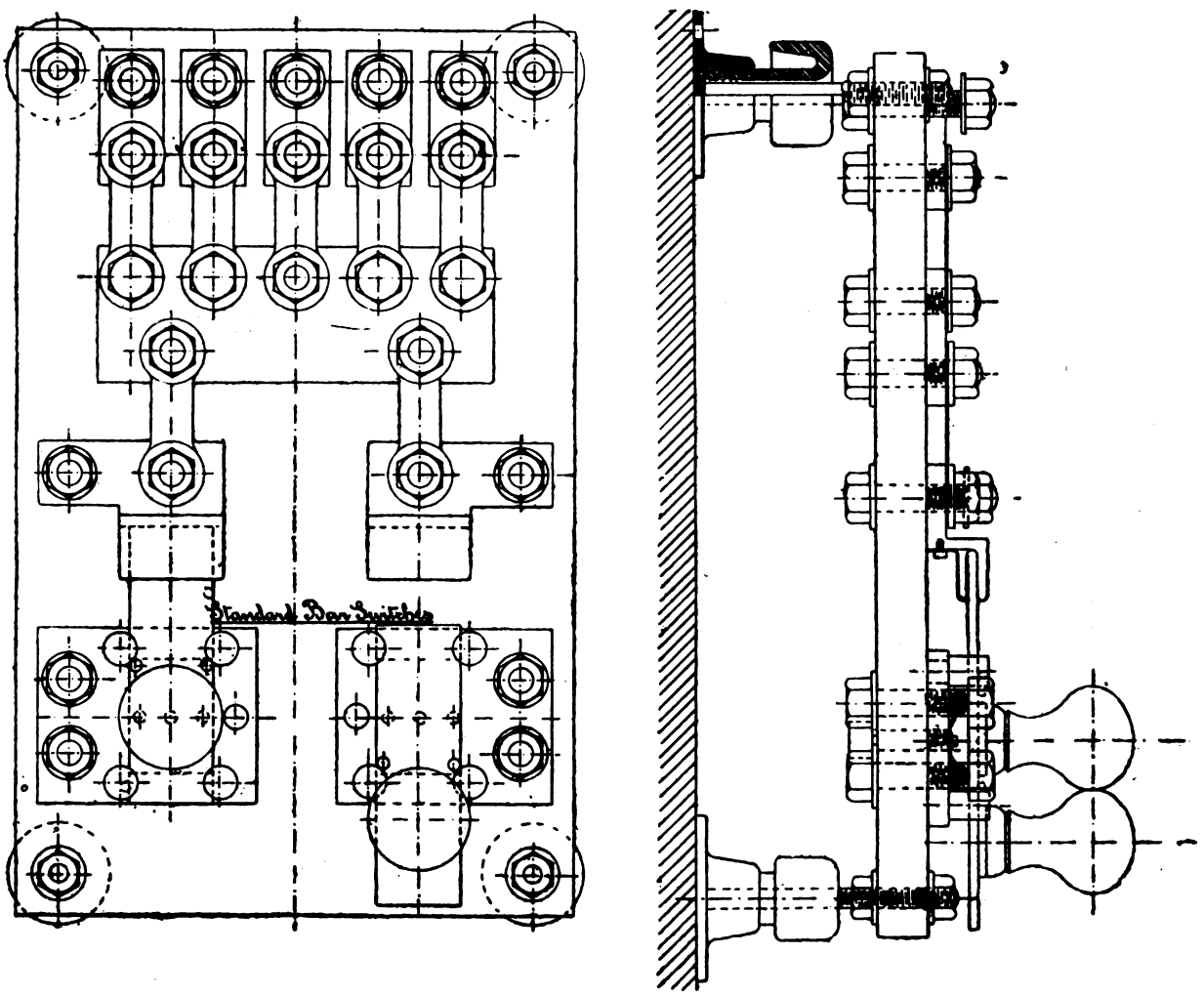
box and the farthest lamp shall not exceed 2 per cent. when the maximum number of lamps is on. All conductors to be insulated with pure and vulcanised indiarubber, braid and compound, to give a minimum insulation resistance of 300 megohms per mile. Lead-covered or armoured cables must not be used unless concentric, and in any case not without the special permission in writing of the borough electrical engineer. Where metal tubes are used as a protection, both conductors must be placed together in the same tube, which should be of sufficient size to prevent damage in drawing in or out. Under no circumstances whatever are staples or metal saddles to be used to fasten down conductors.

Samples.—The Corporation, through their electrical engineer, may require samples of the various wires and cables proposed to be used, with a statement of the maximum current to be sent through each.

mains to it free of charge, when the distance from the nearest distributing main does not exceed 60ft. The house mains must be brought to the cut-out box by the consumer, but connection thereto is only to be made by the Corporation officials. Sufficient cable must be left for the meter connection. The Corporation will supply meters at fixed rentals, and reserves to itself the right of deciding upon the positions of all meters. When the householder has made proper application for the supply of current, the borough electrical engineer, or his representative, will, if desired, point out the position to be occupied by the main cut-out box and meter.

Main Switch.—A double-pole switch must be fixed by the consumer in each circuit of the house mains, and on the consumer's side of the meter. Such switches to be securely protected, and to be of a type approved by the borough electrical engineer.



Bolton.—Low-pressure Switchboard for Transformer Sub-station.

Arc Lamps.—When arc lamps are used they should be specially made to burn with alternating currents of the stated periodicity, and a regulating resistance must be used in each circuit instead of a choking coil. Special permission in writing must be obtained before a choking coil is used on an arc lamp circuit. The type of arc lamp, resistance, choking coil, etc., must be approved by the borough electrical engineer before being used.

Motors and Other Apparatus.—Any apparatus not used for ordinary lighting purposes, such as motors, regulating switches, resistances, choking coils, heating appliances, etc., must be approved by the borough electrical engineer before being used.

Gas Fittings.—Gas fittings must not be used for the support of electrical lamps or wires, unless the gas supply is entirely cut off, and the fittings are thoroughly insulated from "earth." Special permission, however, may be given for a modification of this rule under certain circumstances.

Main Cut-Out Box and Meter.—The Corporation will supply and fix a main cut-out box, and bring their service

Testing.—No building will be supplied with current until the wiring has been tested and passed by the borough electrical engineer. One test will be made free of charge. At least 24 hours' notice must be given, in writing, to the engineer before a test can be made, and the engineer will then appoint a time. The contractor's representative should be present at the time appointed. The whole work must be completed, with fuses in and lamps fixed, before a test can be made. If the work be found not ready for testing, or should it fail to pass the test, a fee of 10s. 6d. must be paid at the office of the electrical engineer before any further test can be made. To avoid misunderstandings with their clients, wiring contractors are advised to test the work themselves before giving notice to the Corporation.

Refusal to Supply.—The Corporation may refuse to supply current to any building if (1) the work be not carried out in accordance with these regulations; (2) the whole of the work be not completed, and the fittings permanently fixed; (3) when tested with a continuous current of 100 volts

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pressure, the insulation resistance of any circuit falls below the following—viz.,

$$\text{insulation resistance in ohms} = \frac{15{,}000{,}000}{\text{max. current in amperes}}.$$

This applies to the insulation resistance measured either between the circuit and "earth," or between the circuit and any other circuit.

Leakage.—The Corporation reserves to itself the right at any time, and if necessary without notice, to cut off the supply to the whole or any part of a building if the insulation become defective or the work otherwise unsafe.

Additional Lights.—If alterations to the wiring, or additional lamps be contemplated, notice must be given, in writing, to the borough electrical engineer, and such additional work must be tested and passed by him before current is supplied to the altered or new circuits. Non-compliance with this rule will render the whole supply liable to be cut off.

Access for Inspection.—Free access must be allowed to the premises at all reasonable times to the proper officers of the Corporation, to examine, test, or inspect in any way they may deem necessary the wiring, fittings, meters, and all other matters connected with the electric supply; and all reasonable and suitable facilities must be afforded by the consumer to the officers of the Corporation to enable them to do so.

CITY AND GUILDS OF LONDON INSTITUTE.

LECTURE VIII.—THE CONSTRUCTION AND ACTION OF ELECTRIC BELLS—THE ARRANGEMENTS OF BATTERY CELLS, AND OF CIRCUITS FOR BELLS.

(Specially contributed.)

Modifications of Daniell Cell.—Various modifications of the Daniell cell have been made to diminish internal resistance. Several of these get rid of the porous jar, and depend upon difference of density to keep the solutions apart. The copper sulphate, being heavier than zinc sulphate, is placed at the bottom of the containing vessel, with copper strips therein. Connection with the external circuit is made by a wire covered with some material not acted upon by the chemicals. The upper part of the vessel contains the zinc plate, surrounded by a solution of zinc sulphate. It will at once be seen that such modifications as this are not very well suited for practical use, inasmuch as any mechanical vibration would soon cause the solutions to mix, and thus impair the usefulness of the cell. The Calland, Meidinger, and Lockwood cells are of this description. In these cells, when the hydrogen appears in the copper solution it displaces the copper, and forms in its place hydrogen sulphate, or sulphuric acid. Thus

$$CuSO_4 + H_2 = H_2SO_4 + Cu;$$

which, read as before, is hydrogen added to copper sulphate displaces the copper, forming hydrogen sulphate, and leaving the copper free. The free copper is deposited on the copper plate, keeping it clean; while the hydrogen sulphate diffuses through the solution and reaches the zinc plate, when the zinc is attacked and zinc sulphate formed, freeing the hydrogen to resume the cycle of operations over again. The zinc is thus continuously dissolved. The copper sulphate is also consumed, and has to be fed by a supply of the crystals. It is sufficient if, in the first place, when setting up one of these batteries, instead of zinc sulphate we pour in water, and after the cell is at work from time to time the zinc sulphate must be syphoned off and replaced with water. In a dry room evaporation at the top of the liquid causes the formation of crystals of zinc sulphate just above the liquid in the containing vessel, and the liquid creeping up by capillary action crystals are formed higher up. In this way creeping will go on to the top and over. To prevent this, brush a little raw linseed oil upon the glass above the liquid. I might have said that such cells as these are often called *gravity* cells.

Grove and Bunsen Cells.—The Daniell cell, by what may be termed an electro-chemical method, gets rid, as we have seen, of the hydrogen of polarisation, and is a fairly constant cell. Its E.M.F. is only a little over a volt. Another way of getting rid of the hydrogen, and at the same time obtaining a higher E.M.F., is due to Grove, who was the first to surround the copper plate, or the plate used instead of copper, with a strong oxidant—that is, with some compound that would part with its oxygen easily and freely to oxidise the free hydrogen, and thus form an harmless compound, such as water, from

$$H_2 + O = H_2O,$$

which we may read: one part by volume of oxygen added to two parts by volume of hydrogen combines to form two volumes of water.

Grove could not use copper for his cell because he used nitric acid as an oxidant, and nitric acid acts rapidly on copper. You will recollect that I told you the voltaic cell requires two metals, or two something equivalent to metals, one of which is acted upon chemically. So Grove replaced the copper of the Daniell cell by platinum, and the copper sulphate of the Daniell cell by nitric acid. Thus the Grove cell consists of zinc in dilute sulphuric acid outside the porous jar, and platinum in nitric acid in the porous jar. When the cell is at work the zinc is attacked, and sulphate of zinc formed, as in the Daniell; the free hydrogen coming into contact with the nitric acid, takes oxygen from the acid and with it forms water, leaving, however, another compound of nitrogen and oxygen, which is given off in poisonous red fumes, so that this battery should not be worked anywhere unless provision is made for carrying off these fumes. You will see that, though the hydrogen *is* got rid of in this battery, if it is constantly used the nitric acid will soon get weak, and the sulphuric acid be replaced by zinc sulphate. Thus the E.M.F., which is large (1·96 volts) to start with, falls off.

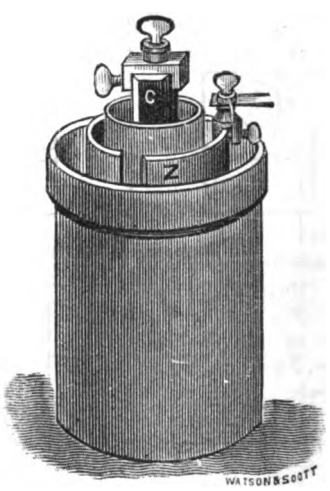

FIG. 1.—Bunsen Cell.

Platinum being very expensive, Bunsen suggested the use of hard gas coke or carbon in its place, and this modification is known as the Bunsen cell, which usually takes the form shown in Fig. 1. The E.M.F. of this cell is about the same as that of the Grove, but it has its weak points. The Grove cell is more compact; its porous jar is usually rectangular, while that of the Bunsen is cylindrical. Then there is more difficulty of making a good metallic connection with the carbon, and the internal resistance is greater. On the other hand, it contains more nitric acid, so that its current lasts longer.

Bichromate or Chromic Acid Batteries.—The fumes from nitric acid cells, or rather from cells using nitric acid as the oxidant, being so objectionable, it was desirable to replace the nitric acid by some other oxidant which should not give rise to this objectionable feature. For this purpose chromic acid and bicromate of potash have been largely used. The Fuller form of bichromate cell is perhaps more largely used than any other. It is shown in section in Fig. 2, where you see a lump of zinc cast round the connecting wire placed inside the porous jar. With the zinc is placed some two ounces of mercury, so that it is kept self-amalgamated. I will explain this question of amalgamation in a moment. The carbon plate is outside the porous jar, and around it are placed four ounces of bichro-

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mate of potash and four ounces of sulphuric acid. Both outer jar and porous pot are thus filled to near the top with water. According to Preece and Sivewright the following is the action of the cell: "When the circuit is completed the sulphuric acid passes into the zinc cell, attacks the zinc, and forms sulphate of zinc, while the liberated hydrogen reduces the bichromate of potash to a lower form. There is a secondary action in the battery when the solutions become saturated, which results in the formation of crystals of chrome-alum on the carbon plate . . . As soon as this secondary action is noticed, the crystals should be removed and some of the liquid withdrawn and replaced with fresh solution of sulphuric acid." The E.M.F. of the Fuller cell is high, being 2·14 volts. The internal resistance of most forms of cell can be varied according to the thickness of the porous jar, the strength of solution, and the distance of the plates apart.

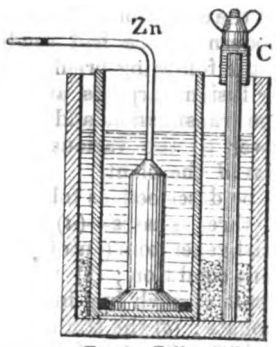


FIG. 2.—Fuller Cell.

I have now described two kinds of cells adapted to get rid of the troubles of polarisation. It is not necessary for us to pursue the subject further. The number of different forms of cell is legion.

Amalgamation.—We have previously seen the essential parts of a voltaic cell, and that one member of the couple is usually chemically attacked by the acid. Now, it is very difficult to get a perfectly pure zinc plate, and when the plate contains impurities and is immersed in the acid a couple is formed between a particle of the impurity and the zinc around it. These minute couples with the electrolyte form complete circuits, and, as we have seen, when the circuit is completed the zinc is attacked. We cannot use the electrical energy developed by such couples. It is wasted—thus forms another evil to be considered. The action of these couples is usually called *local action*, and it has been found that such local action can be avoided by rubbing the clean zinc plate with mercury. When mercury is rubbed over the plate, it dissolves the zinc, forming a coating on the plate of zinc amalgam. The impurities are not dissolved, so that after the rubbing the zinc itself and the impurities are covered with the zinc amalgam, and it is the zinc amalgam that comes into contact with the acid. It is the zinc of the amalgam that is taken by the acid to form sulphate, and as fast as the zinc of the amalgam is taken by the acid just as fast is fresh zinc dissolved from the plate by the mercury. The mercury thus forms a medium by which the zinc is passed from the plate to the acid, but the impurities are not passed. Remember the zinc is not dissolved by the acid unless the circuit is complete.

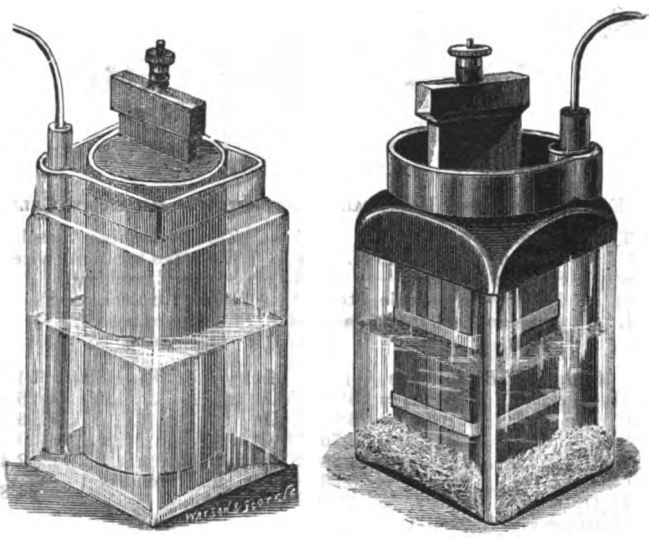
The Leclanche Cell.—Now we can return to the examination of the Leclanché cell in our bell circuit. It is, as I have said, a zinc-carbon couple, the electrolyte being a solution of sal-ammoniac (ammonium chloride). The action is for the ammonium chloride to free its ammonia, forming zinc chloride. Other chemical actions take place. In the end hydrogen is liberated, which comes into contact with manganese peroxide, reducing it to a lower oxide, and forming water. I will not trouble you with the whole chemistry of the cell, but merely that which refers to the getting rid of the hydrogen.

Manganese peroxide is chemically symbolised thus:

$$MnO_2, \text{ and } 2MnO_2 + H_2 = Mn_2O_3 + H_2O,$$

which we may read: hydrogen added to manganese peroxide combines with part of the oxygen of the manganese peroxide, forming water and a lower oxide.

Thus in a way the Leclanché cell provides for the getting rid of the troublesome hydrogen, but unfortunately the manganese peroxide parts with its oxygen comparatively slowly, so that if hydrogen is produced too fast—and it is so produced when the cell is working—only a part of it is neutralised. If, however, the cell is worked intermittently, and only for short times, the hydrogen is gradually neutralised, and the cell soon recovers its normal state. Now, bell work is very intermittent work, and so Leclanché cells have been largely employed for that work. They require very little attention, last a long time, and are easily renewed. Various modifications of this cell have been suggested to reduce the internal resistance, two of which may be mentioned. M. Leclanché got rid of the porous jar, which is used merely to keep the materials together in a compact form, by compressing a mixture of carbon, manganese peroxide, gum, and a little potassium hydrogen sulphate into a hard mass after keeping


Ordinary Form Agglomerate Form.
FIG. 3.—Leclanche Cells.

the mixture for some time at the temperature of boiling water. Plates of this compressed material are fastened to a carbon strip by means of indiarubber bands. This form is known as the *agglomerate* Leclanché, Fig. 3.*

The second modification I will mention is made by combining the porous jar and the carbon, making, in fact, a compound carbon containing cylinder, the inner part being porous, the outer forming the hard carbon of the voltaic couple. The zinc is put at the centre, Fig. 4, and

FIG. 4.—Leclanche Cell—Carporous Form.

surrounded by the peroxide of manganese mixture which serves as an insulator to the zinc. This form is known as the Carporous form.

Dry Cells.—During the past two or three years another class of cell has been coming into favour for bell work. These cells are termed dry cells, but that is hardly a correct

* By a mistake the agglomerate form was shown in our issue of October 19 as Fig. 3. The ordinary form is now shown above, together with the agglomerate form.

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term, as all such cells have moist electrolytes. There is, however, no free liquid, so that the cell can be closed. The two cells of this class that are mostly used are the Hellesen cell, Fig. 5, and the E.C.C. cell, Fig. 6. These have been carefully examined and described by Prof. Jamieson, who gives their construction as follows:

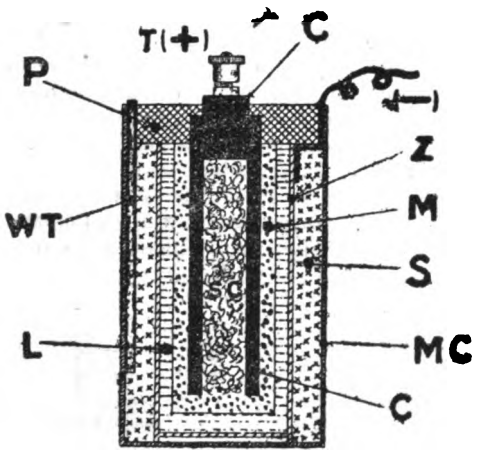

FIG. 5.—VERTICAL DIAGONAL CROSS-SECTION.—HELLESEN CELL.

T (+)	Terminal positive.	Z	Zinc containing vessel.
C	Carbon (bored hollow).	T (−)	Negative terminal wire.
SC	Silicate cotton.	S	Sawdust packing.
M	Manganese dioxide, etc.	P	Pitch (top covering).
L	Lime and sal-ammoniac, etc.	MC	Millboard case.
		WT	Waste tube.

Analysis of Black Paste (M).		*Analysis of White Paste* (L).	
MnO_2	= 25·54	CaO	= 26·18
Carbon	= 16·02	ZnO	= 6·00
SiO_2	= 12·76	MgO	= 0·57
MgO	= 12·88	NH_3	= 2·49
CaO	= 0·96	Water and binding material	= 64·82
Fe_2O_3	= 3·46		
Moisture and ingredients not determined	= 28·38		
	100·00		100·00

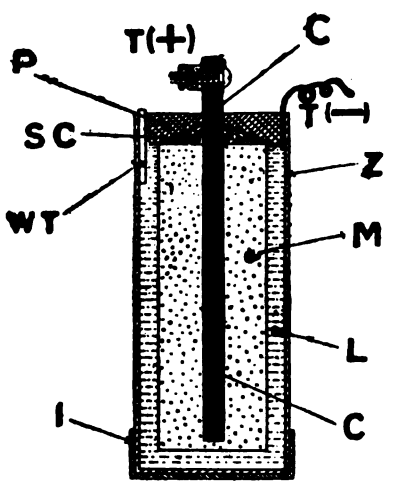

FIG. 6.—VERTICAL CROSS-SECTION.—E.C.C. CELL.

T (+)	Terminal positive.	Z	Zinc containing vessel.
C	Carbon.	T (−)	Negative terminal wire.
SC	Cotton.	P	Pitch (top covering).
M	Manganese dioxide, etc.	I	Insulating base.
L	Lime and sal-ammoniac, etc.	WT	Waste tube.*

* This short glass tube should have been drawn with its lower end terminating in the cotton at SC. These tubes in both cells are evidently to carry off any waste gas.

Analysis of Black Paste (M).		*Analysis of White Paste* (L).	
MnO_2	= 7·57	CaO	= 20·89
Carbon	= 47·26	NH_3	= 20·29
MgO	= 7·20	Cl	= 6·31
CaO	= 1·40	Water and binding material	= 52·51
Fe_2O_3	= 2·12		
NH_3	= 12·78		
H_2O	= 9·77		
Ingredients not determined	= 11·90		
	100·00		100·00

Dry cells possess certain practical advantages over wet batteries for bell calls, telegraphic, telephonic, medical, and military purposes. Thus their unbreakableness, compactness, portability, cleanliness, and freedom from accumulating crystals, and the creeping of salts to the outside of the containing vessel, as well as the fact that they are always ready for use, and may be laid on their sides or even upside down, are evident advantages.

ELECTRICITY AS A MOTIVE POWER.

(Concluded from page 476.)

Mr. B. H. THWAITE stated that some months ago he was requested to design a small iron and steel works for abroad, in a position where the utilisation of the fullest possible measure of heat in the fuel available was of the highest importance. A careful study of all the conditions of manufacture, and of the resources that modern science had rendered available, led him to decide on the following briefly described scheme of producing heat for fusion purposes, and for the production of power, and the transmission and application dynamically of such power to the various mechanically and widely separated parts of the plant.

The scheme might be described as follows: (1) the production of power, in three phases—(*a*) the conversion of the solid fuel in special generators (automatically controlled and fed) into a gaseous condition; (*b*) the recovery of the nitrogenous constituents of such fuel in the form of commercial ammonic sulphate; (*c*) the storage of such gaseous fuel in containers, and its utilisation for furnace work, and for the production of power by an internal combustion or thermo-dynamic motor, or gas-engine. N.B.—Such plant should be centralised so that it would be convenient for the delivery of the fuel, and be centrally placed for distri buting its gaseous production to various parts of the work, and be sufficiently removed as to prevent the incursion of iron or slag dust suspended in the atmosphere.

(2) The transformation of the thermo-dynamic into dynamo-electric power. This was intended to be effected by electric machines actuated by the gas motors.

(3) The transmission of such dynamo-electric or electromotive force (E.M.F.) to the different mechanical elements of the plant by means of underground or overhead well-insulated conductors.

(4) The transfer of such power to the machines themselves. This was effected by electric motors placed either directly in connection with the machine, the armature of which formed the driving shaft, or the power is transmitted by belting from a pulley on the armature shaft to a pulley on the driving shaft of the machine.

In the scheme all the machines were intended to have separate electromotors, and even the hammers were to be worked by powerful magnets with same power agency. The rolling mills were to be equipped with a powerful electric motor fixed on the same bedplate. All the cranes, both derrick, jib, central, travelling, overhead, and loco., had to have their own respective electric motors. The cold and hot saws, the shears, the skull-breaker, the ladle carriage, the trolleys, the rotary fans, were all to be equipped with their special motors and regulating switches. The ores, pig iron, limestone, fuel, and finished products were to be transmitted from one part of the works to the other by electric locomotives. In the machine-shops, the punch and shears, the portable and stationary drills, the lathes, grinding wheels, planing, boring, and slotting machines were each to be electrically actuated by separate motors.

By the scheme briefly described, it was calculated that an actual equivalent energy of 1 h.p. per hour could be directly applied in hoisting, propelling, conveying, and actuating the whole of the mechanical elements, including pumping, with an expenditure of only 1½lb. of coal. The loss of dynamic power in the electric conversion and transmission in any iron and steel works need not exceed one-fifth of the initial available power, so that, given the development of the 1 b.h.p., by the expenditure of 1lb. of gas in a gas-motor cylinder, and one-fifth of this being added for losses of transformation and trans-

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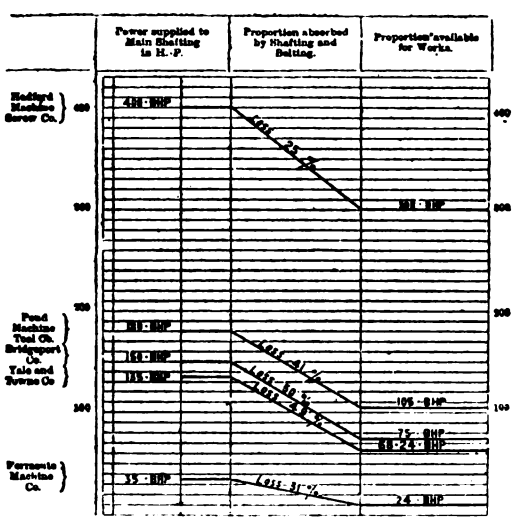
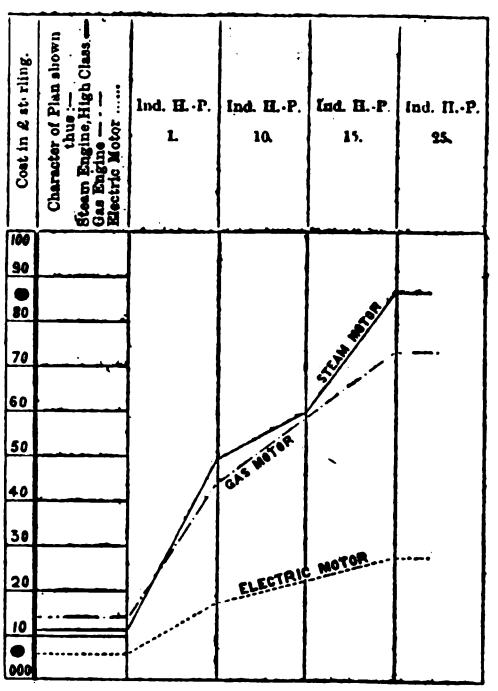
mission as indicated, it would seem that there was actually a margin for reduction on the 1½lb. estimated. Comparing the present system of generating and transmitting power by steam-boilers, steam-pipes, and steam-engines with the system of gas generators, gas motors, electric machines, and electric conductors and motors it would be realised, on examination, that many of the attendant disadvantages of the first-named system would be either avoided or reduced. Some of these disadvantages might be enumerated as follows: (*a*) Generally in iron and steel works the steam-engines were of an inferior design, and were exceedingly wasteful in fuel. If the efficiency of these smaller steam motors was examined, it would be found that it was very low, at least 6lb. of fuel being absorbed for one actual horse-power used applied for one hour, and this independently of the losses in the generation of steam and in the transmission of the steam power by exposed steam-pipes. (*b*) As iron and steel works generally consisted of draughty open sheds, or covered spaces, open at the gable ends and sides, the pipes for conveying the steam power were necessarily exposed to severe cooling conditions and changes of temperature, so that both leakage and condensation were associated evils. (*c*) Finely-divided iron and slag particles floating in the atmosphere of iron and steel works, especially in the rolling and forging department, were productive of much deterioration of steam-engine machinery and its efficiency. The metallic



Graphic Diagram, showing the Absorption of Power by Belting and Shafting, based on Dynomometric Investigations.

and slag particles fall on the moving and frictional parts, and wear them away—it was a rare sight to see a perfect steam-tight gland in an ironworks' steam-engine. (*d*) The steam-engines, large and small, scattered throughout the works, exposed to the draughty and cold influences, could not be expected to give the same efficiency as the well looked after and high-class textile-mill engine in its beautifully kept house. (*e*) The difficulty of starting the engines, through condensation of steam, was an excuse for uninterrupted light load and wasteful running of the machines, so that much wasted energy was associated under this head. (*f*) In the present repair or machine shops, the main line and much of the countershafting was constantly in motion, whether the machines or tools were working or not. (*g*) The present system of scattered small steam-engines was prejudicial to good and economical work, and it would not compare in economy with the central system of a large power plant equal to the aggregate of the smaller engines. (*h*) If steam-engines were not used, a long line of shafting was employed, and the waste of power by this means of transmission, whether by belt or toothed transmission gears, was most serious.

Considering the enumerated disadvantages to ascertain if the proposed central electric system will remove or modify them, he pointed out that: (*a*) The high-class steam or gas motor plant erected in a central station would at once lower the cost of fuel by fully one-third. It was well known that 1 i.h.p. could be developed in gas motors with generated gas fuel, with an expenditure of less than 1lb. of coal. (*b*) The transmission of the electric energy by well-insulated electric conductors would not be affected by changes of atmospheric temperature of the open and draughty sheds, and between the electric machines and the electric motor the loss of energy would be very fractional. (*c*) The central power station would not be exposed to floating metallic and slag particles. The electric motors could be completely boxed in, so that they were not affected by dampness or by the iron or slag dust deposits. *d*. and *e*. There was only one power generating station. Each electric motor could be thoroughly guarded, and when not required in action it could be instantly switched off or be restarted as requirements demanded. There was no need for free and wasteful running. (*f*) Each tool in the repair, turning, fitting, or other machine shop was actuated by its own motor, and could be switched on or off instanter. There was no need for the main and counter shafting to be wearing its bearings away by free and costly running. Reference to the accompanying diagrams would elucidate the loss of power in transmission of power by belting.



Diagram, showing respective Cost of Maintenance, Interest, Amortisation, and Repairs of Three Forms of Motor Installation.

Besides the striking advantages of the scheme set forth, the system enabled electric lighting of a well-distributed character to be obtained at a trivial addition to current cost. Electric energy could, with a little ingenuity, be applied for special and local purposes and conditions much more conveniently than any other system.

The Oerlikon Machine Company, of Switzerland, as well as other continental firms; the Electric Construction Company, Wolverhampton; Messrs. Mather and Platt, Oldham, had introduced numerous applications of E.M.F. In the United States many of the machines in daily use in iron and steel works were actuated electrically. The Carnegie Works, the Wrought-Iron Bridge Company, the Cambrian Iron Company, the Bucyrus Steam Shovel Company, the Pencoyd Ironworks, in the United States, were utilising this economical and efficient form of transmitting power.

Mr. Selby-Bigge's practical contribution was very opportune, and should tend to the popularisation of electrical applications in iron and steel works. The paper called for very few remarks beyond those of a congratulatory nature. He was glad to notice that stress was laid on the loss occasioned by condensation in steam-pipe transmission. The absence of dynamometric tests in British iron and steel works was to be deplored. In the United States this practicable method of testing the power absorbed by different machines had become common, and the information so far gathered was in the highest degree valuable and instructive. He would strongly recommend engineers to peruse Flather's work on the dynamometer, the information given being extremely valuable and practical. The thanks

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of metallurgists were due to the progressive firm of Dorman, Long, and Co., Limited, for their pioneer work in electrical power applications in steelworks in this country. Their obtained results were alone an eloquent testimony in favour of electric power transmission.

Obviously the best method of producing power for intermittent work when a storage of power was required was to use a gas-engine and gasholder plant. In the latter a large accumulation of power could be held in reserve ready for momentary use, and without such storage involving any loss. This could not be said of any other system of power storage.

By means of a special switchboard and a multiplicity of motors, as the load was reduced part of the gas motors might also be automatically cut off as well as the gaseous fuel plant generating the gas that fed them. The suggestion for comparing the daily coal consumption per electrical horse-power absorbed was an admirable one, and would conduce to the highest economy. The characteristic elasticity of the magnetic field of an electric motor was of the utmost value, and in no instance more than in the application of electric motors for driving a train of rolls, and this feature would probably be the means of preventing many disastrous and sudden strains that would be fatal with present methods. The author did not give any reason why the heavier rolls should not be electrically driven. He might have obtained useful information on the advantages of electric methods of driving workshop tools from the Electric Construction Company, of Wolverhampton, who were on a large scale the pioneers in this country in the use of electric transmission of power for actuating workshop engineering tools.

GAS-DRIVEN ALTERNATORS.

A specification and plans were some time ago prepared for the Municipality of Calais by M. Brillouin, a Paris electrician, for the establishment of a central electric light station in that town. As in the case of the neighbouring towns of Cambrai and Boulogne, the Municipality of Calais asked the Compagnie du Gaz whether they would lay down plant and supply the electric light. The proposal was not only accepted, but the gas company also adopted the plans and scheme devised by M. Brillouin and entrusted him with the carrying out of the work, using, as might be expected under the circumstances, gas-engines as motors.

The plant has been laid down in the old coal-store belonging to the gas company, and situated some distance from the place of consumption. Consequently the high-pressure alternating-current system with transformers was introduced. The cables have been arranged on large masts in a rough-and-ready style in the streets and on the footpaths, three transformer stations being provided in kioskes. The station, which was set in operation last June, contains two Niel gas-engines, each of 80 h.p.; these engines are of the double-cylinder type, with opposite cranks, and running at 160 revolutions a minute. There are two alternators, by Messrs. Brown, Boveri, and Co., capable of furnishing 50 amperes at a pressure of 1,000 volts when driven at 160 revolutions a minute. The exciters give from 30 to 35 amperes at from 80 to 115 volts at a speed of 1,500 revolutions.

A new arrangement has been adopted in driving the alternators. Instead of being belt driven, as might be expected in the case of gas motors, these machines are coupled direct to the gas-engines by means of Snyers elastic couplings. This arrangement will be understood by reference to the plan of the generating plant given in Fig. 1, where clutches are shown at A_1 and A_2. A similar coupling, A_3, is employed to couple together the two alternators. This method allows of each of the machines being actuated by either one or the other motor, or of both being driven by one gas-engine only. It will be seen that the Snyers coupling, which is represented in Fig. 2, is composed of two discs, one of which carries steel-wire brushes and the other radial teeth similar to those projecting from a comb. When a dynamo at rest is being connected with a motor which is already running, the steel brushes are gradually brought into contact with the teeth, thus revolving the dynamo slowly until the speed of the latter reaches that of the motor. This fact is observed when the noise caused by the friction between the two discs ceases, when the coupling can be completed. The exciters are belt driven, as shown on the plan.

ELECTRIC PROPULSION OF BARGES.

Some interesting experiments were conducted on the Canal de Pouilly on October 10 with a new system of propelling barges by electric power. This method, which has been devised by M. Galliott, one of the engineers of the Ponts et Chaussées, is being promoted by a syndicate in connection with the Maison Farcot, who have equipped the barges with which tests are being made.

The system consists in the substitution for the ordinary rudder of an appliance of the same form and connected to the barge in the same manner. The appliance is in effect a combined screw and rudder. It carries on its upper part an electric motor which drives, by means of shaft and gear, a screw which is arranged a short distance from the back of the barge. This form of propeller has been fitted to a barge belonging to the Compagnie Havre-Paris-Lyon. The screw was calculated for a speed of 300 revolutions a minute, the gear allowing a reduction in the ratio of

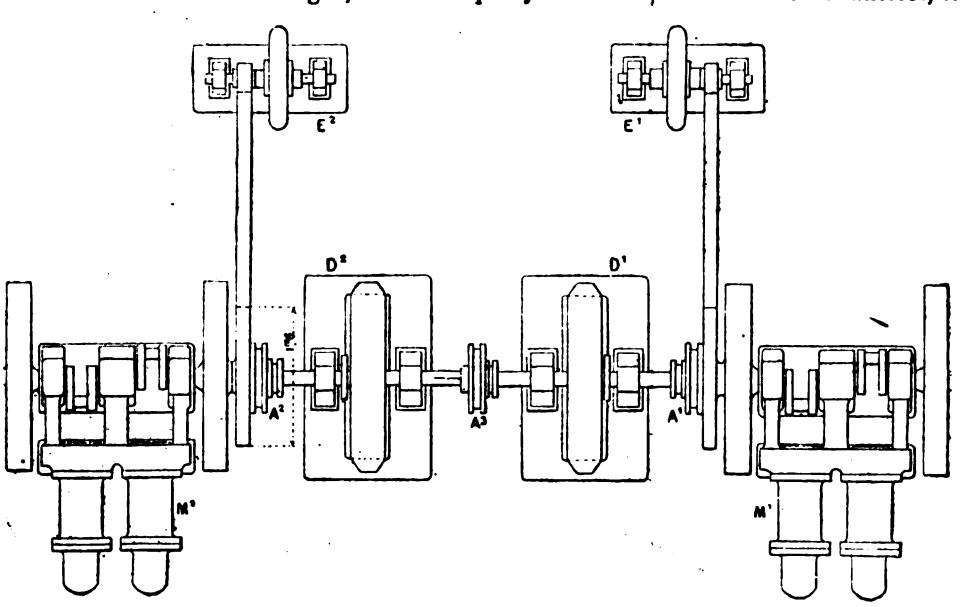

FIG. 1.—Plan of Gas-Driven Alternators.

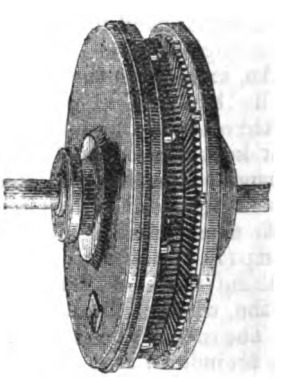

FIG. 2.—Snyers's Elastic Coupling.

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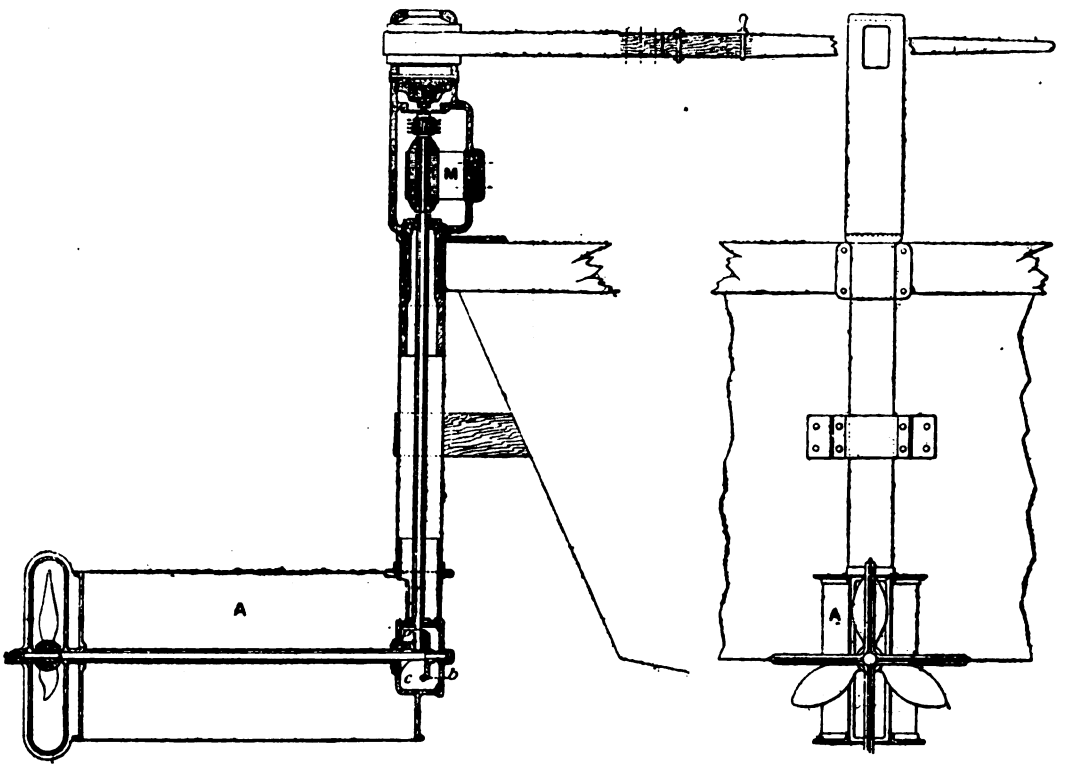
1 to 3½. The accompanying illustrations (Fig. 1, a section, and Fig. 2, a back view of the apparatus) are reproduced from our contemporary *L'Industrie Electrique*.

It will be seen that the shaft of the screw is contained in the interior of an iron case, A, carrying at one end the screw and at the other a bevel wheel, *b*, gearing with a similar wheel fixed at the lower end of the vertical shaft shown, which is driven by the electric motor, M. The bevel gear is arranged in an iron box filled with oil. The motor shaft is encased in a tube, down which the oil for lubricating the gear is passed. The barge is 38 metres in length, and with a load of 180 tons it has a normal speed of 85 centimetres per second, or 40 per cent. over that when hauled by two horses, and the electrical energy required amounts to 3,400 watts, or 4·6 h.p. The current is supplied from a battery of Laurent-Cely cells, which are charged at any convenient spot.



FIGS. 1 AND 2.—Section and Back View of Electric Propeller.

CENTRAL STATION WORKING ABROAD.

An article in *L'Industrie Electrique* of October 25 deals with the position of the electrical industry in various foreign countries. The writer gives some interesting information concerning the duration of the concession, municipal charges, cost of coal, and sale price per 100 watts. Dealing first with the Vienna Electrical Company, which competes with the General Austrian and International Electrical Companies, it is mentioned that it was established in 1889 with lighting powers over the whole town. The duration of the concession is 50 years, the town having the right of acquiring the undertaking at the end of either 15, 25, or 35 years. In addition to steam and electrical plant of 1,500 h.p., batteries equivalent to 500 h.p. are also provided. The number of lamps connected, estimated in 16-c.p. lamps, is 25,000, and current is sold for lighting at 9d. per unit, with reductions ranging from 3 to 30 per cent.; and for motive power at 4¾d. per unit, with rebates of from 10 to 30 per cent. Coal costs between 14s. 1d. and 17s. 8d. per ton, and the company pays to the town 3 per cent. of the receipts on the sale of current. The last dividend was at the rate of 2 per cent. on the total capital. At Dusseldorf, where the central station was established in 1891, plant to the extent of 400 h.p., supplying 18,300 lamps, is installed. The price charged is 9¾d. per unit, but reductions reaching 20 per cent. are made. The fuel used costs 8s. 11d. at the pit. The Breslau station, started in 1891, has an unlimited concession. Steam dynamos and accumulators are used, the number of 16-c.p. lamps or their equivalent supplied being 15,118. Coal at the railway station costs 7s. 8d. per ton. The Berlin Electricity Works, which commenced operations in 1884, supply under a 30 years' concession, but the town has the right to acquire the enterprise in 1895, according to the conditions fixed in the agreement. The power of the works is 15,100 h.p. and 194,000 16-c.p. lamps are energised. The charge for current varies; coal costs between 16s. 11d. and 18s. 3d. per ton, and the company pays to the town 10 per cent. of the net receipts. The last dividend was 10½ per cent. After considering several English stations in a similar manner the author refers to the Edison General Electricity Company in Milan. Established in 1893, the company has the right to furnish light until 1904. The generating plant, comprising 3,100 h.p., feeds 34,821 incandescent and 957 arc lamps. The charge for current is 9½d. per unit; coal costs 26s. 5d. a ton, and no payment is made to the town. A dividend of 10 per cent. was distributed in 1893. At Geneva, the Electrical Industry Company, which has a concession for eight years dating from 1887, supplies 15,000 lamps; water power is used, and the price per unit varies between 4½d. to 6¾d. per unit, according to circumstances. No payment is made to the town, and the company distributed a dividend of 5½ per cent. in 1892, but nothing in 1893. The Copenhagen station, started in 1892, uses 1,430 h.p., and distributes by means of batteries. The number of lamps connected is 25,800; current for lighting is purveyed at 7¾d. per unit, and for motive power at 3d. in summer and 4d. in winter. The fuel used is coke and coke dust, the former costing 10s. 5d. and the latter 4s. per ton.

THE SURPLUS AND DEFICIT THEORY OF ELECTRICITY.

BY W. PERREN MAYCOCK, M.I.E.E.

(Continued from page 487.)

(*d*) *Influence, or Electrostatic Induction.*—Notwithstanding the almost general acceptance of the term "influence machine" *vice* "induction machine," the use of the term "influence" in place of "electrostatic induction," as proposed, so far as I can remember, some years ago by Dr. Oliver Lodge in his lectures on "Lightning Conductors," does not seem to have received the encouragement it deserves. The term "induction machine"

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is in any case a vague one, for it might equally well be applied to a Wimshurst machine, a dynamo, or an induction coil. From a practical point of view, the phenomena of electrostatic induction differ very much from those of magnetic or electromagnetic induction, and it is very necessary to avoid a confusion of terms. A +ly charged body is constantly endeavouring to rid itself of its surplus, and the probable path of its discharge is prepared beforehand by influence or electrostatic induction. In other words, a deficit, or negative electrification, will be developed on all the nearest parts of neighbouring conductors, especially earth-connected ones. On the other hand, a −ly charged body will tend to draw electricity into itself from neighbouring conductors to fill up its deficit, and consequently influences or induces a surplus, or + electrification, on the nearest parts of all those in its vicinity. Let us consider the case of an insulated +ly charged ball, A (Fig. 3), acting influentially or inductively on an insulated uncharged ball, B. The usual explanation given is that "− electricity" is induced on the nearer side of B, and "+ electricity" on the farther side. Now, applying the theory of surplus and deficit, we may say that before A was brought near to B, the electricity on the latter, of which there is neither a surplus or deficit, was evenly distributed. As A is brought up to B electricity is gradually

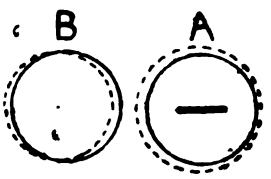

FIG. 3.

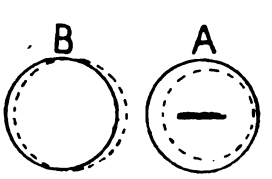

FIG. 4.

displaced from right to left, leaving a deficit, or − electrification, on the side nearest A, and creating a surplus, or + electrification, on the side remote from A. This unequal distribution of B's normal charge, and the consequent variation of density, is clearly indicated by the dotted line. Let A be −ly charged—*i.e.*, in a state of deficit, Fig. 4—we may then suppose that the electricity on B is drawn over to the side facing A, creating a + density there, and leaving a deficit or − density on the farther side of B. A, Figs. 3 and 4, before being brought near to B may be supposed to have had a uniform density, as in Fig. 2. On being approached to B its density (+ or −, as the case may be) is no longer uniform, but is greatest on the side nearest to B.

(*e*) *Charge and Potential.*—We have hitherto assumed that a +ly or −ly charged body is at a + or − potential respectively, and that a body at a potential has a charge of similar sign. This is true only so long as no appreciable influential or inductive action takes place between the body under consideration and neighbouring bodies. When a body is under influence, or electrostatic induction, though as a whole it may be uncharged, on one side it will have what is generally called a "bound" charge, and on the other a "free" charge of opposite sign. A previously neutral body will also acquire a potential (+ or −) when under influence, and a previously charged body at a potential may have its charge bound and its potential reduced to zero, or even reversed, by influence. When we speak of a charge without prefixing the words "bound" or "free," the state of the body as a whole is referred to. These matters, which at first sight are a little confusing, are considered in the following three sections.

(*f*) *A Body at a + or − Potential is not necessarily a Charged Body.*—The elementary student is often at a loss to account for the potential of a body, but all difficulty is removed if it be borne in mind that a body is at a + potential when, if connected with earth, there would be a flow of electricity from the body to the earth: and a body is at a − potential when, if connected with the earth, there would be a flow of electricity from the earth to the body. Thus in Fig. 3 both A and B are at a + potential, while in Fig. 4 they are both at a − potential, but in neither case can B, considered as a whole, be said to be charged; although we may speak of the "free" charge on one side, and the "bound" charge on the other, yet electricity has merely been displaced or altered in its distribution on B; none has been put on or taken away. A, on the other hand, has clearly both a + charge and a + potential in Fig. 3, and a − charge and − potential in Fig. 4.

(*g*) *A Body at Zero Potential is not necessarily an Uncharged Body.*—If B, Fig. 3, were momentarily earth-connected, the surplus on its left-hand side would flow away to earth, and a further displacement of electricity would take place, the surplus flowing to earth, so that in the end we should have a state of things as represented in Fig. 5; the − density on the right-hand side of B being greater than in Fig. 3, even though A's charge be the same in each case. Now here, clearly, we have a body, B, with a negative charge upon it, but so long as we do not alter the relative positions of A and B, connecting B with earth will not give us a flow of electricity either way, therefore B must be at zero potential. If A be brought nearer to B, the potential of the latter will rise, a surplus collecting on the left-hand side; but if B's distance from A be increased, some of the charge or deficit will be set free, a slight redistribution will take place, and B's potential will fall—*i.e.*, become negative. In short, decreasing the distance between A and B will raise the potential of the latter, while increasing the distance will lower it. In the case depicted in Fig. 4, where the influencing or inducing body, A, has a − charge, if B is momentarily connected with earth, we may say that electricity will flow from the earth to fill up the deficit existing on B's left-hand side—in other words, the free negative charge and potential is neutralised; then immediately a further displacement of electricity takes place, the positive density on the right-hand side increasing, creating for the moment a deficit on the left-hand side, which is, however, immediately filled up from earth. This will give the state of affairs shown in Fig. 6, the + density on B being greater than was the case before it was earth-connected. Now, although B has a bound + charge upon it, since it has just been connected with earth, whatever difference of potentials before existed must have been neutralised, and B is consequently now at zero, or earth's potential. If the distance between A and B be decreased, more electricity will be drawn over to the right-hand side of B, its potential will fall, a deficit being left on its left-

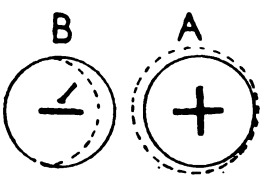

FIG. 5.

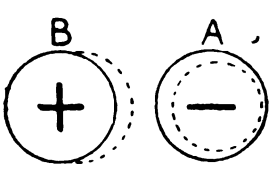

FIG. 6.

hand side. If the distance be increased, B's potential will rise, a certain amount of electricity being set free. All this goes to prove that *a body may be charged and yet be at a zero potential*; or, what is the same thing, *when all the charge on a body is bound by the presence of an opposite charge, the former is at zero potential.*

(*h*) *A Body may have a − Charge and + Potential, or vice versâ.*—In B, Fig. 7, the dotted circle C represents the uniform − density when the +ly-charged body, A, is far removed, B having a deficit, or − charge. If A be brought up to the position A′, the − density on B will be no longer uniform, it being greater on the right-hand side than on the left, where it is practically nothing. This is indicated by the dotted circle C′. If A be brought up still farther into the position A″, the − density on the right gets still greater, and a + density will be created on the left, signifying a + potential.

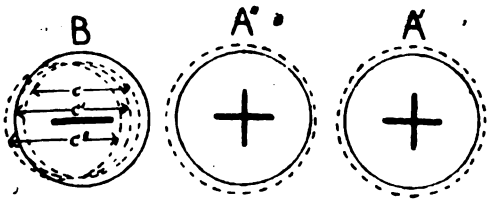

FIG. 7.

The opposite case of a body with + charge and − potential may be deduced from the above. Such an effect as that just described would occur when a highly-charged body acted influentially or inductively on a slightly oppositely charged body. If A is +ly charged it displaces the electricity on B from right to left; if −ly charged it will displace it from left to right—in the first case repelling, and in the second case attracting it. From the foregoing, the truth of the following statements must be evident to the student: (1) The potential of a charged (either + or −) or uncharged body at any initial potential (+, −, or zero) will *rise* on the approach of a body at + potential, and *fall* on its withdrawal. (2) The potential of a charged (either + or −) or uncharged body at any initial potential (+, −, or zero) will *fall* on the approach of a body at − potential, and *rise* on its withdrawal. The seven cases arising out of the conditions mentioned in (1) above are illustrated in Fig. 8, where the body to the left is the one whose change of potential is to be considered. In cases IV., V., VI., and VII. the required conditions of charge and potential are brought about by the presence of an influencing body, B, which is supposed to remain *in situ*, while the body at + potential, A, is brought up. The latter is not shown in the figure, but it should for simplicity's sake be considered to approach from the right-hand side, although the effect would be substantially the same, no matter from what direction it approached. The reader can reason for himself how the stated effect occurs, and he should also work out the seven similar but opposite cases pertaining to (2), where the body brought up is at a − potential. It should be borne in mind that a rise of − potential means a *diminution* of the potential difference between itself and earth, and *vice versâ*.

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On the other hand, rise of + potential means an *increase* of the P.D. between itself and earth, and *vice versâ*. "Rise of potential," or "increase of potential," may be taken to mean the same thing when applied to + potentials. With − potentials, on the contrary, a "rise of potential" means a decrease of − potential; a "fall of potential" means an increase of − potential.

(*i*) *Capacity.*—The capacity of a conductor may be defined as a measure of the amount of electricity that has to be put into it (+ charge) in order to raise its potential one unit above that of the earth; or the amount that has to be abstracted from it (− charge) in order to lower its potential one unit below that of the earth. The capacity of a conductor, charged or uncharged, is increased by bringing it near to another *uncharged* conductor, this increase of capacity being much greater if the neighbouring conductor is earth connected. If the conductor whose capacity is being considered is charged, and is brought near a conductor at an opposite potential, its capacity will be increased.

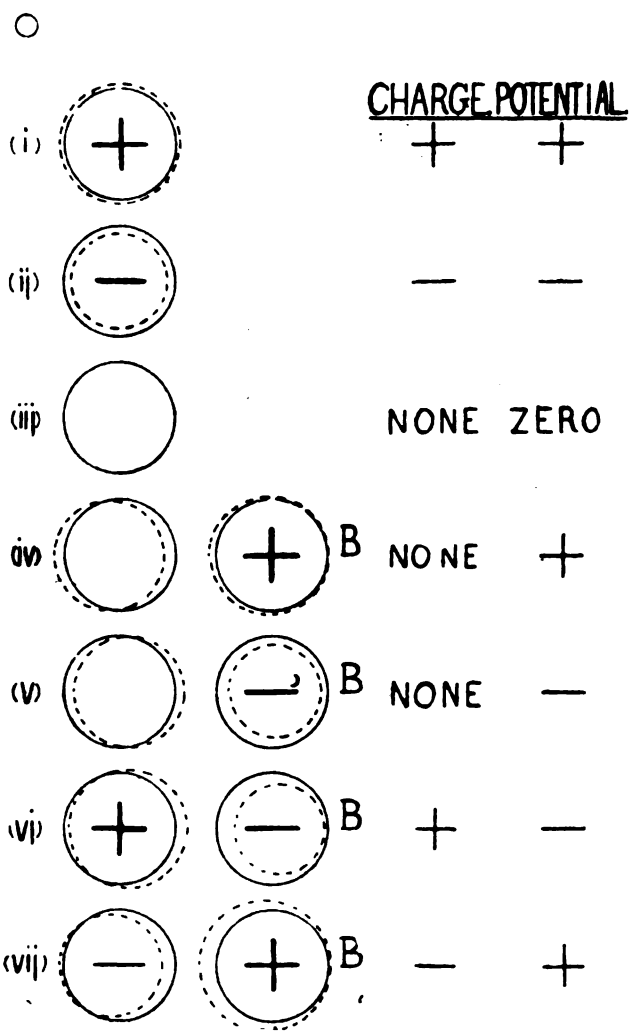

FIG. 8.

If the conductor is unchanged, its capacity will be increased by bringing it near a body with a + or − potential; but in this case its capacity will be increased only for charges of opposite sign to that of the potential of the body to which it is brought up. Referring to Fig. 3, when the charged sphere A is far removed from B (and all other bodies), its potential is a maximum; as it is brought nearer to B, its potential gradually falls, as its charge becomes more and more "bound" by the reaction of the influenced or induced charge on B; in other words, its capacity is increased, for it will require more electricity to be put into it in order to raise its potential to the same degree as before. This increase of capacity is not, however, very great, as B is not earth connected. The effect of connecting B with earth is, as we have already explained, to enable the repelled surplus or + charge to run to earth, and a much greater deficit, or − charge, to be influenced or induced on the side opposite A. More of A's charge is thus occupied in binding the influenced − charge on B, and A's potential falls much lower than in the first case, when B was not earth connected; in other words, A's capacity is much increased, as represented in Fig. 5, by the accumulation of the charge on the side opposite B; and it will need an increased amount of electricity to be put into it to raise its potential to the same value as before. In Fig. 4 we have the opposite case of a −ly charged body. When A is far removed from B (and all other bodies) its (−) potential is a maximum, and its density uniform, as shown to the left hand of Fig. 2. As A is brought up to B, in its effort to fill up its deficit, it will influence a surplus on the near side of B, leaving a deficit on B's farther side. Reaction takes place between the influencing charge on A and the influenced charge on B; or we may say that part of A's charge is occupied in binding or holding the influenced charge on B. However we express it, the influencing and influenced charges attract each other, there being a greater deficit on the left than on the right-hand side of A, and A's potential rises—*i.e.*, its −potential decreases (*vide* end of section *h*)—and it will require a further subtraction of electricity to reduce its potential to the same value as before. If B be connected with earth, electricity will rush up into B to fill up the deficit on its left side, and, under A's influence, to increase the surplus on its right side. A's potential will consequently rise still more—*i.e.*, its − potential will decrease—and the final state of things will be as shown in Fig. 6.

We shall have more to say about capacity in dealing with the subject of condensers (section *k*).

(To be continued.)

LIGHT RAILWAYS.

The following letter has been sent by Sir Courtenay Boyle from the Railway Department of the Board of Trade to the Associated Chambers of Commerce, the Central and Associated Chambers of Agriculture, the London Chamber of Commerce, the Railway Companies' Association, the Institution of Civil Engineers, the London County Council, the Association of Municipal Corporations, and the Association of County Councils: "I am directed by the Board of Trade to communicate with you on the subject of a movement recently set on foot with the object of obtaining further powers and facilities for the construction of light railways and steam or electric tramroads. It has been alleged in some quarters that the requirements which are imposed by the Board of Trade upon new railways in the interest of the safety of the travelling public and of the railway servants, as well as for the public convenience, may stand in the way of those who are desirous of promoting railways through agricultural or sparsely-populated districts. It has also been urged that light railways may have great utility and importance as a means of assisting those who suffer from the depression in agriculture by affording them easy and inexpensive means of bringing their produce to the best markets. The same observation has been made as regards an even more difficult branch of the subject—namely, the possibility of relieving populous urban districts by giving special opportunities to workpeople to travel in and out of towns at a minimum cost, or by making it easier for manufactories to be established in suburban or country districts. Interest in the movement has, no doubt, been stimulated by the action of those foreign countries in which light railways have been developed. The Board of Trade are sensible of the importance of the question in these various aspects, and have taken great interest in the representations which have from time to time been made to the Department; but they have not yet had before them practical proposals which would enable them to decide how far a demand for economy in construction would justify relaxation of any of their usual requirements now enforced in the interest of safe working, and whether a change in the law by which necessary powers might be more easily or cheaply obtained would be likely to be followed by any considerable development of the modes of transport contemplated. It may no doubt be contended that the powers conferred by the Railways Construction Facilities Act, 1864, as amended by the Railways (Powers and Construction) Acts, 1864, Amendment Act, 1870, and the Regulation of Railways Act, 1868 (Part V.), on the one hand, and the Tramways Act, 1870, on the other, are sufficient to satisfy the requirements of ordinary trading companies desirous of constructing and working light railways or tramroads. The Board of Trade are, however, so much impressed by the desirability of obtaining all the information which can be afforded by persons interested in the movement, that they think it well to take prompt steps for the purpose of eliciting and focussing such views and information; and they conceive that both local authorities and traders, as well as the existing railway companies, will welcome an opportunity of joining in a discussion inaugurated with this object. I am, therefore, directed by the Board of Trade to enquire whether you would be disposed to attend such a conference at the Board of Trade on an early day, with the object of discussing (1) how far the usual requirements of the Board of Trade as to constructing and working new railways may fairly be relaxed, especially in the case of lines built through sparsely-populated and agricultural districts; (2) whether additional legal facilities for obtaining powers to construct tramroads and light railways are necessary or desirable."

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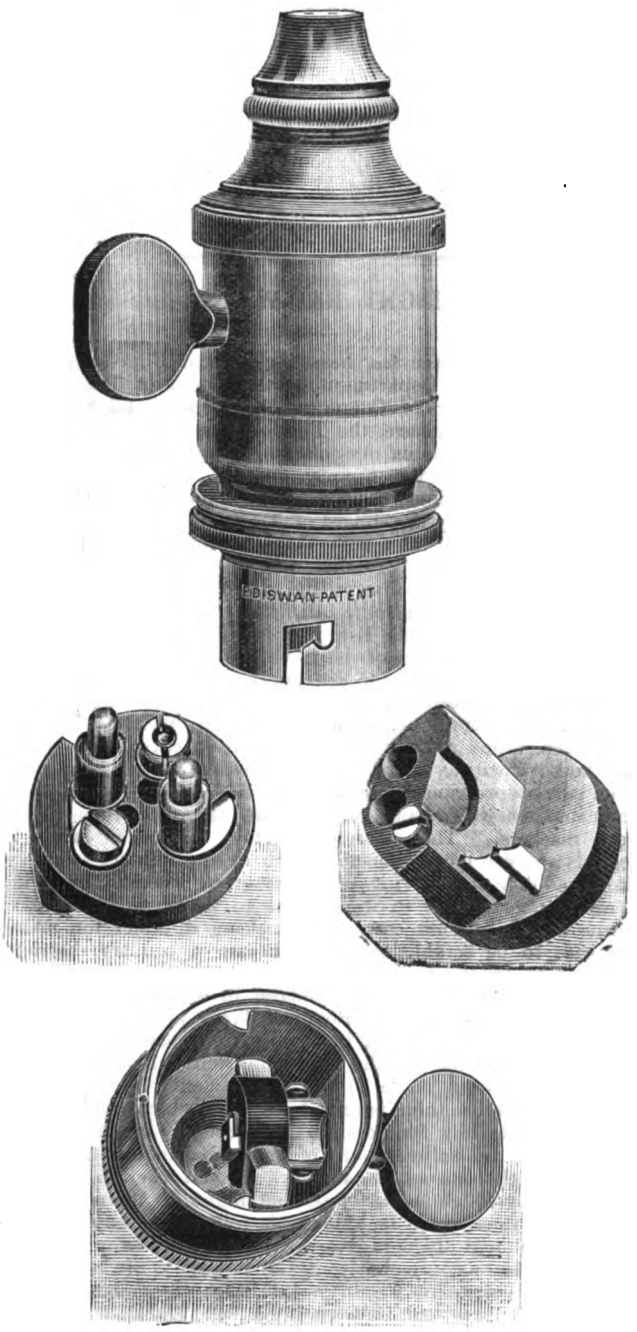
EDISWAN NEW LAMPHOLDER.

The accompanying illustrations represent the Ediswan new lampholder, which is fitted with shade carrier, key, and cord grips. As will be seen from the illustrations, it is easy to wire, and it is naturally claimed by the makers that short-circuits are impossible by the use of this holder, which is made in silver, aluminium, nickel-plated polished brass, black bronze, etc. The illustrations are self-explanatory, and the holder, as will be readily understood, is made by the Edison-Swan United



Electric Light Company, Limited, of 36 and 37, Queen-street, Cheapside, E.C.

CROYDON.

The Croydon County Council had presented to them on Monday night the following recommendation by the General Purposes Committee: "That the Corporation should arrange with some company of undoubted stability to establish an installation for a compulsory area at such contract price as the consulting engineer of the Corporation may approve; that the Corporation should find the necessary capital for the above purpose; that the company should undertake to work the undertaking for a term of years to be agreed, and to maintain the plant in thorough working order, taking the revenue to be derived from the undertaking and satisfactorily guaranteeing to pay to the Corporation interest and sinking fund upon the capital expended; that powers should be reserved to the Corporation to take over the undertaking from the company upon terms to be agreed at an earlier date than the expiry of the period stipulated in the first instance; if the foregoing recommendation be adopted the committee recommend that the sub-committee be authorised to obtain the advice of a consulting engineer, to make all needful enquiries and to report further."

Mr. Alderman D. B. Miller, J.P., the chairman of the committee, in moving the adoption of the report, said the question of electric lighting had exercised the Council for some six years.

Mr. Councillor Martin Luther Moss seconded the motion.

The **Town Clerk** said that some of the councillors seemed to think that the Corporation would have to find the money for working the undertaking, but that was not so.

After some discussion the report of the committee was adopted without a division.

COMPANIES' MEETINGS.

EASTERN EXTENSION TELEGRAPH COMPANY.

A general meeting of the Eastern Extension, Australia, and China Telegraph Company was held at Winchester House on Wednesday, Sir John Pender being in the chair.

The **Chairman**, in moving the adoption of the report, stated that the gross receipts for the half-year under review amounted to £247,681, against £257,986 for the corresponding period of 1893. During the half-year the loss on exchange had been exceptionally heavy, amounting to £21,000; otherwise the revenue would have shown an increase. The loss resulting from the third year of working under the Australian tariff guarantee arrangements amounted to £12,384. During a portion of last year, however, an abnormally large traffic was carried on in connection with the reconstruction of many of the Australian banks. With regard to the proposed Pacific cable, he remarked that it was ripening. The Canadian Government was very anxious to see the scheme carried out. There had been a meeting in Australia and a conference at Ottawa, at which they were all very complimentary to one another; but, so far as he could learn, the result of the conference was to ascertain what would be the best water in which to lay a submarine cable, and afterwards to invite tenders. It was not their business to oppose, but when the cable came to be laid he thought the Government would be wise if it consulted the Company, not only as to where it should be laid, but also as to its maintenance. If it was decided that the cable should be laid, he thought it was likely that that Company would have something to do with it. In any event, they would use the power they possessed to protect their interests. In answer to a letter received from a shareholder, he defended the maintenance of a substantial reserve fund.

The **Marquis of Tweeddale** seconded the motion, which was carried.

MONTEVIDEO TELEPHONE COMPANY.

The annual general meeting of the Montevideo Telephone Company, Limited, was held on Wednesday at the offices, Gresham House, E.C.

Mr. Herbert Ward proposed the adoption of the report and accounts, and said the net profit of the year's working—£6,902—was slightly in excess of the net amount of profit last year. The subscriptions had increased by £460, and the item under this head to the credit of profit and loss was still further augmented this year by the rent received for sub-letting the lower portion of the central premises at Montevideo. He was happy to say that no bad debts had been made during the year, which was an evident effect of the improvement which had at last set in in Uruguay, and which, as it continued, was sure to make itself felt in all branches of trade and enterprise connected with that country. The number of subscribers continued to be well maintained, and showed, in fact, an increase of 46 at the end of July, compared with the same time last year. Altogether, he thought it might fairly be said that the Company was steadily progressing, and with greater activity in business circles in Montevideo would make even greater and more rapid progress. By placing to the reserve £1,000, the position of the Company was further strengthened by the possession of an actually liquid asset to that extent.

The motion was seconded by **Mr. F. W. Jones**, and, after a short discussion, agreed to and a dividend of 4 per cent. on the preference share capital was declared.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Liverpool.—Tenders are invited for putting up 100 (16 c.p.) electric lights and one arc light, with dynamo. Apply to Messrs. Kauffmann, Lawson, and Co., Fox-street, Liverpool.

Sunderland.—The Corporation require tenders for wiring the Town Hall, including the supply and fixing of all cables, casings, switch and fuse boards, lamps, etc. Copy of specification, etc., may be obtained at the office of the borough electrical engineer on the deposit of £1. 1s. Tenders must be delivered at the office of Mr. Fras. M. Bowey, town clerk, not later than November 8.

London, E.C.—Tenders will be shortly invited by the National Telephone Company, Limited, for the following articles. Persons and firms desiring to tender must forward their names and addresses, on or before 5th inst., to the Head Storekeeper,

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National Telephone Company, Limited, Oxford-court, Cannon-street, London, E.C.: magneto blackboards, trembling bells, magneto driving bands, brass-headed nails, soap, leather bags, chairs, towels, switchboard cords, pitch-pine poles (square), linoleum, creosoted duck boarding, charcoal, Portland cement, slates, glass and emery cloth, beech pole-tops, uniforms, handcarts, roofing felt, composition tubing, tiles, bricks, sand, galvanometers, iron and brass screws (for wood), call signs, raw hide suspenders, sheet lead, sheet zinc, linseed oil, turpentine, French polish, putty, whitening, size, paints, white lead, rope, sash line, mattress twine, tarred canvas, spun yarn, tinman's solder, plumber's solder, glass jars, muriate of ammonia, sulphate of copper, silence call-boxes, methylated spirits, ladders, larch poles, tools, nails, staples, battery-boxes, cast-iron pipes, terminals, tool basses, snatch blocks and double blocks, stationery supplies. Mr. W. E. L. Gaine is general manager.

RESULTS OF TENDERS.

Islington.—Last week the Electric Lighting Committee of the Vestry sat to consider tenders for the erection of an installation on the site acquired by the Vestry, at the west end of Eden-grove, adjoining the Great Northern Railway, at a cost of about £19,000. Of the following tenders, that submitted by Messrs. Macfarlane Bros. was accepted, the price, including glazed bricks, being £22,785. The following are the tenders for the erection of the central station, including extra cost for glazed bricks:

		Extra.
Bush and Sons	£23,360	£1,718
Hall, Beddall, and Co.	24,440	1,710
Harris and Wardrop	23,978	1,790
Higgs and Hill	24,484	1,764
Holloway Bros.	23,210	1,938
Lester and Co	24,731	1,670
Macfarlane Bros	21,685	2,100
Mattock Bros	21,991	1,885
J. T. Messom	22,750	1,700
Perry and Co.	23,229	1,682
Rider and Son	24,996	1,800
L. H. and R. Roberts	23,493	1,896
W. Shepherd	22,500	1,680
G. S. Williams and Sons	22,264	1,917

BUSINESS NOTES.

Wolverhampton.—The new works of Messrs. Thomas Parker and Co. are nearly completed.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,975.

Bristol.—The old King-street Baptist Chapel and Highbury Chapel are to be lighted by electricity.

Stafford.—The new county technical instruction buildings are to be lighted throughout by electricity.

Llanelly.—The Dafen Works have been lighted electrically. The work has been carried out by Messrs. J. C. Howell and Co.

City of London Electric Lighting Company, Limited.—The telegraphic address of this Company is now "Lumen, London."

Thurlstone.—The new woollen mills at Plumpton, Thurlstone, belonging to Messrs. Tomasson and Co., have been lighted by electricity.

Change of Address.—Mr. L. A. Groth, the inventor of the electric tanning system, informs us that he has removed to 88, Neckarstrasse, Stuttgart.

Tonbridge.—New buildings in connection with the Tonbridge School have been opened by the Archbishop of Canterbury. They are lighted by electricity.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 29th ult. amounted to £901, as compared with £583 in the corresponding week of last year.

Derby.—The Duchess of Rutland on Thursday last week opened the new Midland Deaf and Dumb Institution. The electric light has been installed throughout the building by Mr. Edwin Haslam, of the St. Helen's Works.

Change of Telegraphic Address.—Mr. J. Burns, of 15, Long-lane, E.C., the representative of the Delaware Hard Fibre Company, informs us that he has changed his telegraphic address from "Isolateur" to "Isolement."

Altrincham.—The Altrincham Electric Supply, Limited, propose commencing the supply of electric light in the Altrincham and Bowdon districts shortly. The price which will be charged is 8d. per unit, subject to a discount.

Chelmsford.—The Town Council have ordered new electric lamps to be placed in South-road (Barrack-square), Wolsey-road, Railway-square-road, and Seymour-street. All defects in the main cable have now been repaired.

Llanberis.—The survey of the proposed electric railway up Snowdon is rapidly proceeding. The promoters have acquired from Mr. Assheton Smith the lease of the Victoria Hotel, Llanberis, and it is proposed to erect another hotel on the summit.

Gloucester.—The town clerk has reported to the Town Council as to correspondence with certain companies in regard to electric lighting, and stated that both had decided not to apply for a provisional order this year, and had withdrawn their notices.

Wigston Electrical and Engineering Company, Limited.—This Company has been registered with a capital of £25,000 to carry on business as electrical, mechanical, and general engineers, wholesale and retail ironmongers, cycle manufacturers, boiler-makers, etc.

Telephony in Kent.—In a few weeks an exchange will be opened at Sevenoaks and another at Gravesend, while it is proposed at an early date to open exchanges at Sittingbourne, Wateringbury, and Kearsney, all of which will be connected with the trunk lines.

Halifax.—The Town Council have appointed Mr. W. Henwood, of London, foreman of the electric lighting department, at a salary of two guineas per week. It was decided to abandon the negotiations with the vicar of Halifax for an exchange of land adjoining the electric lighting works.

Camberwell.—The Vestry have resolved to inform Messrs. Ellis and Son, of Fenchurch-street, that before they could lay mains for electric lighting on an estate at Red Post-hill they must obtain either parliamentary power or a license from the Board of Trade, and then the Vestry could concur in or dissent from the scheme.

Burnley.—Alderman Lancaster, vice-chairman of the Gas and Electric Lighting Committee of the Town Council, stated at the last meeting of the Council that the use of the electric light was steadily increasing, and in a short time they would have 6,000 8-c.p. lights connected.

City and South London Railway.—The receipts of the Company for the week ended October 28 were £948, against £850 for the corresponding week of 1893, or an increase of £98. The total receipts for the current period of the present half-year amount to £14,811, as against £13,806 in the corresponding period of 1893, an increase of £1,005.

The Foreign Office.—Some of the electric lights went out at the Foreign Office on Monday. This was not due to any failure in the supply of energy from the mains of the Westminster Electric Supply Corporation, but owing to the melting of a safety fuse within the building. The lamps on one floor were out until a new fuse was inserted.

Llangollen.—The members of the Llangollen Bowling Club have played the closing match of the season by the aid of electric light. A further display of the electric light was made in the centre of the town, three arc lights being placed respectively in front of the Royal Hotel, Messrs. Morris and Hughes's, and Mr. P. Davies's establishments.

Bolton.—Wesley Chapel is to be lighted electrically on Sunday next. The work has been carried out by the Corlett Electrical Engineering Company, of Bolton and Wigan. There are over 90 32-c.p. lamps in the chapel, two 50-c.p. lamps in the transept, 67 8-c.p. lamps in the mission-hall below the chapel, besides others in the vestries, lobbies, etc.

Aberdeen.—The question of introducing the electric light into the Municipal Buildings has been considered by the Finance Committee of Aberdeen Town Council. It was remitted to Treasurer Bissit, Mr. Cran (city chamberlain), and Mr. Murray (electric engineer) to procure tenders for the necessary wiring, etc. The cost has been estimated at about £200.

Storage Battery Litigation.—The Electrical Power Storage Company, Limited, write to us as follows: "The Accumulator Company of Philadelphia (the owners in America of the Swan and other patents known as the E.P.S.) have obtained a preliminary injunction issued by Judge Lacombe in the United States courts against the manufacturers of the chloride storage battery in the U.S.A."

Bristol Electric Lamps.—The carriage exhibits of Messrs. Holland and Holland at the Antwerp Exhibition, and which took a *grand prix*, were fitted with the electric light installed by the Bristol Electric Safety Lamp Works, of 63, Queen Victoria-street, E.C. The latter firm inform us that after prolonged experiments the new range-finding instrument devised by Profs. Barr and Stroud are all fitted with their accumulators.

Hull.—The Electric Lighting Committee of the Hull Corporation state that for the quarter ending September 30 they have delivered to consumers 20,149 units, against 10,740 units in the corresponding quarter last year. Their expenditure was £1,927. 8s. 8d., and their income £2,013. 16s. 6d., so that they have a balance of £86 7s. 10d. in hand, and the best quarter to come. They hope by the end of the year to present a very flattering report.

Sunderland.—The Museum and Library Committee of the Town Council have again considered the question of the electric light. An estimate was submitted placing the necessary installation at £314 and the annual cost of the light for the whole building £165. The committee thought it would be better at first to apply the light only to the library and reading-room, and the matter was adjourned till the next meeting to obtain an estimate for that purpose.

Automatic Recording Instruments.—Mr. L. P. Casella, of 147, Holborn-bars, the well-known scientific instrument maker to the Government, has been appointed agent in Great Britain, America, and the Colonies for the sale of the automatically-recording instruments of Messrs. Richard Frères, of Paris, and of which Mr. Casella has just published an interesting catalogue. These instruments can be adapted to all kinds of engineering, electrical, meteorological, and other purposes.

Heckmondwike.—The electric light has been installed in the purifying department of the Heckmondwike Gasworks, the object being to illuminate the shed without the dangers which the use of the ordinary gaslight exposed the place to. The installation is by Messrs. A. Hirst and Sons, Dewsbury, and comprises

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20 incandescent lamps of 16 c.p. each, though the dynamo is capable of supplying other 30 lights of similar power. It is worked by one of Crossley's 3-h p. gas-engines. The cost of the installation is about £150.

Bootle.—A special meeting of the Town Council has been held in pursuance of the provisions of the Electric Lighting Act, 1882, and it was resolved, upon a motion submitted by Alderman Webster, "That application be made to the Board of Trade, on or before December 21, 1894, for a provisional order under the Electric Lighting Acts, 1882 and 1888, to authorise the mayor, aldermen, and burgesses of the borough of Bootle, in the county of Lancaster, to supply electricity for public and private purposes within the said borough."

Dover.—The arrangements for giving Dover the electric light are being pushed forward. During the past week the hauling in of the cables has been going on, and the transformers are now being put in. The filling up of the station is also being pressed on. With regard to the wiring of premises so as to receive the light, negotiations are going on with owners of house property to put in the fittings and charge the tenants a percentage of the cost in their rent. This is expected to lead to business in cases where the initial cost would have been a hindrance.

Birmingham Central Trams.—A special meeting of the Birmingham Central Tramways Company has been held to discuss a proposition from the directors to reduce the capital from £388,000 to £194,000, in consequence of the heavy burden of unremunerative expenditure in the early years of the company. A fortnight earlier an unsuccessful attempt was made to pass the resolution, but at the last meeting the directors were provided with proxies representing the necessary three-fourths of the company's capital, and the opposition being withdrawn and the proposal carried.

Western and Brazilian Telegraph Company.—At a meeting of the Board of the Western and Brazilian Telegraph Company, Limited, it has been decided that, after placing £2,000 to the reserve fund and £5,000 to the debenture redemption fund, the directors would, subject to audit, recommend at the forthcoming meeting a dividend at the rate of £2 per cent. per annum, free of income tax, for the six months ended June 30 last, carrying forward £5,630. This dividend will be payable as follows: 3s. per share to the ordinary shares, and 3s per share to the preferred ordinary shares. The transfer books will be closed from Tuesday, November 6, to Friday, November 16, both days inclusive.

Bury.—The following report was submitted at the last meeting of the Town Council: "At a meeting of the Electric Lighting Committee on October 17 there were present Alderman Parks (in the chair), Alderman Brierley, Councillors Byrom, Collinge, Hopkinson, and Thornley. Tenders for the central station and other works from five firms were opened, and handed to Mr. Cartwright for tabulation and comparison. The borough engineer submitted his report on the progress at the works. It was resolved that Mr. G. E. Smirk be appointed clerk of works to superintend the erection of the new buildings." Alderman Peel: When may we reasonably expect any result from the Electric Lighting Committee? Shall we have it next year or next year but one? The Mayor: Well, I am not a prophet, or the son of a prophet, but I think some time next year. The minutes were carried.

Appointments Vacant.—The Corporation of Dewsbury invite applications for the following appointments at their electric lighting station—viz., engine-driver, must be a thorough mechanic and accustomed to condensing engines; stoker, accustomed to high-pressure Lancashire boilers and mechanical stokers; dynamo attendant, must have had experience in the running of dynamos; jointer, accustomed to high-class work; and office clerk, who shall also act as meter inspector and keep statement of electric energy consumed; a knowledge of shorthand preferred. Applicants to state age, experience, and wages required. Applications, with not more than three recent testimonials, under sealed cover, endorsed "Electrical Staff," to be in the hands of Mr. E. Mawdesley, town clerk, Town Hall, Dewsbury, by 12 noon on Nov. 3. The Hull Corporation want an improver at their electric light works. Particulars appear in our advertising columns.

Artistic Electric Light Fittings.—A visit paid by one of our representatives to the works of Messrs. S. Haynes and Co, artistic metal workers, of 2, Longford-street, Regent's Park, N.W., afforded ample proof of the company's facilities for manufacturing high-class fittings of a variety of descriptions. Not only do the company produce by their own artists any special designs which any firm in the trade may require, but they also carefully carry out designs prepared by architects. A speciality is made of wrought-iron work, and the standards, pendants, electroliers, and table lamp fittings on view at the works are sufficient to satisfy the most fastidious. The company, in fact, make electric, gas, and oil fittings of every description, and they will, we feel sure, obtain the support and goodwill of the trade. No wiring contracts are undertaken by the company, who have recently supplied to special design fittings for the Baths Club and for the Bishopsgate Foundation Institute.

The Rhondda.—At the fortnightly meeting of the Rhondda Local Board, which has been held at the Public Offices under the presidency of Alderman W. H. Mathias, J.P., a discussion took place upon the proposal by one of the members that the various streets and roads in the valleys now lighted by gas should be illuminated by electric light. Mr. T. Griffiths, M.E., head manager of the Cymmer Collieries, Porth, stated that he was quite prepared to lay an installation at his collieries to generate sufficient electricity to light the whole of Porth and the Cymmer district, as well as the collieries belonging to the company, at a cost not greater than that charged by the gas company. It was agreed that the clerk should write to the other colliery companies asking them if they were prepared to supply the other portions of the valleys. It should be stated that the Cwmparc district, where the Parc and Dare Collieries (Ocean) are situated, is already lighted by electricity generated by a powerful dynamo at the Parc Colliery.

Cardiff.—A special meeting of the Lighting Committee of the Cardiff Corporation was held on Thursday last week, under the chairmanship of Alderman Carey, for the purpose of making a final selection of the candidates for the post of foreman of the electrical machinery at the new electric lighting works. The four candidates who were selected from the applicants for this post were examined by Mr. Massey before the committee as to their experience in central lighting stations. There is a resolution standing on the Council minutes to the effect that all appointments worth £3 per week be opened to the town only. The effect of this resolution was to confine applicants for this post to the town, a thing which Mr. Massey objected to. After some discussion the following resolution was carried: "That in the opinion of the committee the candidates, after having been examined by Mr. Massey in the presence of the committee, do not meet the requirements of the committee, and that the matter be referred back to the Council for instructions."

Newcastle.—A special meeting of the Corporation of Newcastle has resolved to go forward for a provisional order to obtain borrowing powers for laying down cable trams on the Byker, Scotswood, and Westgate sections of the tramways, and to negotiate with the lessees for terms to cover principal and interest. In the course of the discussion, Mr. Morton said that Mr. Alex. Siemens, who advocated the electrical system, called upon the committee and presented a copy of his circular to him (Mr. Morton). Mr. Laws, in his report, had said that the total cost of the system at Budapest was £12,000, whereas Mr. Siemens said the actual cost of construction was one-third of that. He asked Mr. Siemens if he had included the power stations and all the cost that came upon the construction of the line. He now had a letter from Mr. Siemens, in which that gentleman said that they estimated the total cost at £10,000 per mile, though much, of course, depended on the total length and the intended frequency of traffic. According to Alderman Stephens, "electrical science is only in its infancy."

Sheffield.—The Sheffield Electric Light and Power Company, Limited, are extremely busy in supplying lamps and fittings on the premises of new consumers. The progress made during the past year amounts to about 110 per cent. The demand for current has gone up rapidly, so that the company have been obliged to hurriedly obtain additional generating power, and it is expected that a new 300 kilowatt steam alternator, by Mr. Ferranti, will be working on the supply mains by the middle of December next. The new town hall, which is rapidly approaching completion; the Weston Park Museum; Oakbrook, the late residence of the Firth family; and the Church Institute, are among the many orders that the company have in hand for the installation of the electric light. The company is somewhat unique in its method of operation. In addition to holding a provisional order for the supply of current, it, as far as possible, strongly encourages consumers to have their premises wired by the company. They are also contractors in a considerable way for isolated and private installations for residences, collieries, etc.

Chelsea Electricity Supply Company.—The Finance Committee of the London County Council on Tuesday reported: "On January 13, 1888, the late Board granted a license for seven years to the Cadogan Electric Light Company for the erection of a temporary iron smoke-stack at 91, Manor-road, Chelsea, and under the terms of the agreement then entered into the sum of £250 was deposited with the Board to ensure the removal of the stack. On March 9, 1888, the Board at the request of the Company invested the £250 in the purchase of £259. 8s 1d. of Government 2½ per cent. stock, and the dividends received and now in the hands of the Council amount to £17. 7s. 2d. The smoke-stack having been removed, application has been made for a return of the deposit and the dividends accrued thereon, and the solicitor being now satisfied that the secretary of the Company is the person entitled to receive the amount, there appears to be no reason why the money should not be repaid. As the stock now stands in the name of the Council, it is necessary that it should be sold, so that the proceeds may be paid over. We accordingly recommend that the comptroller be instructed to direct the treasurer to sell the sum of £259. 8s. 1d. 2½ per cent. Government stock now standing in the name of the Council, and that the proceeds be paid over by the solicitor to the Chelsea Electricity Supply Company, Limited." This was agreed to.

Islington.—Last week the first step towards making electric lighting in Islington an accomplished fact took place at the corner of Blackstock-road. Operations would have commenced at The Angel, but having regard to the fact that the cattle show and Christmas are approaching, it was thought by the Electric Lighting Committee that excavating and pipe-laying work would seriously inconvenience shopkeepers at the busiest time of the year. It was therefore decided that the laying of the mains should be commenced at Finsbury Park, and after Christmas operations should be commenced at the other extremity of the parish, as within two years the Vestry is compelled to supply electric lighting along the main thoroughfare, stretching from the Archway Tavern and Finsbury Park to The Angel. Amongst those present to witness the cutting of the ground were Messrs. S. Lambert (chairman of the Electric Lighting Committee), D. W. Williams, W. Barratt, J. H. Mote, J. T. Johnson, S.

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Rayson, A. Walkley, F. T. Bailey, A. J. Fearnhead, T. W. Vine, J. Oldis, Albert Gay (electrical engineer), and G. W. Clarke (chief clerk of the Vestry). Mr. S. Lambert, dislodged a flagstone at the corner of Blackstock-road with a pickaxe, and afterwards dug up a portion of earth. Mr. Johnson went through a similar performance with a shovel, and within a few minutes 20 labourers were busily engaged in digging a trench on either side of the footway in Seven Sisters-road.

Newhaven.—A local paper states that the installation of the electric light at Newhaven, which was inaugurated last week by the London, Brighton, and South Coast Railway Company for their stations, sheds, quays, etc., is now in full swing, and gives the greatest satisfaction. Mr. Smith Mannering, the resident engineer of the hydraulic machinery, has had charge of laying down the generating plant, under the direction of the company's locomotive superintendent, Mr. R. J. Billinton. The engines are of the well-known Willans and Robinson high-speed single pattern, and are supplied with steam from the same boilers that Mr. Billington designed for the hydraulic machinery, thus ensuring a great economy in working, as both plants can be worked at the same time. A notable feature in the engines is an approved application for adjusting the speed to suit whatever load may be on the dynamos, and thus ensure a regular speed, a most important factor in the governing of electric light engines. The dynamos, which are of the Anglo-American Brush type, are each capable of an output of 55 arc lights of 2,000 c.p. The whole of the lighting, including laying the mains and testing, was efficiently carried out by Mr. Cowley and his assistants, under the direction of Mr. E. J. Houghton, the company's electrical engineer. One dynamo is sufficient to meet the present requirements, but a spare set is always ready to start in case of partial failure. Mr. Billinton has put in foundations for a third set, and will no doubt fix the necessary machines as soon as there is a demand for further extension.

Dewsbury.—The report of the Lighting and Water Committee of the Town Council presented to the Council stated that on October 1 a payment of £1,000 was made to Messrs Crompton and Co., Limited, on their contract for engines, etc., at the electric lighting central station, and a second payment of like amount to Messrs. J. and J. Horsfield on account of boilers. Mr. A. Pickersgill, of Dewsbury, was appointed assistant electrical engineer, at the weekly wages of £2, such appointment to commence on the date of the first working of the electric lighting station, and to be terminable by one week's notice, he to devote the whole of his time to the duties of the appointment. On October 15 Mr. Preece, having considered the analysis of beck water, and being of opinion that a cold-well should be constructed outside the condensing-room at the central electric station, it was agreed to build one to hold 25,000 gallons of water. The chairman, vice-chairman, and Councillors Birkhead and Bullock were appointed a sub-committee to engage necessary workmen at the electric light station, also to provide an office for the electrician. On October 22 it was resolved to convert the room in Bradford-road, lately occupied by Mr. Petty, into an office and testing place for the electrician. Amended draft rules by Mr. W. Preece for installation work were approved. A former resolution respecting the construction of the cold-well was rescinded, and the borough surveyor ordered to obtain tenders. Alderman Robinson moved and Councillor Archer seconded the confirmation of these minutes. Councillor Barstow asked if it was the intention of the committee to advertise for workmen or to arrange as to how many to employ for the electric lighting station, and whether the committee were going to confine intending customers for the supply of electric light to any special maker of wire and compel them to purchase from a certain manufacturer of wire. Alderman Robinson, in reply, said that without the men required they could not commence the installation. Men would be selected who were suitable for the work, and they would, of course, have the recommendation of their engineer. They required rules for wiring customers' premises. If they allowed any kind of wire to be used it would be open to abuse. The wire to be used would have to be approved before the lighting could be carried out.

Coventry.—The Electric Light Committee of the City Council are about to issue a circular to householders along the line of route of the electric mains inviting intending consumers to send in their names. It was necessary to state the price at which electrical energy will be supplied. The maximum price authorised is 8d. per Board of Trade unit, and the committee recommended that the price to be charged be fixed at 6d. per Board of Trade unit. At the last meeting of the Council Alderman Hill proposed the adoption of the report, and stated that the 6d. per unit mentioned in the report was equal to about 4s. per 1,000ft. of gas. Of course there were advantages connected with the electric light which might or might not commend themselves to persons. As to the supply outside the line of route, that would depend upon the distances of houses requiring the light and the number that might apply to be connected. He was glad to say that the buildings were progressing very satisfactorily, and that towards the end of January the Corporation would be in a position to supply the light. Mr. James seconded, and Mr. West, in supporting, said he understood that for 6d. the consumers would get sufficient current to work 30 8-c.p. lamps for one hour. Mr. Andrews, as chairman of the Gas Committee, took the opportunity of congratulating the Electric Light Committee on having so far proceeded with the scheme. At the same time, he doubted whether they could afford to supply the light at 6d. per unit and make both ends meet or some profit. It would be very unfair to the gas department if electric light was supplied at a loss, or even without any profit. Both lights should be put on the same footing. If the gas undertaking were expected to yield a profit, so should the electric light. Gas might have been sold at 2s. 5d. per thousand, instead of 2s. 8d. last year, but that the department were expected to produce a profit. He had supposed that the Electric Light Committee would be expected to do the same. Alderman Hill: I may say it is the intention of the Electric Light Committee to play fair. Alderman Tomson was glad to be able to agree with Mr. Andrews on this point, and said it would be a bad way of supporting the Gas Committee if their consumers got a shove off. Mr. Goate asked what the line of route was, and Alderman Hill replied that the information would be given in the circular.

Portsmouth.—Major H. Tulloch, R.E., inspector to the Local Government Board, has held an enquiry at the Town Hall with regard to the application of the Town Council for sanction to borrow £20,000 for electric lighting purposes. Among those present were Alderman G. Ellis, J.P. (chairman of the Electric Lighting Committee), Councillors J. J. Young and Commander W. L. Bamber, R.N., Mr. A. Hellard (town clerk), Mr. Manville (consulting engineer), Mr. Price, and Mr. Johnson. The Town Clerk explained that although sanction was asked to borrow £20,000, the amount immediately required was only £6,000, that sum being needed for the purchase of a new engine and dynamo, and the necessary transformer batteries. Alderman G. Ellis, who explained the matter in greater detail, said that the cost of the engine, dynamo, and fixing would amount to £4,500, and the balance of £1,500 would be required for transformers and the necessary cable connections to the houses. The Inspector: I have noticed that [the electric light is in use in a good many shops, but I was not aware that private houses were taking it up. In reply, Alderman Ellis said that the committee had had a good many applications from houses. The plant, costing £4,500, consisted of a coupled compound engine of 330 h.p., precisely similar to those previously erected, and the balance of the £20,000 would probably be required for more machinery and to extend the electric lighting area. They had already 363 applications from just outside the compulsory area, and if they got 500 such applications they would ask for powers to extend it. They had now actually expended £58,237. 19s. 3d. out of the £60,000 originally sanctioned, and they asked for sanction to take up the balance of about £1,800 for house connections. The cost of house connections amounted on the average to from £8 to £10 per house. They had now in use in shops and houses 5,224 16-c.p. lamps, independent of the street service, and they had besides applications for 1,202 more 16-c.p. lamps within the prescribed area not yet joined up. Of these 182 had come in that morning. Besides these they had an application for supplying the current to a 5-h.p. motor at the technical schools, and an application to supply current for a one man-power motor in a hairdresser's shop. The Inspector said that the progress during the year had been wonderful, and the enquiry was then closed, the inspector afterwards going with Alderman Ellis and other gentlemen to inspect the electric lighting plant.

Salisbury.—A special meeting of the Town Council was held on Friday last to consider the draft form of license applied for by the Salisbury Electric Light and Supply Company, Limited, as approved by the Board of Trade. The Town Clerk laid before the Council the draft form of the license, as approved by the Board of Trade, and Mr. Hammond's report upon it. He read this report, from which it appeared that the principal alterations made by the Board of Trade were the reduction of the period of duration of the license from seven years to two, and the reduction of the maximum price of electricity per Board of Trade unit from 9d. to 8d. The report also drew attention to the fact that the amending clauses which it had been suggested should be inserted in the license had been rendered unnecessary by the clause which limited the duration of the license to two years instead of seven. The Town Clerk said that the object of the special meeting was to give the Council an opportunity of offering any objections to the amended form of the license. Mr. Watson asked whether, supposing the company did not apply for the provisional order, and did not carry out the works proposed, the Council would have any remedy against them for the expense and trouble they had been put to? The Town Clerk said he should think not. The Mayor said the company had spent a considerable sum of money already, showing that they were in earnest. Mr. Horder said he supposed the carrying out of the proposed works depended upon the shares being taken up by the public. What Mr. Watson meant was, supposing the public did not take up the shares, would the Council have any remedy. The Town Clerk: The company have given an undertaking to apply for a provisional order, but they will not move until they get this license. Mr. Fullford said that naturally the company would not begin the work until the license was sanctioned and in their hands. Mr. Horder: Not until the public have taken up the shares. Mr. Watson asked what guarantee they had that the company, which was at present unpersonal, would carry out the work? The Town Clerk: None. Mr. Brittan remarked that the chief part of the expense the Council had incurred was £50 for Mr. Hammond's services. The Mayor said that although some people thought there had not been a great deal done for £50, the information and knowledge they had gained would be of great use to them later on. In reply to Mr. Watson, the Town Clerk said if the company did not get a provisional order within two years of the commencement of the license the whole scheme would be at an end, and any works which they had constructed would be valueless to them. Alderman Brown proposed, and Mr. Fullford seconded, a motion to the effect that the Council had no objections to offer to the amended form of the license. This was carried.

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Worcester.—The Electrical Exhibition Sub-Committee of the Town Council have presented a balance-sheet showing that the total receipts in connection with the recent exhibition amounted to £212, and the expenditure left a credit balance of £49. 6s. 10½d., without using the grant of £50 made by the Council's resolution of July 3 last. The admission receipts amounted to £133. 14s. 9d. The Mayor, in moving the adoption of the balance-sheet, spoke of the educational value of the exhibition. Mr. Cock pointed out that Mr. Davenport was paid £21 as secretary to the exhibition. The Mayor replied that Mr. Davenport undertook the whole responsibility of organising the exhibition. He placed himself in correspondence with all the firms who exhibited, and made himself responsible, at very great labour, to keep the exhibition in order. He thought the thanks of the committee were due to Mr. Davenport for the admirable way in which he carried the exhibition through. Mr. Chaplin endorsed the Mayor's remarks, and said he thought Mr. Davenport must have had an enormous amount of work to have brought the exhibition to so successful an issue. Alderman Hill seconded the adoption of the balance-sheet, and said he believed the exhibition had been not only a source of great gratification to everyone who attended it, but that if there had been no profit at all, they would have received a great deal of profit in the advertisement which the exhibition had given to the electric light, and in promoting applications for installation. The proposition was agreed to. A letter was received from the secretary of the tramways company, asking the committee to reconsider the tram by-laws, as they proposed to introduce a modern light car for 13 passengers, to be drawn by one horse. The Mayor remarked that in reconsidering the by-laws they might suggest to the company that the cars should be run by electricity. The matter was referred to the sub-committee. An application was received from Messrs. McKenzie and Holland asking that the current should be supplied to the Vulcan Works from 5 a.m. The Mayor stated that the committee were in a position to authorise the manager-in-charge to put on the current from five o'clock in the morning until 12 at night, and he proposed that this should be done. He had no doubt that in a fortnight they would be able to have a continuous current during the 24 hours. Although they opened the generating station on October 11, the entire work throughout the city was not completed, and the high-tension main had had to be interfered with for various purposes. They would also have the street lamps alight within the time he had mentioned. If they could have a continuous current for the 24 hours by the end of the first week in November they would have achieved a great success. The proposition to turn on the current from 5 a.m. to 12 p.m. was agreed to, and certain lamps are to be dispensed with at the end of November.

Liverpool.—Mr. Charles Reltie writes to the *Liverpool Echo* as follows: "The Liverpool Municipality know they will have to adopt electric light sooner or later, but evidently they mean to make us wait as long as ever they can. The idea, 'considering the great improvements being made in the electric light, they would not lay out any money at present." Now, sir, my opinion is that the electric light is at its highest state of efficiency, and is only waiting for people to take it up, and the only room for improvement is in small details. The cost of electricity for supply purposes has been worked out by many men of authority to be about 3d. per unit. The Liverpool Supply Company charge 7½d. But they rightly take into account first cost and heavy expenditure of laying down mains and plant. But I would guarantee if they had not the monopoly of Liverpool plenty of companies would be glad to supply the current for 4d. per unit, and then would be making 25 per cent. profit. It would not mind so much if the Municipality, or whoever has the public lighting in their hands, were more thoughtful. We as contractors would get more work, and be able to give others work, as being better for themselves and keeping pace with the times. The electric light should be used in all public buildings and thoroughfares supposing it cost treble the price of gas. What is the good of cheap gas if it is not effective? London now has the electric light, as many know, and is admitted, even by the Americans, to be the finest lit city in the world. All the gas poles have been taken down as they were obstruction. Gas consumes enough air in one hour to keep five men. If it were only for that one reason the electric light ought to be used at any cost; but as it happens (if you use your own engine, as would be the case if St. George's Hall and other buildings were lighted up) it can be produced for about a third less than gas, as well as having all the advantages over gas." At a meeting of the subscribers to the school ship "Conway," held in Liverpool, Mr. Charles McIvor stated that the installation of the electric light throughout the ship had cost £600. The committee felt that the "Conway" must advance with the time, and they were also conscious of the competition with the sister ship on the Thames, the "Worcester." The electric light was an advantage which would be most highly valued, and it had been provided at a cost which was considerably less than the cost to the "Worcester." Alderman Smith, at the last meeting of the Town Council, alluded to the motion down in his name in favour of authorising the Watch Committee to enter into negotiations with the Liverpool Electric Lighting Company for the purchase by the Corporation of their undertaking at an early date. He asked the Council to refer the motion to the Watch Committee, without expressing any opinion whatever upon it. Mr. Miles seconded this proposition. Mr. Houlding thought the Health Committee should have something to say upon the question of electric lighting. Alderman Smith agreed that the question should also be placed before the Health Committee. After further discussion it was decided that the question of the position of the electric light company with the Corporation of Liverpool should be placed before the committee mentioned for their consideration and report.

Edinburgh.—A West-end correspondent writes asking over what area in the city the streets are to be lighted by electricity, as he says that while the electric mains are being laid down in many thoroughfares he sees no arrangements made for street-lighting. The streets which are to be lighted by the Corporation by electricity are Leith-street, from Theatre Royal to Princes-street; Princes-street, Maitland-street, westwards to Haymarket; Lothian-road, Earl Grey-street, Tollcross, Home-street, Leven-street, to Barclay Church; Fountainbridge, from Earl Grey-street westward; Queensferry-street and continuation to Dean Bridge; North and South Bridges, Nicholson-street, Clerk-street, South Clerk-street, to Hope Park-terrace; Waverley Bridge and Cockburn-street; High-street, from George IV. Bridge to Holyrood; George IV. Bridge, Lindsay-place, Greyfriars-place, and Forrest-road. Three lamps are to be placed in front of the Science and Art Museum, Chambers-street, and possibly the back of the Castle may be lighted. The other streets where mains are being put down are within the compulsory area formed for the private lighting of houses, shops, offices, etc. The new Craig House Asylum for the Insane, which was opened on Friday last by the Duke and Duchess of Buccleuch, is lighted by electricity, the work having been carried out by Messrs. Ernest Scott and Co., of Newcastle. Mr. Bryson was the consulting electrical engineer. At Tuesday's meeting of the Town Council, Mr. Mackenzie asked Mr. Williams on what authority he said at his ward meeting "that owing to the electric light contracts being above the estimates, the first part of the work was not properly done. No provision was made (Mr. Williams said) in the way of water-tanks, so that when the ground subsided, as it certainly would, the pitch points would crack, and moisture would percolate into the conduits, with the risk of combustion and perhaps serious accident, as had happened in America." Mr. Williams said that the report was correct, with the exception that he prefaced the statement with the words that "he had heard it stated." But if the convener could assure him that means had been taken to prevent the water from getting to the wires, he would be, and he was sure the public would be, perfectly satisfied. Mr. Mackenzie said he had written Prof. Kennedy, who wrote him as follows: "The paragraph you sent me in a newspaper cutting is absolutely untrue. On the contrary, all the contracts have come very well within the estimates. Indeed, although there have been very great extensions made in the scheme since my estimate was sent in, I believe they will very slightly exceed the estimate for the smaller quantity of work exclusive of the station. The sentences about the water-tanks are perfectly unintelligible to me. There has been no trouble in the matter, and no alteration whatever from the original scheme as designed." At a later stage, Mr. Mackenzie said he was sorry they were not quite so far on with the electric light as they had expected. They had 20 miles of road works laid and had now only three to lay; and if nothing came in the way they would be in a position to turn on the current about the beginning or middle of March.

New Swindon.—At the last meeting of the General Purposes Committee of the Local Board, it was resolved that Mr. J. G. W. Aldridge, of 9, Victoria-street, Westminster, be the electrical engineer for the purpose of the provisional order, and that the clerk arrange the fee to be paid for his services. It was also resolved that the necessary notice to be given applying for a provisional order for electric lighting should include every street within the district, and also all public buildings belonging to the Board. Mr. Jones, at the last meeting of the Local Board, took exception to this report, and moved as an amendment to the committee's recommendation that the said committee reconsider the question of obtaining this provisional order. He objected to the whole area being included, because the scheme as previously laid before the Board only applied to this Board's district and certain streets therein. The present proposal would be a very large item financially, and he for one would like to know something of the cost before the members of the Board committed themselves. Moreover, he thought that at the present stage the idea of electric light was too premature. The surveyor would tell the members that there were 20 miles of streets in the district, and if the provisional order was to include the whole of that, then a large expenditure must necessarily be involved. He thought the whole matter should go back to the committee for further consideration, and then be more clearly laid before the Board. He was aware that the clerk would say that all the necessary formalities had to be carried out early next month, but even supposing the Board did not insert the necessary advertisements in the local newspapers in November, no private company could come into the town and fix a plant for electric light without the Board saying yea or nay to it. He considered that the new authority, to be elected by the vote of the electorate, should say whether this new light should be adopted. Personally, he should welcome it, but as the Local Board would soon go out of office they should not hand over to the new body a great responsibility in which that new body had no voice. The Clerk pointed out that it was necessary to carry out these formalities, but that did not bind the Board to carry out all the details. Mr. Mills: It does not follow that because we name all the streets that we shall light them all. The Clerk: No; certainly not. Mr. Longland contended that there was no time now for the Board to reconsider this matter if they wished to obtain the provisional order this year. Mr. Jones had been talking about placing a responsibility on the new authority, but so far as he could understand the matter the only responsibility they would place upon the new Urban District Council would be the cost of obtaining the provisional order and the plans. It would then be

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in the hands of the new authority to throw the matter over or otherwise. This Board, by doing what was now recommended, would be simply securing a position for the new authority. It seemed to him a rather doubtful question whether if the Board took no action in the matter they would be able to keep out a private company. The Clerk said the proposed action would give the new body who were to succeed the Board power to proceed. Mr. Protheroe expressed surprise that Mr. Jones should raise his opposition now, when he readily acquiesced in the matter at the General Purposes Committee meeting. He (Mr. Protheroe) thought the Board would act very wisely in adopting the recommendation. Mr. Jones: I say the scheme is in a crude state, and we have not had the full details brought before the Board. Mr. Mills wished to say that Mr. Jones was making an incorrect statement, because the Board had had the report of the Electrical Committee before them, and fully discussed it. Mr. Jones: I agree that we have had figures put before us, but we have not had the advice of the electrician. The matter is too premature. Mr. Jones's proposition did not find a seconder, and the committee's report was adopted.

Ealing.—The Electric Lighting Committee have reported to the Local Board that they had had before them a memorial from residents in the Mount Park district asking for the electric light mains to be laid in that district, with the view to the introduction of private lighting into their residences. The committee recommended that all applicants for the electric light be asked to fill up the necessary form of application, when the matter could be brought formally before the Board for further consideration. The committee recommended the adoption of a similar course as to the Drayton Court shops, in respect of which a memorial had also been received. The memorial from Spring Bridge was ordered by the committee to stand over for further consideration. The Surveyor, reporting on the scheme, mentioned that application had already been made for 2,500 private lamps (half the number estimated for). The cause of the flickering experienced in the light at present was that the machinery had not sufficient "load" on; as the supply was increased that defect would disappear. Mr. St. John, in reference to the application that had been made for an extension of the electric light mains to the northern part of the district (Haven Green, Woodville-road and vicinity), urged that, if practicable, the Board should for the present discontinue the laying of the electric cable along the Uxbridge-road, from the foot of Hanger-lane to the Acton boundary, and use the cable that would have been employed between those points for the introduction of the light over the railway into the Haven Green district. The Clerk, in reference to the legal difficulties that might be encountered in carrying out Mr. St. John's suggestion, said that, apart from that Board, there would be three parties whose consent would be necessary to the alteration proposed being made—the contractors, the Board of Trade, and the Local Government Board. He did not apprehend that the contractors would raise any objection in the matter, and he also did not think that any difficulty which could not be surmounted would emanate from the Board of Trade or from the Local Government Board with regard to the proposal (having regard to the fact that the portion of the Uxbridge-road, the electric lighting of which would under this proposal be temporarily abandoned, was included in the area of compulsory supply as defined in the electric lighting order obtained by the Board from the Board of Trade, and in the loan consent to the borrowing of which had been granted by the Local Government Board). The Board, the clerk added, could not legally make the alteration without the consent of the Board of Trade and of the Local Government Board. To do so would be a breach of faith towards those bodies, and the Board could not legally apply, without the consent of the Local Government Board, money which had been borrowed for the provision of electric lighting in one part of the district to the provision of that lighting in another part. The Surveyor, in reply to a question, said that the length of the road thus proposed to be left unlighted electrically was about 1,000ft. He added, in reply to a further question, that it would, of course, be practicable for the Board to order the engineers or contractors to cease the laying of the mains at the point indicated—the foot of Hanger-lane. He would point out, however, in regard to the proposal, that although the portion of road, the electric lighting of which it was proposed to abandon for the present, contained but few houses, the Ealing Common Station of the District Railway was included in it, and there was considerable traffic along the road to and from that station. The District Railway Company were also large ratepayers in the district, and they might, of course, have something to say with reference to this suggested deviation from the plans sanctioned by the Board of Trade and the Local Government Board. After some further discussion, Mr. St. John formally moved: "That the engineers be directed to stop the work of laying the electric cable along the Uxbridge-road from the bottom of Hanger-lane to the Acton boundary until the next meeting of the Board. That formal notice be given of the intention to discuss at that meeting a proposition to temporarily abandon the laying of the electric mains along that part of the Uxbridge-road, with a view to utilising for the introduction of the electric light into the northern part of the district the cable that would otherwise have been used in that part of the Uxbridge-road, such notice to be placed on the agenda paper for the next meeting of the Board; and that in the meantime the clerk communicate with the Local Government Board and the Board of Trade with the object of ascertaining whether they would be prepared to consent to this contemplated temporary diversion (for the reasons mentioned) from the original plans for the laying of the electric mains." Mr. Kasner seconded the proposition, on the ground that he was anxious that the Board should not apply for any additional loan at present, and because, while application for any additional loan would in his opinion be objectionable, the Board were desirous of meeting as far as possible the wishes of the residents for the supply of electric light into private premises in the district. The proposition was carried, a remark being made that if the Local Government Board and the Board of Trade refused consent to the proposed deviation, no expense would have been incurred, and the Board would simply be in the position they were in at present in regard to extending the electrical lighting of the Uxbridge-road to the Acton boundary. On the suggestion of the Surveyor, and on the proposition of Mr. Kasner, the Board unanimously passed a cordial vote of thanks to the firms, the assistants, and others who had worked in connection with the recent electrical exhibition, and had helped to make that exhibition the success it had been. Mr. Kasner, in moving the proposition, observed that the members of the Board were all delighted at the success that had attended the exhibition, and certainly thanks were in a special measure due to those exhibitors from outside the district who at considerable expense had fitted up stalls at the exhibition.

Kingston-on-Thames. — The minutes of the Lighting and Market Committee of the Town Council contained the following items: "Resolved that the borough electrical engineer be authorised to draw up a circular letter to all persons on the circuits where the electric cable is being laid, calling their attention to the benefit to be derived by using the electric light. The borough electrical engineer was instructed to report at the next meeting the probable cost of laying mains for charging electric launches. The borough electrical engineer reported that a letter had been received from Mr. W. H. Preece, engineer-in-chief to the General Post Office, enquiring on what terms the Corporation would supply current to the post office at Kingston. The further consideration of the matter was adjourned to the next meeting. The chairman reported that the floor at the electric light station was in an imperfect condition. Resolved that the borough surveyor be instructed to report at the next meeting as to the cost of laying down block flooring. The consulting engineer reported that a new boiler was necessary at the electric works. Resolved that the same be ordered from Messrs. Belliss and Co., similar to the previous boiler, but with certain modifications. The consulting engineer handed in a certificate for £2,000 to Messrs. Siemens—viz., £1,000 on account of work under their contract, and £1,000 for general work. Resolved that such certificate be passed on to the Finance Committee with a recommendation for payment by the Council. A letter was read from Messrs. Siemens with regard to the arc lamps, in which they said: 'With the view of showing our confidence in the cables already laid, we are prepared to extend the guarantee we have given under our contract for 12 months, and until the expiration of this period we will make good, free of expense to the Corporation, faults which may show themselves in these cables, and which are clearly traceable to defects in the cables themselves.' Resolved that the Council be recommended to make application to the Local Government Board for permission to borrow a further sum of £4,000, and that the necessary steps be taken so that the enquiry may extend to the above-mentioned sum as well as to the £6,000 already applied for." At the meeting of the Town Council when this report was brought up, Councillor Collings moved that application be made to the Local Government Board for sanction to borrow an additional £4,000 for electric lighting. He said the Council had already sanctioned an application for £6,000 which the Local Government Board had not yet dealt with, and the committee found that the £6,000 would not be sufficient to enable them to carry out the works that would be necessary during a comparatively short period. They therefore thought it far better to have one enquiry for £10,000, which would carry on the work for some time. The committee did not anticipate that it would be necessary to borrow anything like that extra £4,000 at present, nor would they take it up without coming to the Council for permission to do so. But in consequence of the increased demand for the electric current the present machinery was quite insufficient to provide all that was necessary, and even the £6,000 already authorised by the Council to be borrowed would not be enough to provide for all the expenditure which would be necessary within a very limited time. They wanted at least £2,000 more to pay for extensions of mains which were in prospect at a very early date, and for a new boiler which had been ordered, subject of course to the approval of the Local Government Board to the borrowing of the money. They anticipated that further extensions would be necessary within a very short time which would take up another £1,000, leaving a balance of £1,000, which would probably not be expended for 18 months or two years. It was impossible to forecast exactly what money would be required, but as the undertaking grew and the number of consumers increased, extension would be necessary, and the cost must be met. He spent some time that morning in going through the figures, which he thought might be of interest to the Council. The original contract of Messrs. Siemens was £11,800, buildings and architect's commission cost £4,500, extras on Messrs. Siemens's contract £600, wiring and lighting the central station £80, meters and testing instruments £300, small extensions of mains £460, connections for customers £160, engineer's commission £650, making the total original outlay £18,550. The extensions, many of which had already been ordered, and which the £6,000 was intended to cover, were: new engine and alteration £1,450, gas-engine and alteration £450, foundations for engines £100, connection to the gas-engine £25, spare machinery £225, customers' connections £300, extension of mains, arc lighting lanterns, etc., £400 and meters £500. This brought the total expenditure up to £22,000, which was the amount which the Council had at present consented to borrow. What they really wanted to expend beyond that amount was £800 for a new boiler, £100 for setting it, £500 for further transformers and a sub-station which would shortly be necessary at the

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other end of Thames-street, £250 for a new workshop and tools, £1,000 for further low-pressure mains and meters, and £350 for contingencies. This would bring the total up to £25,000, and would leave £1,000 in hand for working capital, or to be devoted to further expenditure as customers increased. Councillor Walker seconded the motion, and said they were all aware that as business increased so must the capital outlay. He thought this application was a very good sign of increasing business, and he hoped the Council would see it in that light, and not imagine that because the committee were asking for more money they would be running the Corporation into debt. He believed that before long the electric lighting business would be a paying concern. For the first two or three years there must be a certain amount of loss, but he was sure that eventually it would be a good thing for the Corporation. They were continually receiving fresh applications for the current, and it was the right thing to go on. Councillor Wellbelove: Is the new boiler necessary to replace an old one that is worn out, or is it an additional one? Councillor Collings: An additional one. The motion was carried *nem. con.* Councillor Collings said at the last meeting something was said about the arc lighting cables possibly having to be taken up. The Council would see from Messrs. Siemens's letter that they had perfect confidence in their cables, and had extended their guarantee for another year.

PROVISIONAL PATENTS, 1894.

OCTOBER 22.

20105. **Improvements in electric measuring instruments.** Benjamin Davies, University College, Liverpool.

20127. **Improved porous pot for primary batteries.** Michael Martin Bair, 7, Carteret-street, Queen Anne's-gate, London.

20152. **Improvements in incandescent electric lamps.** Vincent Fabris, 64, Mark-lane, London.

20170. **Improvements in electrical soldering and welding apparatus.** Hugo Zerener, 46, Lincoln's-inn-fields, London.

OCTOBER 23.

20223. **Improvements in electrically-worked pumps.** Robert Luke Howard, 77, Chancery-lane, London.

20241. **Improvements in alternating-current motors.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Edward Andrews Clark, United States.) (Complete specification.)

20259. **Improvements in electrolytic apparatus for decomposing metallic salts.** Carl Kellner, 46, Lincoln's-inn-fields, London.

OCTOBER 24.

20293. **Improvements in holders for globes or shades of electric, gas, or other lamps.** George Frederick Sanders, 36, Temple-street, Birmingham.

20317. **Improvements in electric glow lamps.** Joseph Robert Mally, 18, Fulham-place, Paddington, London.

20330. **Improvements in electromagnetic machines.** Ignaz Vago, 70, Wellington-street, Glasgow. (Complete specification.)

20354. **Improvements in and connected with the electro-deposition of aluminium and aluminium alloys.** Pascal Marino, 33, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, May 31, 1894, being the date of application in France.)

20363. **Improvements in rests or supports used with telephones for supporting the arms or elbows of persons using the telephones.** Henry Gilbert and Alfred Brawn Gilbert, 7, Staple-inn, London.

20366. **Apparatus for applying electricity to regulate and control engines or machinery.** Ludwig Epstein, 28, Southampton-buildings, Chancery-lane, London.

20382. **Improvements in electric telephones and means of signalling thereon.** Alfred Charles Brown and George Richard Neilson, 50, Old Broad-street, London.

OCTOBER 25.

20397. **An improvement for cutting out electric arc lamps.** Henry James Creffield, 3, St. Fidelis-road, Erith, Kent.

20432. **An improved electric bell for mines and outdoor use generally, with damp-proof or hermetically sealed contact breaker.** Frederick Charles Allsopp, 165, Queen Victoria street, London.

20439. **Improvements in the production of electrical energy and in means or apparatus employed therein.** Henry Tipping, Henry Ashur Tobias, William Henry Cadman, and Richard Joseph Crowley, 55, Chancery-lane, London.

20442. **Improvements in and connected with arc electric lamps.** James Eglinton Anderson Gwynne and Rankin Kennedy, 11, Furnival-street, Holborn, London.

20462. **Improvements in and connected with induced current telegraphy.** Frank Eustace Wilkins Bowen, 6, Bream's-buildings, Chancery-lane, London.

OCTOBER 26.

20482. **Improvements in junction couplings or clips for electric lighting installation.** Hahnemann Adolphus Cutmore, 172, Queen Victoria-street, London.

OCTOBER 27.

20546. **Improvements in electric telegraph systems for working double current translation.** Samuel Butcher, 47, Lincoln's-inn-fields, London.

20548. **Improvements in electrical motor fittings for transmitting motion to light machinery.** Henry Lea, 18, Southampton-buildings, Chancery-lane, London.

20561. **Improvements in electric arc lamps.** George William Lowcock, 70, Market-street, Manchester.

20595. **Improvements in electrical signalling devices for railways.** Walter Grimes, 323, High Holborn, London.

20596. **Improvements in or connected with electric accumulators.** Siegfried Hammacher, 6, Lord-street, Liverpool. (Complete specification.)

20613. **Improvements in electric relays.** Charles Langdon-Davies, 24, Southampton-buildings, Chancery-lane, London.

20614. **Improvements in or connected with electric heating wires or coils.** Friedrich Wilhelm Schindler, 433, Strand, London.

SPECIFICATIONS PUBLISHED.

1891.

5461. **Overhead system of electric traction.** Dickinson. (Second edition.)

1893.

19251. **Electric indicator for colliery engine-houses, etc.** Crawshaw and Battye.

20384. **Electricity meters.** Hookham.

20847. **Carbon brushes, blocks, etc., for electric generators and motors.** Scott.

20975. **Voltaic batteries.** Gregg.

22856. **Printing telegraphs.** Fowden.

23477. **Electrical signalling on railways.** Orme.

23478. **Electrolytic preparation of oxygen, etc.** Coehn.

1894.

16408. **Printing telegraphs.** Fowden.

16425. **Storage batteries.** Young. (Hess Storage Battery Company.)

16859. **Electrical distribution.** Coykendall.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	5	5⅜-6
Bournemouth Electric Company	—	—
Brush Company, Ordinary	3	2⅝-2⅝
—— Nom. Cum., 6 per cent. Pref.	2	2¼-2¾
—— 4½ Debenture Stock	100	111-114
Charing Cross and Strand	5	4½-5½
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	13-14
—— 6 per cent. Cumulative Pref.	10	14½-15
—— 5 per cent. Debenture Stock	115	131-133
City and South London Railway, Consolidated Ordinary	100	36-38
—— Debenture Stock	100	121-123
—— 5 per cent. Pref. Shares	10	13-14
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	94-99
Electric Construction, Limited	2	½-⅝
—— 6 per cent. Debentures	—	87-92
—— 7 per cent. Cumulative Pref.	2	1½-2
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1⅝-1⅝
Elmore's French Company	2	3/16-5/16
Elmore's Wire Company	2	1⅛-1⅜
Fowler-Waring Cables	5	½-1½
W. T. Henley's Telegraph Works, Ordinary	10	8-9
House-to-House Company, Ordinary	5	2½-2¼
—— 7 per cent. Preference	5	6¼-6⅝
India Rubber and Gutta Percha Works	10	24½-25½
—— 4½ per cent. Debentures	100	102-104
International Okonite, Ordinary	—	—
Kensington and Knightsbridge	5	4⅜-5½
—— 6 per cent. Pref.	—	6¼-6⅜
Liverpool Electric Supply, Ordinary	5	6⅜-6⅞
—— Pref.	—	—
Liverpool Overhead Railway	10	8-8½
—— Pref.	10	13-13½
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric	5	⅜-1½
Metropolitan Electric Supply	10	
—— 5 per cent. Reg. Debentures, 1-10,000 in Bonds of £10, £20, and £40	—	—
National Telephone, Ordinary	5	4⅜-5½
—— 6 per cent. Cum. First Pref.	10	15-16
—— 6 per cent. Cum. Second Pref.	10	14-15
—— 5 per cent. Nom. Cum. Third Pref.	5	5¼-5⅝
—— 4½ per cent. Deb. Stock	—	110-113
Notting Hill Company	10	5¼-6½
Oriental and Electric Company, £1 shares	1	1-1½
—— £5 Shares	—	6¾-7¼
—— £4½ shares	—	5¾-6¼
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7¾-8
—— 7 per cent. Pref.	5	8¾-9¼
Swan United	—	—
Telegraph Construction and Maintenance	12	41-43
—— 5 per cent. Bonds	100	106-109
Westminster Electric Supply, Ordinary	5	6¾-7½
Yorkshire House-to-House	4½	4¼-4⅜

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NOTES.

Telephony in Germany.—Telephonic communication has been established between Berlin and Dortmund.

Gas-Engine Competition.—A competition between gas-engines is now taking place in France, more particularly between the Charon and the Crossley motors.

Laundry Exhibition.—Electricity as applied to ironing machines, etc., is being demonstrated at this exhibition, now being held at the Agricultural Hall, Islington, N.

Telegraphing Through Space.—The Allgemeine Elektricitäts-Gesellschaft have been experimenting in telegraphing through space between Wansee and Neu-Cladow on the Havel, a distance of about 2¾ miles.

Electric Lighting Powers.—In Paris the duration of concessions for electric lighting is 18 years. Evidently the French are more content with shorter powers than the English, or they would have adopted our Electric Lighting Act of 1888.

Electric Traction in Austria-Hungary.—A preliminary concession has been granted by the Austrian Ministry of Commerce to Mr. Wenzel Formanek for an electric tramway from Königgrätz railway station to Freihofen.

Electric Traction in Switzerland.—At the close of 1893 there were nine electric lines in Switzerland—namely, at Orbe-Chavorney, Grütschalf-Mürren, Sissach-Gelterkinden, Bürgenstock, San Salvatore, Stanserhorn, Vevey-Montreux, Zürich. and Stannsstaad.

Electric Lighting in Algeria.—Messrs. Gally and Viette have taken over the electric light installation at Batna, and will instal a 50-h.p. Laval steam-turbine. M. Dalloz is erecting a central station at Bougil, where he will employ Boulet steam-engines and Desroziers dynamos.

The Telegraph in British North Borneo.—The British North Borneo Company has communicated to Reuter's Agency the following telegram respecting the progress of the telegraph line across North Borneo: "Eastern section trial trace, 117 miles; permanent 24ft. trace, 32 miles."

Royal Institution of Great Britain.—The general monthly meeting of this institution was held on Monday, Sir James Crichton-Browne, treasurer and vice-president, occupying the chair. Mr. Arthur Salvin Bowlby, Sir Charles Cameron, M.P., Baroness de Knoop, and Lord Romilly were elected members.

Madras Electric Tramway.—The company carrying out this undertaking have obtained an equitable extension of time, owing to a circumstance over which they had control. The "consideration of route" in the city of magnificent distances is still occupying attention, and forms the subject of municipal discussion.

Battersea Polytechnic.—Mr. Joseph Harwood (the secretary) announces that this institution is attracting an increasing number of students. The total number of entries for day and evening schools and classes is 3,607, as against 2,816 in the first quarter of last session, these entries being represented by about 2,520 individual students.

Electric Cranes in France. — The Bordeaux Chamber of Commerce have been considering the advisability of the introduction of electric cranes on the quays, and offers have been received from the Compagnie Française pour l'Exploitation des Procédés Thomson-Houston, Messrs. Guilton and Bertolus, of St.-Etienne, and Messrs. Lombard, Gérin, et Cie.

Institution of Junior Engineers.—Mr. Alexander Siemens has accepted the presidency of this institution (formerly the Junior Engineering Society) for session 1894-5, in succession to Mr. J. Wolfe Barry, vice-president, Institution of Civil Engineers, and will deliver his presidential address on Friday evening, 16th inst., at the Westminster Palace Hotel.

Institution of Civil Engineers.—The first meeting of the ensuing session of the Institution of Civil Engineers will be held on the 13th inst. in the existing theatre of the society, to which a temporary access has been arranged from the old entrance in Great George-street. The library, reading-room, and offices are at present located at No. 9 on the other side of the street.

Central Telegraph Office Library.— On Friday evening last a promenade concert took place at the Holborn Town Hall, with the double object of celebrating the opening of the extended premises for the Central Telegraph Office Library, now capable of containing 10,000 volumes, and of aiding the funds for further increasing the number of works of a scientific and philosophical character.

Northern Society of Electrical Engineers.—This society will meet at the Palatine Hotel, Hunt's Bank, Manchester, on Monday evenings, November 12, December 10 (annual general meeting), January 14, February 11, March 11, April 8, and May 13. The second annual dinner of the society will be held on Friday, January 11. At next Monday's meeting a paper will be read by Mr. H. Henderson on "Lighting Installations."

Telephony in India.—The use of the telephone in India increased considerably during the year. There are now 1,360 subscribers and 1,380 exchange connections of the telephone companies at Calcutta, Madras, Bombay, Karachi, Rangoon, and Moulmein, besides 26 exchanges and 205 exchange connections under the control of the Telegraph Department. The new telephonic apparatus introduced last year is stated to be an unqualified success.

Ohm's Law.—One of the directors of an electric railway company, the *Electrical World* says, enquired of one of the electrical engineers of the road the meaning of $C = \frac{E}{R}$, which he saw around so much, and on being told that it stood for capital $= \frac{\text{earnings}}{\text{receipts}}$, he replied that he thought it was a capital joke.

Personal.—Dr. W. E. Sumpner, of London, has been appointed principal of the new technical school, Birmingham, at a salary of £500 per annum. Dr. Sumpner is a doctor of science, and has been connected with the movement inaugurated by the City and Guilds of London for the advancement of technical education. In 1887 he was appointed a demonstrator and lecturer at the Central Training College, and last year went to the Battersea Polytechnic, being elected head of the physical and electrical departments.

New Books.—We have received from Messrs. Whittaker and Co. "Electric Light Installations," by Sir David Salomons, Bart., B.A., seventh edition, revised and enlarged, of which vol. 1 deals with "The Management of Accumulators," vol. 2 with "Apparatus," and vol. 3 with "Application." Messrs. Whittaker also send us the second edition of "Electric Lighting and Power Distribution," by Mr. W. Perren Maycock. From Messrs. S. W. Partridge and Co. we have received "Electricians and their Marvels," by Mr. Walter Jerrold.

Hampstead Central Station.—Before a meeting on Saturday last, at the Hampstead central station, of the Association of Municipal and County Engineers, Mr. W. H. Preece, F.R.S., read a paper describing the station. The author mentioned that the undertaking was started four

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weeks ago with 2,176 8-c.p. lamps fixed, that 1,218 had since been added, and that applications were in hand for a further 4,475 lamps, or a total of 7,869 lamps. Mr. Preece expressed the opinion that the station was going to be financially a great success.

Electrically-Controlled Clocks.—A scheme is at present under the consideration of Glasgow Town Council Bazaar Committee for the establishment throughout the city of a system of standard time, by means of electrically-controlled public clocks regulated every second from the observatory clock. Prof. Becker has been consulted, and has informed the committee that it would be easy to connect 20 clocks from the observatory, these in turn controlling a certain number each, and in the case of the street dials, both working and regulating. The system is intended to include private house time-keeping.

Borough Polytechnic.—Sir Bernhard Samuelson, at the distribution of prizes last week at this institution, referring to the increase of scientific and technical education in this country, said that at the present time there were already 150 technical and science schools throughout the provinces, and between 70 and 80 in course of erection. In London there were eight or nine polytechnics, but not one fifth of the workers, in proportion to those in other big towns, such as Liverpool and Bradford, received scientific and technical education. He urged the students to be not only skilful, but versatile, and adapt themselves readily to industrial changes.

Society of Arts.—The arrangements for the one-hundred and forty-first session of the Society of Arts are now announced. It commences on November 21 with an address from the chairman of the council, Major-General Sir John Donnelly. The first regular paper of the new session will be by Mr. Hiram Maxim on his "Experiments in Aeronautics," and this will be followed the succeeding week by one by M. Hermite on "The Electrical Treatment of Sewage." Six courses of Cantor lectures are promised, of which the first is by Prof. Vivian Lewes on "Explosives." There will be, as usual, a course of juvenile lectures after Christmas; the lecture this year is by Prof. Vernon Boys, his subject being "Waves and Ripples."

New Mains in London.—Sanction has been given by the London County Council to the Westminster Electric Supply Corporation to lay mains in Carington-street; to the House-to-House Electric Light Supply Company for mains in Courtfield-road; to the St. James's and Pall Mall Electric Light Company for mains in Argyll-place, Foubert's-place, and across Carnaby-street; and to the Notting Hill Electric Lighting Company for mains in Pembridge-villas. Objection has been taken to transformer-chambers proposed to be constructed by the London Electric Supply Corporation in Burlington-gardens, and by the County of London and Brush Provincial Electric Lighting Company in Wandsworth, Putney, and Pentonville.

Electric Traction in Italy.—The Municipal Council of Milan has extended the time during which the Società Edison is permitted to experiment with electric traction, which has been tested for some months on the Sempione line by that company. The Edison Company and the Società Anonima degli Omnibus are negotiating with a view to an agreement being arrived at concerning large traction schemes. If the proposed agreement is carried out, *L'Elettricità* says that it is probable a large transmission project, embodying some 22,000 h.p., at Paderno sull' Adda, will be brought into use. A scheme has been presented to the Municipal Council of Palermo by Signor Ferrando with a view to the construction of a complete system of electric tramways in that town.

Electric Lighting in Burmah.—An Indian paper remarks: "The lighting of the new Government House at Rangoon—a *pucca*, red brick edifice, which will replace the present wooden structure—the Gymkhana Club, the lunatic asylum, and the gaol with electricity has been claiming the serious consideration of the Government of Burmah. The machinery and dynamos will be placed in the Rangoon gaol. But the public are anxious to know why the town cannot be lighted up in like manner, Mr. D. D. Coath, an experienced engineer, having offered to replace each of the present street oil lamps by an electric light at the same cost as the public are now paying for street-lighting. This offer was made three years ago; but the Municipality cavil at giving Mr. Coath a monopoly for 10 years."

Electric Traction in Germany.—It has been decided that in future as regards Berlin the conversion of light railways into electric lines will not be decided by the President of Royal Police alone without consultation with the Municipality, but by both in conjunction. It is expected that this will lead to good results by avoiding friction. The Allgemeine Elektricitäts-Gesellschaft, of Berlin, will construct an electric tramway at Elbing. The official inspection has taken place of the Bochum-Herne electric tramway. The line is about four miles in length, and the overhead trolley system is employed, the return being by the rails. A speed of 18 miles an hour can be attained. The plant at the power station comprises two tubular boilers, two Kuhn compound engines, and two Siemens dynamos with overset armatures.

Electric Lighting in Austria-Hungary.—The Municipality of Graz are considering the advisability of lighting both the municipal theatres electrically. A meeting has been held at Budapest of the Ungarische Elektricitäts-Aktiengesellschaft, at which Mr. Béla Fischer, the chairman of the company, reported on the first year's business of the Budapest central station. On October 12 there were 48 miles of cable laid, and there were 668 consumers, using an equivalent to 32,451 normal incandescent lamps. There were 685 arc lamps connected, and 37 electric motors of a total of 58 h.p. Tenders have been received from the Budapest Allgemeine Elektricitäts-Gesellschaft and from the Ungarishe Elektricitäts-Gesellschaft for the electric lighting of the general meeting hall in the new Town Hall. The tender of the former company, being the lower, has been recommended for acceptance.

Electric Lighting in France.—The Alais Gas Company having declined to make use of the privilege of adopting any new mode of lighting as laid down in its agreement with the town, the local authorities have given a concession for electric lighting to Messrs. Louche, Bonnefoi, and Froment. The Café de la Paix, Angers, is to be lighted electrically, the local gas company supplying a gas-engine for the motive power. The little town of Courthezon, Vaucluse, is to be lighted by electricity, a concession having been granted to Mr. L. Warnecke, of Lyons. Water power will be used. A small central station has been opened by Mr. Dutertre at Ivry-la-Bataille, Eure. Both water and steam power are employed. Rechniewski dynamos and Dujardin accumulators are installed here. At Lille, Messrs. Thierry and Sigraud, confectioners, have started a private electric light installation, using Crossley engines and Sautter dynamos.

Proposed Acton Electric Railway.—At the invitation of the London United Tramways, Limited, a large party started yesterday for Havre in order to inspect the admirable electric trolley-wire system of tramway lines now operated in that town. The party consisted of members of the Hammersmith and Acton local authorities, and the

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visit has been undertaken by them to see just exactly what may be done in the way of electric traction with overhead wires. The Havre lines, it will be remembered, were equipped this year by the French Thomson-Houston Company, and they rank without exception as the best in the country for excellence of design and good workmanship. There need be little fear but that the members of the party will come back from their short journey so impressed with the advantages of this method that they will welcome gladly the proposal to operate the Acton tramway in a similar fashion.

Royal Society.—The following is a list of those who have been recommended by the president and council of the Royal Society for election into the council for the year 1895 at the anniversary meeting on November 30: President, Lord Kelvin, D.C.L., LL.D.; treasurer, Sir John Evans, K.C.B., D.C.L., LL.D.; secretaries, Prof. Michael Foster, M.A., M.D., Lord Rayleigh, M.A., D.C.L.; foreign secretary, Sir Joseph Lister, Bart., F.R.C.S.; other members of the council, Andrew Ainslie Common, LL.D, William Crookes, F.C.S., Francis Darwin, M.A., Andrew Russell Forsyth, Sc.D., Sir Douglas Galton, K.C.B., Prof. Alexander Henry Green, M.A., Sir John Kirk, K.C.B., Prof. Horace Lamb, M.A., Prof. Edwin Ray Lankester, M.A., Prof. Alexander Macalister, M.D., Prof. John Henry Poynting, D.Sc., Prof. Arthur William Rücker, M.A., Osbert Salvin, M.A., Prof. J. S. Burdon Sanderson, M.D., Thomas Edward Thorpe, Sc.D., and William Henry White, C.B.

Lectures.—Mr. Hall, president of the Carlisle Microscopical Society, has delivered an address to the members on "The Electric Light in Use with the Microscope," and having shown the advantages of the light over other lights in expanding microscopical slides, making use of a four-cell Pitkin accumulator for the purpose, he referred to the question of introducing the electric light into Carlisle. He said that we had excellent gaslight, and it was being continuously improved, but electric light was also wanted because it was the purest and the best light. On Tuesday last Prof. A. W. Rücker delivered a lecture at Victoria Hall, Waterloo Bridge-road, on "The Electric Spark." A paper was recently read by Mr. H. B. Edwards, A.I.E.E., of Wakefield, before the members of the Derbyshire Metallurgical and Engineering Association, at Codnor Park, Derbyshire, in which special reference was made to the pumping and electric lighting plant just completed by him at the Pollington Colliery, belonging to Messrs. Jas. Oakes and Co., Alfreton Low Works. Prof. A. C. Chattock has read a paper, entitled "The Electricity of Water," before the Bristol Naturalists' Society. A paper on "The Electric Light" has been read by Mr. Cozens before the Taunton Literary Society.

The Proposed Pacific Cable.—A *Times* telegram from Ottawa, dated 1st inst., says: "Mail advices received by the Hon. Mackenzie Bowell to-day give a more encouraging account of Messrs. Fleming and Mercer's mission to Hawaii to secure a landing-place for the proposed Pacific cable than had been previously announced. Mr. Fleming says the Hawaiian Government is profoundly impressed with the importance of the scheme, and if the consent of the United States Government can be procured Hawaii will lease Neckar Island or Bird Island to Great Britain for cable purposes, and will give a subsidy of £7,000 sterling annually. Mr. Fleming says that a very favourable understanding has been established with Hawaii. Mr. Mercer will soon be proceeding to Washington." A Reuter's telegram of the same date says: "The Hon. Mackenzie Bowell, Canadian Minister of Trade and Commerce, has received a large number of offers for the construction of the proposed Pacific cable. Tenders will be opened in a few days." A Reuter's telegram from Winnipeg, dated 5th inst., stated that Messrs. Sandford Fleming and Mercer, the commissioners who have recently been in Honolulu endeavouring to secure Neckar Island as a landing-place for the Pacific cable, have returned. Mr. Fleming expresses the belief that his mission will prove successful.

Conference of Science Teachers.—A largely-attended conference of the organised science teachers and teachers of secondary schools receiving aid from the Science and Art Department was held at South Kensington Museum last week. Dr. Forsyth, of Leeds, presided. Captain D. W. Abney and Mr. C. A. Buckmaster, one of her Majesty's inspectors of science classes, represented the South Kensington Department, and Mr. Yoxall represented the National Union of Elementary Teachers. It was pointed out that the continuity of secondary schools must be based on some system of co-ordination with our elementary system of education. One speaker suggested that if the middle classes could get rid of the prejudice they had with reference to the Board schools, the secondary education difficulty would be solved. Another proposed that secondary education should be given only by properly trained teachers, and should be given either gratuitously or at merely nominal fees. Objection was incidentally taken to the appointment of inspectors who had not been practical teachers. Mr. Buckmaster said he had been a science teacher for several years before his appointment, and that three of the recently appointed inspectors had previously distinguished themselves as science teachers It was agreed to embody the spirit of the meeting in the form of resolutions to be forwarded to the Education Department.

British Insulated Wire Company's Cables.—In its issue of October 20, *To-Day*, in referring to the temporary extinction in the supply of light in the City, said that "it might be well if some disinterested person would enquire from the City of London Electric Lighting Company why their cables have so rapidly worn out." The paragraph went on to refer to a rumour that when the City of London Company called for tenders for their cable supply "the tender made by one of the oldest and best of the cable companies was passed over in favour of that of a much smaller company asking a considerably higher figure," and that "now these cables have so signally failed the older company has been called in to repair and make good their former rival's faulty work." In this connection we have been asked by the British Insulated Wire Company, Limited, of Prescot, to draw attention to the retraction contained in *To-Day* of November 3. The latter says: "We have no hesitation in expressing our regret that the paragraph in question appeared in our columns. We thought that the standing and knowledge of our informant warranted the acceptance of his statement, but by some means or other he was misled, and in turn misled us. The error has given the British Insulated Wire Company just cause of complaint, but recognising our good faith in the matter they have made their representations in the spirit of courtesy we gladly recognise, and which makes it doubly incumbent upon us to give this explanation, and to say how much we regret the mistake made by our informant."

Steam Condensation.—M. Ch. Compère recently brought before the Société des Ingénieurs Civils de France the results of a series of experiments which he has made at the Creusot works in regard to the quantity of water necessary for steam condensation. These results show generally that when engineers are limited in the use of water, condensing plant can be adopted without sensibly

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diminishing the economy of the steam-engines. The tests were made with a Corliss engine of the type first constructed at Creusot. The quantity of water injected into the condenser was ascertained by a Samain meter, and the temperature was determined by causing the water to flow from a tap placed closed to the inlet of the meter. The temperature of the hot water from the condenser was taken directly in the delivery pipe of the condenser. Indicator diagrams were taken on the engine, so as to get to know the work, and consequently the consumption of steam per indicated horse-power. It having been impossible to provide a special boiler to supply the engine, the consumption of steam by the latter was established by the calorimetric method, based on the increase in temperature of the weight of water passed into the condenser. Diagrams were also taken on the air-pump. From the result of the experiments, it was found that as the injected water was at 10deg. C., the expense of this water can be reduced by half by condensing at 40deg. C., instead of at 25deg. C., without the consumption of steam per horse-power much increasing, being only from 7·4 to 8 kilogrammes. This conclusion, as M. Compère says, is very interesting in cases where one is compelled to pay a high price for water, or when it is necessary to sink a well and lay down a pump.

Physical Society.—A meeting was held in the rooms of the Chemical Society, Burlington House, on the 26th ult., Prof. A. W. Rücker, F.R.S., president, in the chair. In opening the proceedings, the President said the occasion might be regarded as another sign that the boundary between chemistry and physics was breaking down. On behalf of the council he tendered the thanks of the Physical Society to the Chemical Society for the use of the rooms. Prof. H. E. Armstrong, president of the Chemical Society, said his council offered a cordial welcome to the Physical Society. The change, he thought, would prove of much greater importance than a mere removal. Now that the childhood of the Physical Society was passed, its manhood involved new responsibilities, and great opportunities for good now presented themselves. The Physical Society of London ought now to become the head centre of physics in the United Kingdom. He (Dr. Armstrong) was pleased to learn that the society had undertaken the preparation and publication of abstracts of physical papers appearing in foreign periodicals, and said the matter was of such great importance that it should be done thoroughly. In a work of such a magnitude he regarded the co-operation of other societies, such as the Institution of Electrical Engineers, as absolutely necessary. The President, in acknowledging the welcome, said the Physical Society was extremely obliged to the president and council of the Chemical Society for the great benefits conferred. Dr. Armstrong's advice to go ahead would not be forgotten. He then announced that at future meetings tea would be provided for members at 4.30. The exhibition of a voltameter by Mr. Naber was postponed. Mr. E. H. Griffiths, M.A., read a paper on "The Influence of Temperature on the Specific Heat of Aniline."

Light Railways and Tramways.—As we duly announced in last week's issue, an important meeting of the Engineering, Electrical, and Allied Trades Sections of the London Chamber of Commerce was summoned for the afternoon of Friday, the 2nd inst., and at the time appointed a considerable number of the most prominent members had assembled to discuss the question of better facilities for the development and working of light railways and tramways consequent upon the recently-issued circular from the Board of Trade. Mr. Crompton was voted to the chair, and the discussion at once opened. Mr. Pauling advocated strongly the extension of narrow-gauge lines under more favourable conditions than had hitherto existed, and instanced the results obtained in South America especially as reasons for greater development. Mr. Bolling spoke briefly upon the importance of cheap construction obtained by using the ordinary roads for track laying, with consequent limitation of speeds: and his remarks were of great practical value, coming as they did from an acknowledged authority upon light railway matters in general. Mr. Jeremiah Head gave an abstract of his recent experience in the United States respecting the standardising of railway gauges and the enormous increase of electric tramways operated on the overhead wire or trolley system, concluding with an expression of hope that similar progress might be made in this country during the next few years. The speakers followed at great length, each one expressing the most hearty approval of the movement now initiated: and, finally, Major Flood-Page offered a formal resolution thanking the Board of Trade for their action in the matter, and promising cordial assistance in every possible way. This was adopted with approbation, and Mr. Garcke then proposed a resolution appointing a small committee of eight or nine gentlemen (being members of one section or the other) to elect two delegates for attending the Board of Trade conference, and to decide upon the course of action which the delegates should follow at the conference. Powers were given to the committee to add to their number, and with a vote of thanks to the chairman the meeting then terminated.

Electrically-Operated Centrifugal Machines.—In an illustrated circular which has reached us from the Allgemeine Elektricitäts-Gesellschaft, of Berlin, it is pointed that, owing to their intermittent working and high speed, centrifugal machines are advantageously adapted for being direct driven by electric motors. Continuous current motors, it is submitted, are impracticable for this kind of work, as owing to the vibrations of the shaft of the centrifugal machine the motors can scarcely be run without sparking, whilst at the same time difficulty is experienced in the constant supervision of and attention to the commutator and brushes. With a view to overcome these disadvantages, the Allgemeine Gesellschaft have brought out a rotary-current motor which has neither commutator nor brushes. This motor, it is claimed, fulfils all the conditions required for safe and suitable centrifugal working. It keeps its speed in a higher degree than a direct-current motor, since its number of revolutions only changes in accordance with an alteration in the speed of the steam-engine driving the generator, so that care has only to be taken for its proper regulation. Moreover, a rotary-current motor is able to run with a much greater overload than a corresponding direct-current motor. This is absolutely necessary with centrifugal machines when large masses have to be set in motion, and this advantage is obtained by a special construction of the armature. If the installation, as is mostly the case, consist of a large number of centrifugal machines, and when one motor is thrown in, the others and the countershafting work with it and support it. The centrifugal rotary-current motors made by the company in question are in sizes ranging from 1 h.p. to 5 h.p., and at speeds varying from 1,000 to 500 revolutions. The motor is arranged under and on the same vertical shaft as the revolving drum, various modifications being made for different circumstances. Among the applications already made of this type of motor for driving centrifugal machines may be mentioned their use in textile factories and sugar works. In one case alone no less than 91 motors of about 490 h.p. have been installed in a sugarworks.

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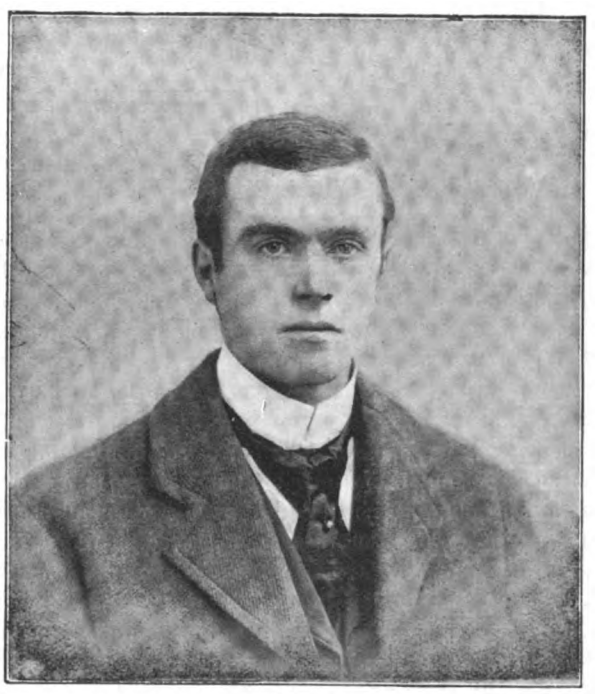
THE ELECTRICITY WORKS AT SOUTHPORT.

General Remarks.

Of the well-known watering places on the west coast of Lancashire, Southport justly occupies a prominent position. It is not only a delightful town in summer, but as the climate is extremely mild and salubrious, the town has become a most desirable and frequented winter resort. Cleanliness and dryness are also characteristics of the town, and even after a heavy storm the streets rapidly dry. The town, it will doubtless be remembered, is situated on the sandy shores of the estuaries of the Mersey and the Ribble. It is possible to see from the Promenade the opposite bank of the Ribble, almost as far as Preston, including Lytham, Ansdell, and St. Annes. Blackpool is out of sight, but its Eiffel Tower is observable.

A sandy shore faces the Promenade, and next comes a deep-water channel, the fringe of which is touched by the end of the pier. This channel is backed by the Horsebank,



ARTHUR ELLIS, A.M.I.E.E.
Electrical Engineer to the Southport Corporation

with the Irish Sea in the rear. At low water this sandbank hides the sea from the Promenade. Thus it has sometimes been said that Southport is a seaside resort without the sea.

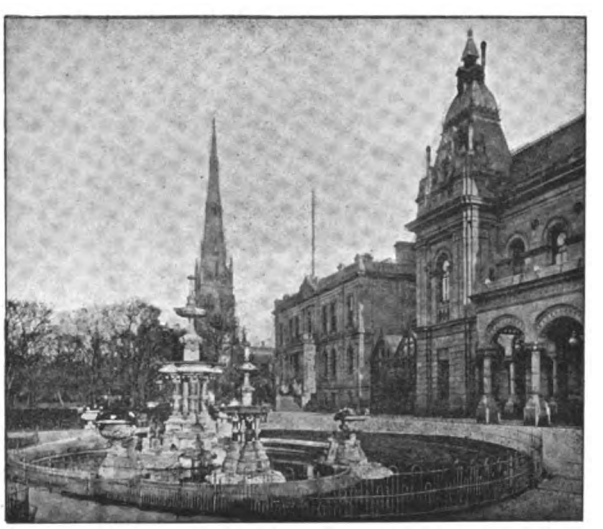
Southport is not an ancient town. In fact, a wilderness of sandhills formed the site of the present Southport just over a century ago, when William Sutton, of Churchtown, established an inn in the locality. Time passed away until 1840, when the population had risen to some 700 persons. In 1867 the town was made a municipal borough, and since then its progress under the energetic administration of the Corporation has been rapid. The borough now covers a superficial area of 7,526 acres, and the population is about 50,000. The Promenade already referred to is a handsome carriage-drive, some 2½ miles long, fronting the sea, and the pier jutting out from it is approximately a mile in length.

The main thoroughfare is Lord-street, which is one of the finest streets in the world. The principal entrance to the Winter Gardens is situated in this street, as are also the Town Hall and Public Buildings, of which a photograph is annexed. There are two tramway companies affording a public service, botanical gardens, aquarium, and winter gardens, and other places of amusement, parks, etc.

The group of buildings shown in the photograph comprises the Town Hall (which is on the extreme left), the Cambridge Hall, the Science and Art School, and the Atkinson Free Library and Art Gallery. As will be seen, the frontages are rendered more attractive by a handsome fountain. Although erected as long ago as 1853, the Town Hall underwent certain alterations and improvements in 1887, which transformed the building so as to meet the present requirements of the Municipal Council. The town, thanks to Mr. Wm. Crabtree, M.I.C.E. (the borough surveyor), is provided with modern sanitary arrangements, and one of the most noticeable features of many of the dwelling-houses, especially those lying in the suburbs, is that they are semi-detached. The town clerk is Mr. J. Davies Williams, and the members of the Gas and Electricity Committee are :

ALDERMAN JAMES WOOD, Mayor.
ALDERMAN HACKING, Chairman.
COUNCILLOR HESFORD, Vice-Chairman.
COUNCILLORS :

AUSTERFIELD.	ISHERWOOD.
BAXTER.	PILLING.
HAYWARD.	ROBSON.
HOWARD.	WATSON.
HULME.	



Southport Public Buildings.

Preliminary Steps in Electric Lighting.

The gasworks, which are located at Crowlands, some 2½ miles distant from the Town Hall in Lord-street, are the property of the Municipal Council. The charge is 3s. per thousand in Southport for lighting purposes, and 3s. 3d. in Birkdale, a discount of 5 per cent. being allowed if the accounts are paid within one month from the end of the quarter. It is also at Crowlands, on spare land adjoining the gasworks, that the municipal electricity works have been erected.

When the subject of electric lighting was first brought forward a few years ago, the Town Council as a body did not think it advisable to establish a municipal supply of the electric light; but the fact gradually became impressed upon the minds of the members that if they did not take any steps in this direction a company would do so. Consequently wiser counsel prevailed, and the Municipality resolved in 1892 to lay down plant and furnish a supply to those who wished to have the electric light. Naturally the first point to decide after obtaining a provisional order was as to what electrical system should be introduced. A report by Mr. George Wilkinson, M.I.E.E., the consulting engineer to the Corporation, was subsequently submitted, giving comparative estimates of the capital expenditure

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that would be required for carrying out a low-pressure system and a high-pressure system respectively.

The Adopted System.

After due consideration, it was eventually decided to supply the town or compulsory area with the electric light, laying down at Crowlands a high-pressure alternating-current system of generation, and a low-pressure system of distribution to consumers from transformer sub-stations arranged in the centre of the town. Plans and specifications were accordingly prepared by Mr. Wilkinson, and tenders were invited for the erection of the buildings for the accommodation of the steam and electrical plant, and for the supply of the machinery and accessories. In the meantime application was made to the Local Government Board for permission to borrow £28,000 for the purpose of establishing electricity works. An enquiry into the matter having been held by an inspector of the Local Government Board, sanction to the scheme and loan was subsequently given by that Department.

There is no doubt, from the scattered nature of the town and from prospective extensions of the supply of electric light outside the compulsory area, the Town Council were fully justified in adopting the high-pressure alternating-current system; but it seems a pity that the works have been erected so far as 2½ miles from the immediate supply area. Even taking into consideration the lighting of the whole of the town and suburbs—a rather unlikely matter—a more central or, at all events, an intermediate position for the site of the generating station would have been preferable; and for that matter there appears to have been sites available nearer the town than the gasworks at Crowlands. Nevertheless, the Corporation have the consolation of knowing that the support accorded by the public to the new undertaking which is being inaugurated to-day is such that it may compensate for any disadvantages of the distant site and the drop in the current pressure due thereto.

The tenders having been received and examined, contracts were entered into as follow for the erection of the buildings and the provision of the machinery and accessories enumerated:

Southport Electricity Works.—Map showing Site of Generating Station, the positions of the cables being indicated by the dotted lines.

Station buildings	Thomas Bridge, jun., Liverpool.
Boilers and steam-pipes	Oldham Boiler Company, Oldham.
Engines	Browett, Lindley, and Co., Limited, Patricroft, Manchester.
Electrical plant and switchboard.	Mather and Platt, Limited, Manchester.
Pump	Tangyes, Limited, Birmingham.
Heater	Patent Heater Condenser Company, Westminster.
High-pressure cables	British Insulated Wire Company, Limited, Prescot.
Low-pressure mains and transformers.	Siemens Bros. and Co., Limited.

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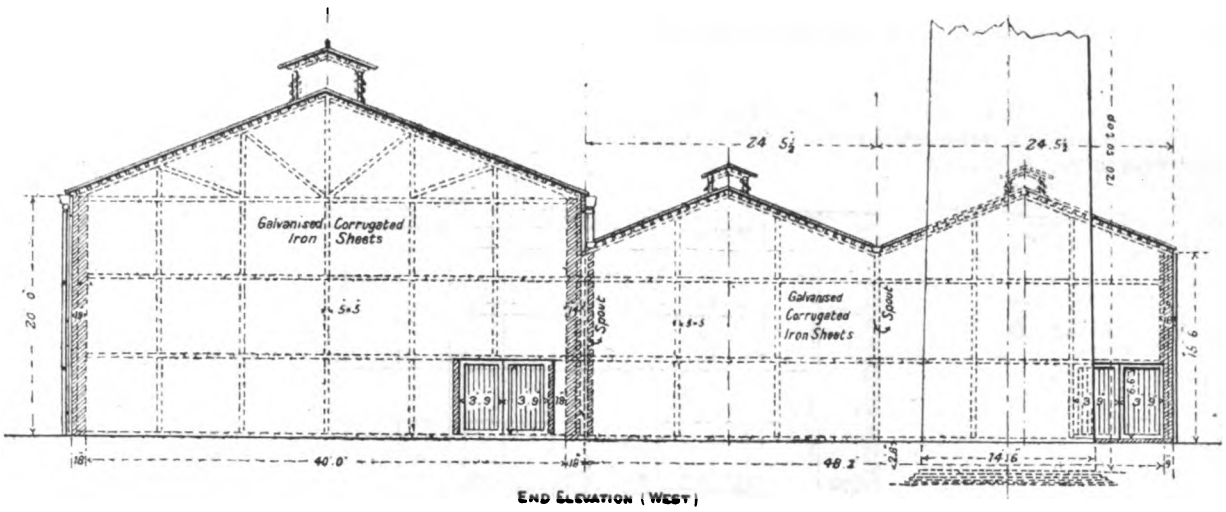
The work of constructing the generating station buildings, on land adjoining the gasworks, was shortly afterwards commenced, Mr. Arthur Ellis, A.I.E.E., being appointed clerk of the works. A sudden attack of illness, however, compelled Mr. Wilkinson to leave Southport shortly after the beginning of the undertaking. Mr. Ellis then took up the work, and was appointed electrical engineer seven months ago. He made certain alterations and modifications in the original plans, and he has supervised the execution of the whole of the work, bringing the station to its present successful position. Proceeding now to describe the electricity works, we first come to—

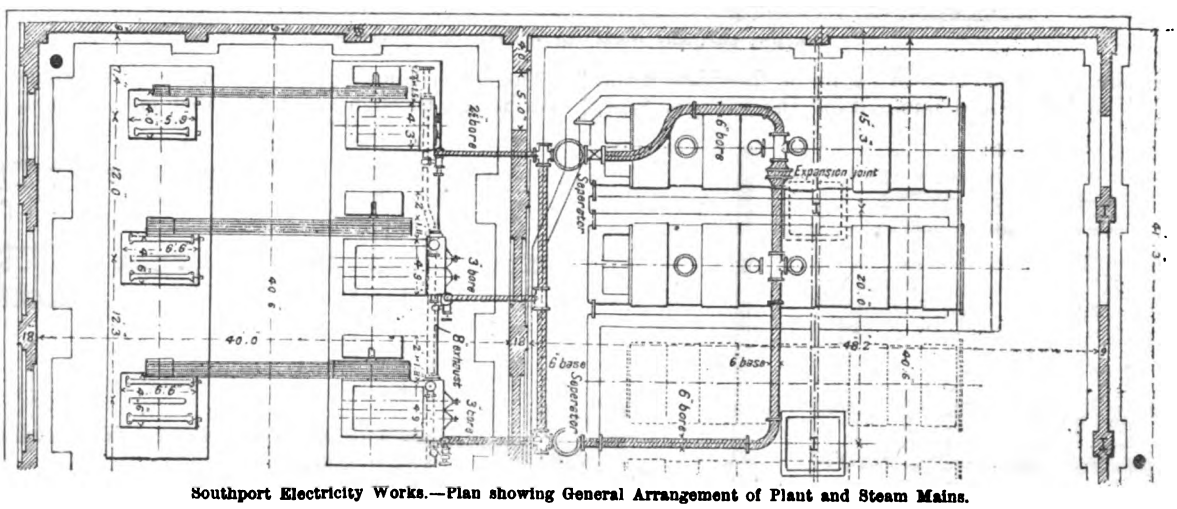


END ELEVATION (WEST)

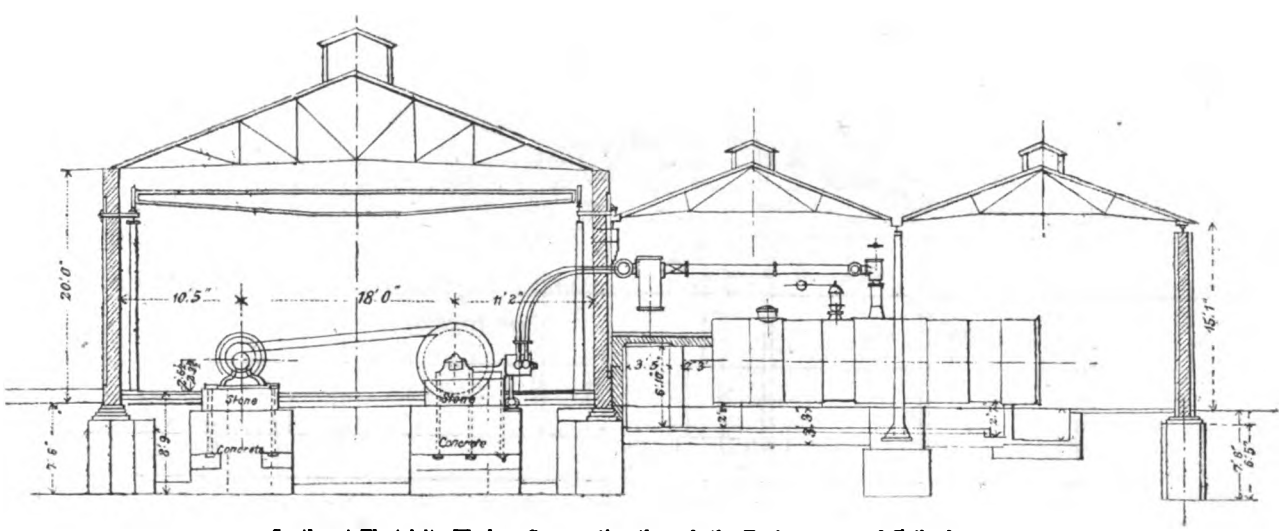
Southport Electricity Works.—End Elevation of Station Buildings.

The Boiler-House.

The boiler-house, which is 40ft. by 48ft. 6in., contains two Lancashire steel boilers, 28ft. long by 7ft. in diameter, constructed for a working pressure of 125lb., and supplied by the Oldham Boiler Works Company, of Oldham. The boilers have been designed so that small fuel may be used for firing.



Southport Electricity Works.—Plan showing General Arrangement of Plant and Steam Mains.



Southport Electricity Works.—Cross-section through the Engine-room and Boiler-house.

Each boiler is provided with two feed back-pressure valves, one being arranged on each side of the end plate so as to provide for a duplicate feed service. A dead-weight safety-valve and a second safety-valve arranged to blow off

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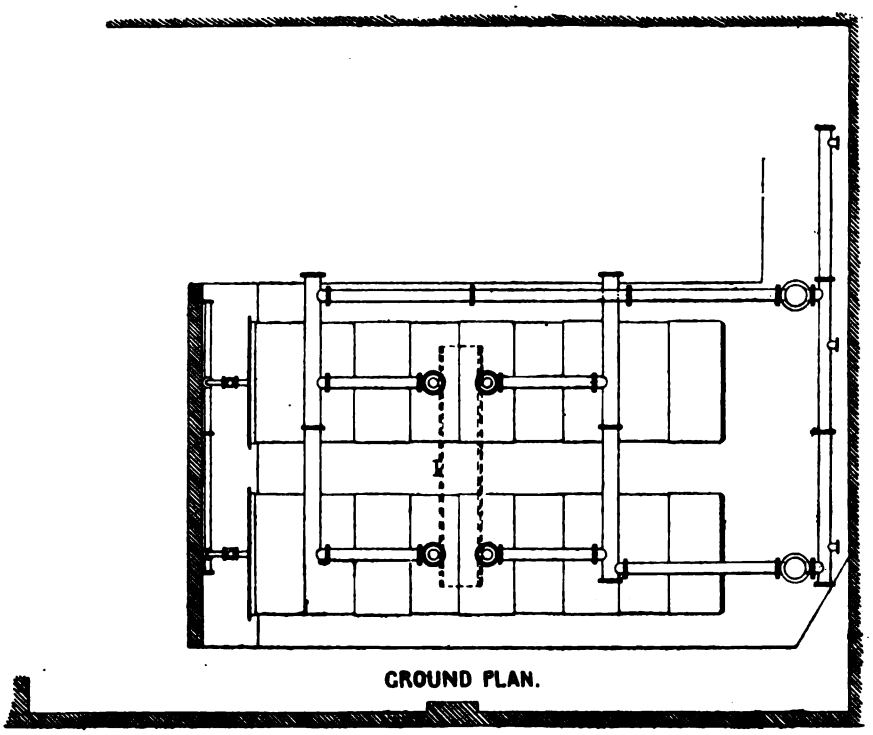
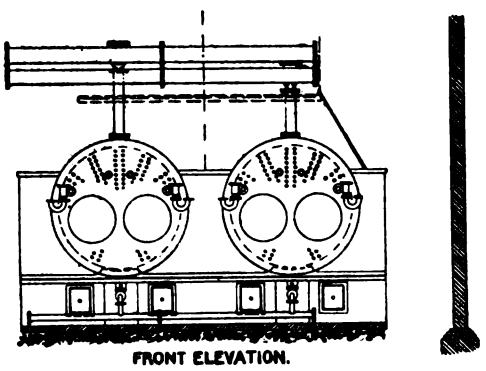
either at low water or high steam, are also fitted to each boiler. In addition to these, two junction valves 6in. in diameter are arranged to provide for a duplicate steam service. The boiler feed pump is of the Tangyes type, geared to a small vertical engine, and carried on a common bedplate. The main steam-pipe is of wrought iron, and is arranged in the form of a ring carried through the wall of the boiler-house into the engine-room, and provided with duplicate branches to the engines, so that any section may be disconnected as may be desired.

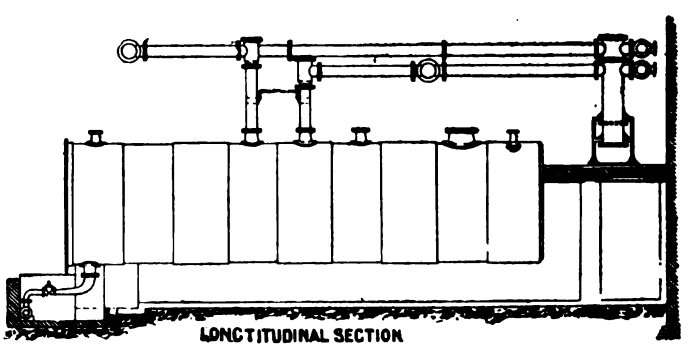


Southport Electricity Works.—Ground Plan of Boiler-house.

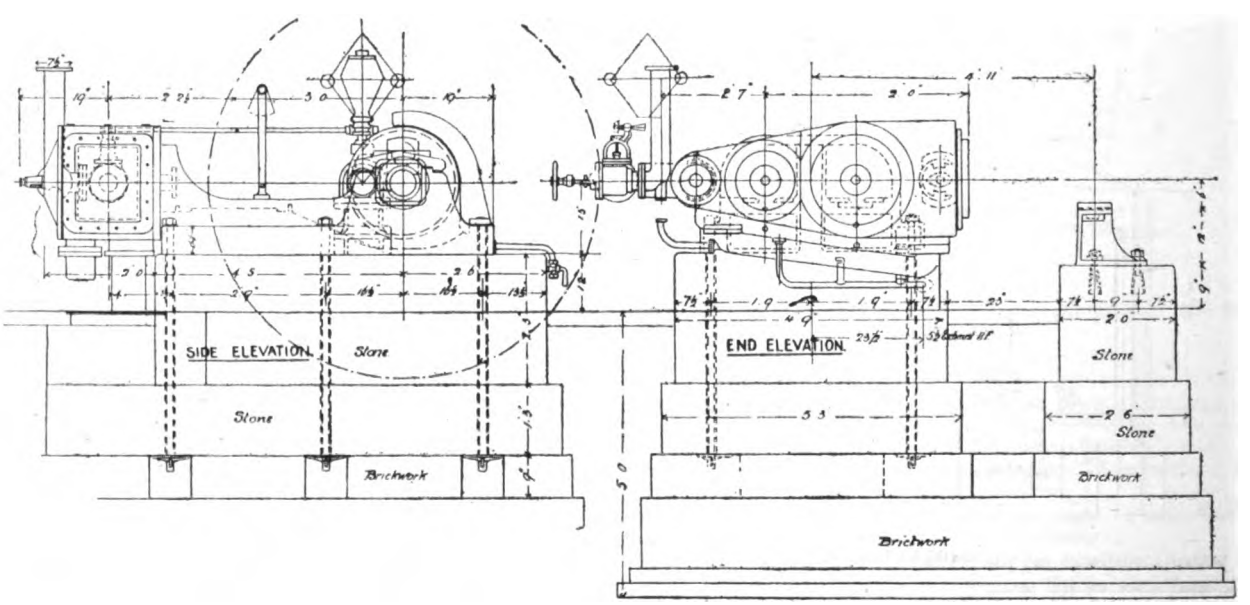
The boiler-house is equipped with an improved Berryman heater, through which is passed most of the exhaust steam from the engines for the purpose of heating the feed water for supplying the boilers. This heater, which has been provided by the Patent Heater Condenser Company, of 16, Great George street, London, S.W., is of the com-



Southport Electricity Works.—Front Elevation of Boilers.



Southport Electricity Works.—Longitudinal Section of Boiler.



Southport Electricity Works.—Side and End Elevations of 100 i.h.p. Browett-Lindley Compound Horizontal Engine.

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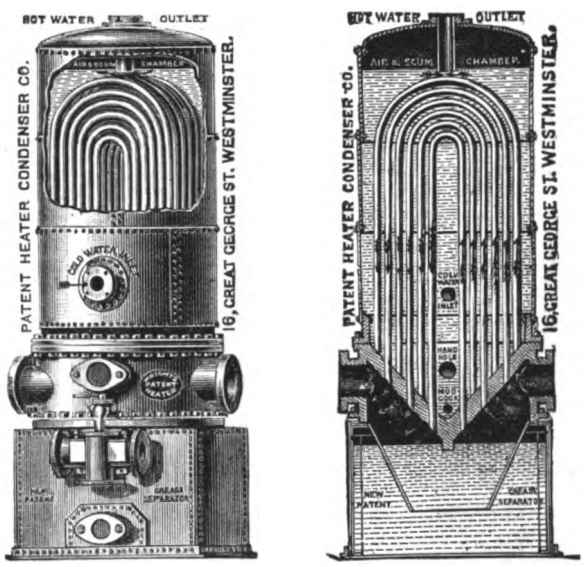
pany's No. 7 type. It is capable of raising the temperature of 500 gallons of feed water per hour up to 208deg. by means of the exhaust steam only. The heater has been made extra strong for a working pressure of 120lb. per square inch. The heater is 13ft. 3in. high, and 2ft. 6in. square at the base. The casing is wrought iron, and measures 21in. diameter. The exhaust steam inlet and outlet are 7in. in diameter, and the water inlet and outlets are 3in. in diameter. The heater is fitted with the new

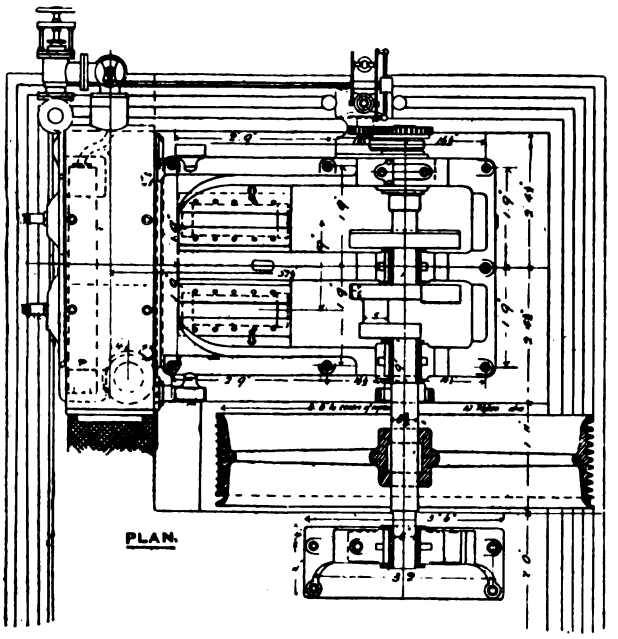

HOT WATER OUTLET
PATENT HEATER CONDENSER CO.
16, GREAT GEORGE ST. WESTMINSTER.
HOT WATER OUTLET
AIR & SCUM CHAMBER
PATENT HEATER CONDENSER CO.
16, GREAT GEORGE ST. WESTMINSTER.

Southport Electricity Works.—Berryman Feed-water Heater.

wrought-iron bottom for the prevention of back pressure. The whole of the exhaust steam does not pass through the heater, which is really arranged in a kind of "shunt" of the exhaust-pipes, and the exhaust steam supply to it is regulated by valves. The heater is fitted with solid-drawn copper pipes inside, through which the steam passes, whilst the water circulates on the outside. A hand hole and mud-cock, and a valve for testing the temperature of the water, are also provided.

The Engines.

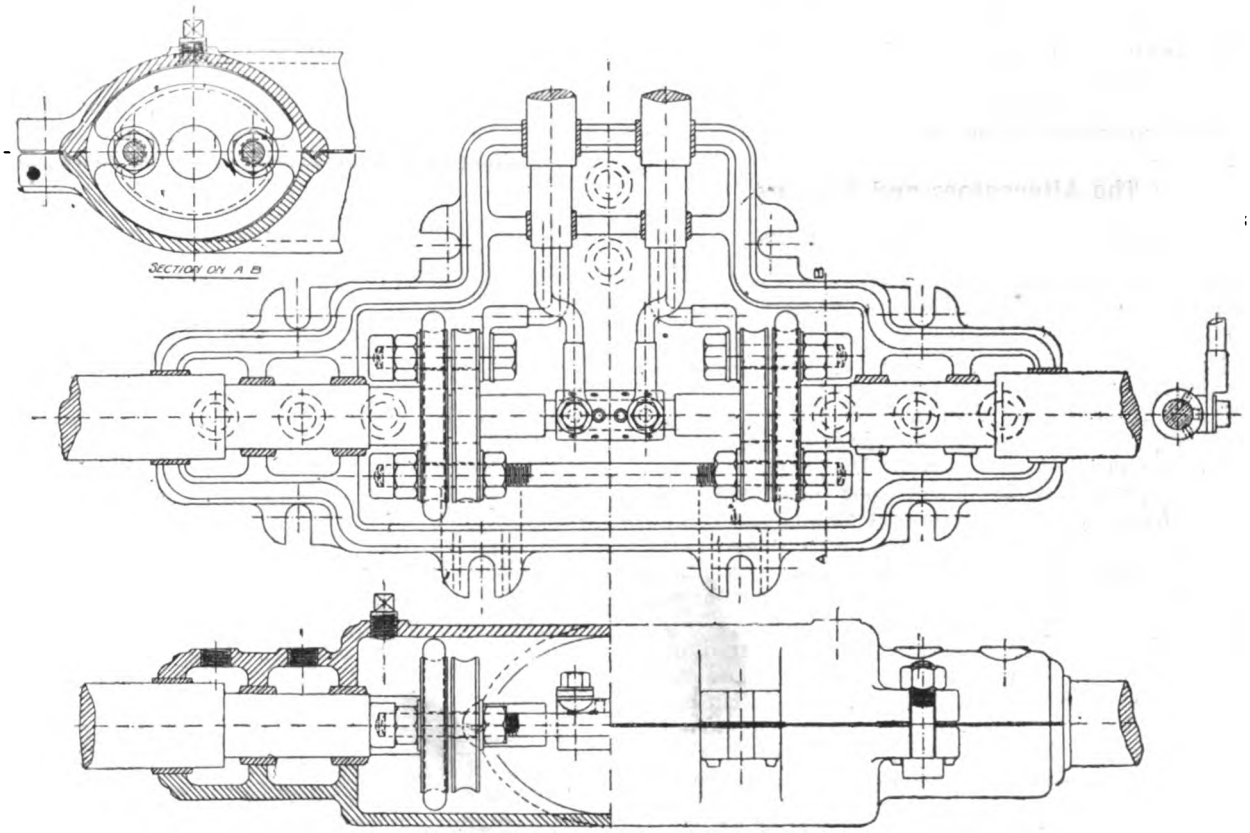
As will be seen from the cross-section of the station, the engine-house, which is 40ft. square, has been built some 9ft. above the level of the boiler-house. The engines were made by Messrs. Browett, Lindley, and Co., Limited, of Patricroft, Manchester, and details of them are annexed. They comprise two horizontal high-speed compound engines, having cylinders 11in. and 16½in. diameter and 12in. stroke, running at 180 revolutions per minute, and indicating 100 h.p. each.



Southport Electricity Works.—Plan of 100 i.h.p. Browett-Lindley Compound Horizontal Engine.

The crankshaft is 5in. diameter, and is extended beyond the flywheel to an outer pedestal bearing. The flywheel is 6ft. 8in. diameter to centre of ropes, and is grooved for 10 1in. ropes. There is also a third engine, similar to the above, having cylinders 8½in. and 12½in. diameter and 10in. stroke, running at 200 revolutions per minute, and indicating 50 h.p. The crankshaft is 4½in. diameter, and is extended with outer bearing. The flywheel is 5ft. 4in. diameter to centre of ropes, and is grooved for eight $\frac{18}{16}$in. ropes.

These engines are fitted with piston valve to the high-pressure and flat slide valve to the low-pressure cylinder A Porter governor controlling the speed of the engines by



Southport Electricity Works.—Plan of Siemens House-box for Serving Two Houses from Double Concentric Cable.

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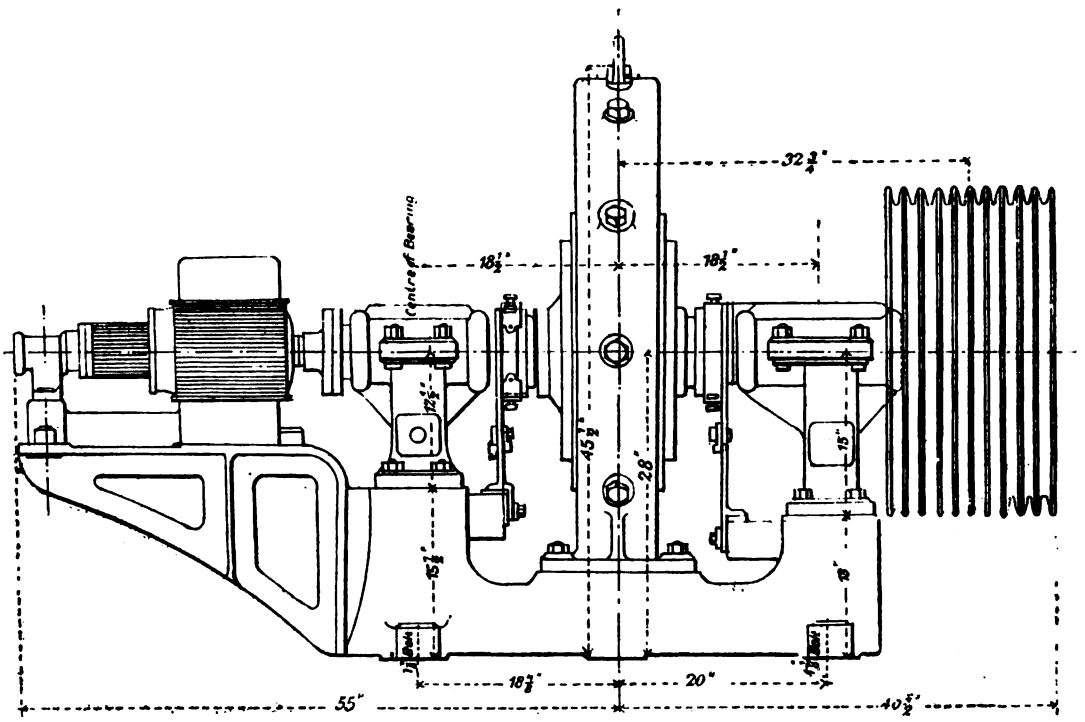
the throttle-valve is used. The bearings are best gunmetal lined with white metal, and Abercrombie's patent ends are fitted to the connecting-rod bolts. The governor is adjustable by hand whilst running. The lubrication is continuous, oil being taken from a central oil-box and conducted down tubes to the various bearings. Sight-feed lubricators are fitted to the cylinders. The details of these engines generally are similar to Messrs. Browett, Lindley, and Co.'s standard vertical engines, but these were specially constructed in horizontal form to conform to the engineer's specification.



Southport Electricity Works.—Side Elevation of Mather and Platt's 50-Kilowatt Alternator and Exciter.

As already mentioned, each engine is provided with two separate steam connections, and the main stop-valves are of the ordinary screw-down type. A starting valve is fixed on the low-pressure cylinder within easy reach of the main stop-valve.

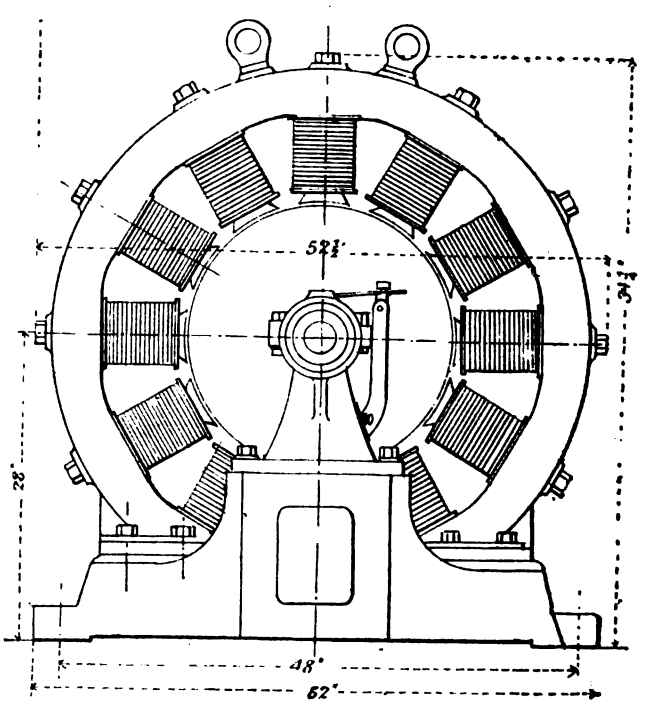
The Alternators and Exciters.

The type of generator adopted is illustrated in the side and end elevations. There are in all three alternators with the armatures revolving and the magnets fixed. Two of the machines are for a capacity of 50 kilowatts, the current being 25 amperes at 2,000 volts, with a periodicity of 50 per second and a speed of 500 revolutions per minute. The pulleys of these machines are grooved to correspond with the grooved pulleys of the two 100-i.h.p. engines. The third alternator, which is driven by ropes from a 55-i.h.p. engine, gives an output of 12½ amperes at 2,000 volts, the speed being 750 revolutions per minute. This machine has eight poles, whereas the two larger ones have 12 poles. Thus the periodicity of all is the same—namely, 50. The illustration shows that the armature coils are so arranged that it is possible to easily remove any coil required and to substitute another.

Each alternator has a direct-current exciter dynamo, coupled direct to the shaft of the alternator, and carried on a bracket bolted to the bedplate. The exciters connected with the two larger machines are each for an output of 25 amperes at 100 volts, and that connected with the smaller machine for 15 amperes at 100 volts. They are of Mather and Platt's patent "Manchester" type. The exciting current required for the full load of the larger machines is 5·75 amperes, and for the smaller machine four amperes. Thus any of the exciters are sufficient for exciting all three machines. It will be observed that the machines require exceedingly small exciting power, this resulting in a very high electrical efficiency; with full load this exceeds 97½ per cent. for all three machines. Both the alternators and exciters are manufactured by Messrs. Mather and Platt, Limited, of the Salford Ironworks, Manchester. It is a noteworthy point in connection with these machines that they may be short-circuited without detriment. The current passing through the armature, if absolutely short-circuited with the fields excited to their full extent, is less than double the normal output of the machine, which would not be injurious for a short time.

The Switchboard Arrangements.

The switchboard, which is arranged on a platform on one side of the engine and dynamo room, is represented in elevation in the accompanying illustration. As will be seen, a panel is provided for each of the three alternators and the exciters; one for the circuit board, and a fifth panel for the synchroniser. Each alternator panel carries a double-pole main switch and ammeters in the exciting and main circuit; also two main cut-outs.



Southport Electricity Works.—End Elevation of Mather and Platt's 50-Kilowatt Alternator.

The circuit panel is also provided with a double-pole main switch, double-pole cut-out, recording voltmeter, and ampere-meter. The synchronising panel is provided with

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a Cardew voltmeter of the vertical type, together with switches for throwing the machines into parallel.

The switchboards and instruments have been designed and supplied by Messrs. Mather and Platt, Limited, of the Salford Ironworks, Manchester.

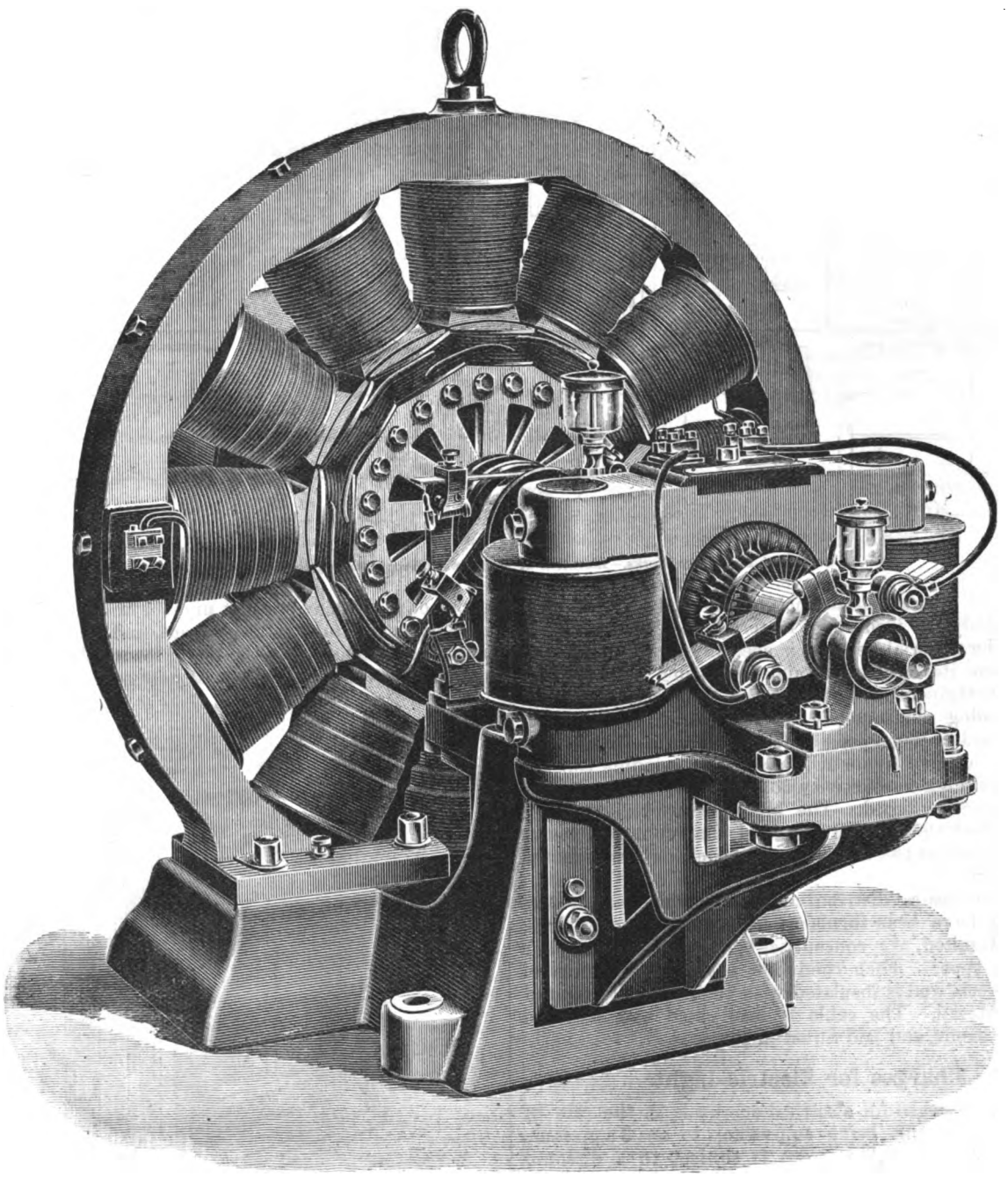
The engine-room is equipped with an overhead travelling crane capable of lifting 10 tons, the width of the span being 38ft. 6in. It has been made by Messrs. Iles, Limited, of Stanningley, Leeds.

The Feeder and Distributing System.

The feeder mains by which the 2,000-volt current is transmitted from the generating station at Crowlands to the various transformer-chambers, together with the other high-pressure mains, have been supplied by the British Insulated Wire Company, Limited, of Prescot, who, it will be remembered, furnished similar cables for the neighbouring town of Blackpool and various other towns. The feeder forms one circuit from the station to the centre of the town.

These high-pressure mains consist throughout of $^{19}/_{14}$ paper-insulated concentric cables, sheathed with lead and armoured over all and laid direct in the ground. It is noteworthy that these mains were supplied under a stringent specification: samples chosen by the engineer to the Corporation had to be cut from the cables at the works and tested with alternating currents of a potential difference of 20,000 volts. The whole of the cable had to be tested in the works in the presence of the engineer for one hour with alternating currents of 10,000 volts, and a test again after the cable had been laid and all connected up was asked for of 5,000 volts for five hours. The cable satisfactorily fulfilled all these tests. The boxes and connections, which were also furnished by the British Insulated Wire Company, were tested by the engineers to a pressure of 15,000 volts when connected up.

At present there are five transformer sub-stations, where the high-pressure current is reduced to 100 volts and distributed to consumers. These sub-stations, each of which contains a 25-e.h.p. transformer, are cast-iron chambers, pillars being arranged 3ft. 6in. above the ground for switching off and on both high and low pressure feeders.



Southport Electricity Works.—Mather and Platt Alternator and Direct-coupled Exciter.

The contract for the transformers, which, together with the low-pressure distributing mains, were supplied by Messrs. Siemens Bros. and Co., Limited, of 12, Queen Anne's-gate, Westminster, London, S.W., called for five converters, each of 25 e.h.p. The type of transformer adopted is shown with the front plate removed.

It consists of a primary and a secondary winding enclosing the middle limb of a double magnetic circuit of lami-

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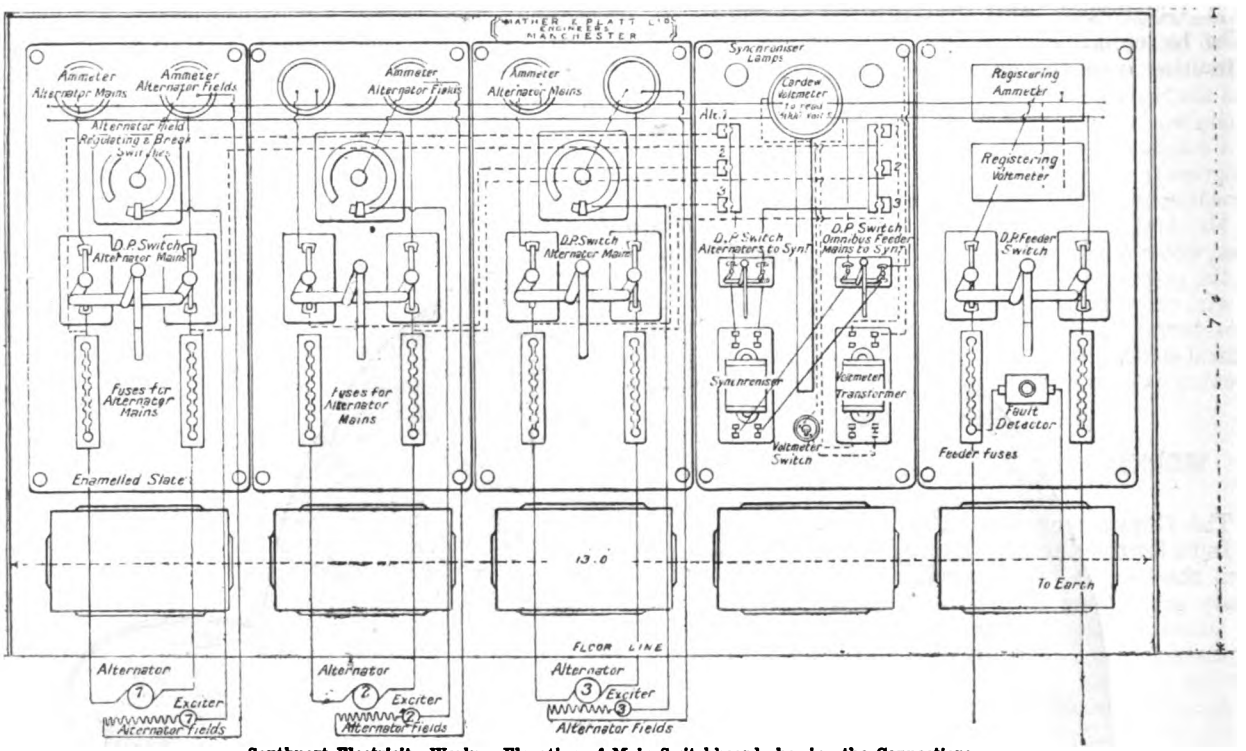
nated iron. The output from the secondary circuit is 18·75 kilowatts, with a frequency of 50 complete periods per second, the ratio of transformation being from 2,000 volts to 100 volts. The core is built up of special stampings of very thin charcoal iron of the best magnetic quality. These stampings are built up into a double magnetic circuit of three limbs by inserting the stampings into the finished winding, the whole being clamped together by means of two strong castings bolted together. The winding is



Southport Electricity Works.—Elevation of Main Switchboard showing the Connections.

arranged on a substantial bobbin, the body of which is made entirely of insulating material and the cheeks of wood. The material being of a specially tough character, it will retain its mechanical and insulating properties at the highest temperature to which the transformer can rise when running continuously at full load. In the high-pressure coil a layer of the same material is inserted between successive layers of wires. The winding consists of turns of high-conductivity copper wire, either double-cotton covered or taped. The high-pressure terminals are insulated from the wooden cheek of the bobbin by means of ebonite, whilst the low-pressure terminals are mounted on the wood.

The low-pressure distributing mains, which, as already mentioned, have been furnished by Messrs. Siemens Bros. and Co., Limited, are concentric, being of the company's ·3 L C. N. type. Each conductor has a sectional area of ·3 square inch, and is insulated with their specially treated fibrous material. The cable is lead cased and sheathed with steel bands, and laid direct in the ground.

Charges for Electric Light.

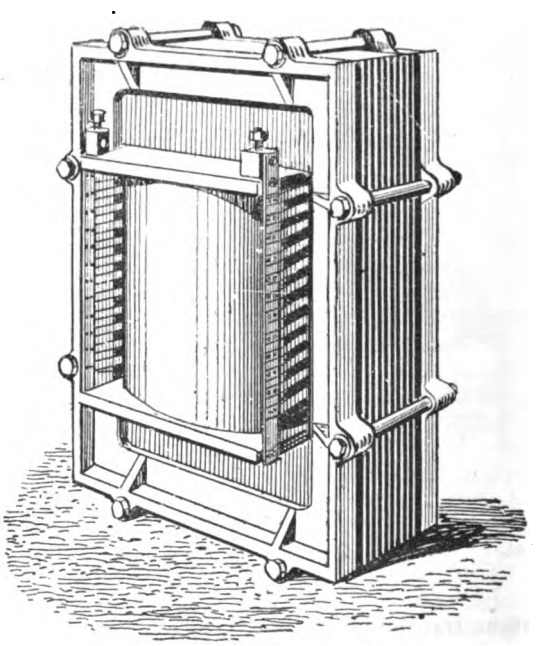
The price charged for electrical energy is at the rate of 7d. per unit, a unit being equivalent to an 8-c.p. lamp alight for 33 hours. This price is subject to a discount of 5 per cent. In addition to this, a fixed charge will be made for the use of meters for measuring the amount of electrical energy consumed by customers. This rental will be as follows per quarter, the meters being of the Shallenberger type:

Meter of a capacity of	5	amperes or	16	8-c.p. lamps,	2s. 6d.
,,	,,	,,	10	,,	,,	33	,,	,,	3s. 6d.
,,	,,	,,	20	,,	,,	66	,,	,,	5s.
,,	,,	,,	40	,,	,,	133	,,	,,	7s. 6d.

Under normal circumstances the Corporation make the connections from the distributing mains in the streets up to the meter on the consumer's premises without making any charges. In cases, however, where the meter is more than 60ft. distant from a street in which the distributing cables are laid the work of connecting up the supply to consumers cannot be done free of charge.

Private and Public Lighting.

The great appreciation shown for the electric light by the inhabitants is demonstrated by the fact that applications have already been received for no less than 5,000 8-c.p. lamps or their equivalent, being practically the whole output of the station for that number of lamps fixed. This is a most successful commencement, and there can be no doubt that extensions of the plant, for which there is ample space at Crowlands, will soon be necessary.



Southport Electricity Works.—Siemens Transformer.

As far as public lighting of the streets by arc lamps is concerned, the Southport Corporation have hitherto done nothing. With its fine Promenade and Lord and other prominent streets, the town cannot very well dispense with this desirable acquisition—a means, too, which for no other consideration is an excellent advertisement for the town and an attraction for visitors. Southport must of necessity follow the example of its neighbour, Blackpool. It will do

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so, we are glad to hear, and early next year it is intended to erect 24 series arc lamps arranged on the high-pressure direct-current system. Two arcs are already being fixed in London-square to see how they work with 50 periods per second.

Conclusion.

A pretty sight should be seen this evening, after the formal inauguration of the electricity works, in front of the Town Hall in Lord-street. The Town Hall and the adjoining Cambridge Hall will then, for the first time, be lighted by electricity, whilst the trees and gardens in front thereof are to be studded with incandescent electric lamps.

In concluding this short description, we must congratulate the Southport Corporation on having established electricity works rather than allow their powers to be transferred to a company. In doing so they have not only followed the progressive spirit of the times, but they have conferred a benefit upon the Southport community. Our thanks are due to Mr. Arthur Ellis, A.I.E.E., the municipal electrical engineer, whose photograph we reproduce, for his kind assistance in the preparation of this article, and it only remains for us to wish prosperity to the Southport electricity works, which, considering the capacity of the plant, stand out unique in central-station working with an initial demand on the opening day for 5,000 8-cp. lamps.

WORKING OF THE INDIAN TELEGRAPHS.

The Government resolution on the telegraph systems in India for the year 1893-94 shows what a profitable concern this branch of the service is: notwithstanding the heavy expenditure incurred in additions to lines, increase of accommodation, plant, and apparatus, the net return on capital to the State was 4·61 per cent. The details of outlay, says *Indian Engineering*, from the commencement of telegraphic operations aggregate the enormous total of 566 lakhs of rupees, of which 22½ lakhs were spent during the year. The additions made during the year were 1,677 miles of line and 8,004 miles of wire. The working expenses were Rs. 53,04,761, while the revenue receipts amounted to Rs. 80,07,306. The working expenses of the new line from Srinagar to Astor, 187 miles in length, while showing an increase in expenditure of Rs. 1,47,763, also showed an increase in the revenue of Rs. 4,24,133, giving a net return to Government of Rs. 2,76,369. At the close of the year the Telegraph Department possessed 3,627 offices, 42,707 miles of line, 134,255 miles of wire, and 274 miles of cable. The principal source of revenue was derived from private messages, which show an increase of 194,480 on inland and 14,266 on foreign messages, giving a net increase of 5·11 per cent., or Rs. 4,03,668 in excess of last year, the highest figures yet attained. A marked increase is also noticeable in the revenue derived from inland deferred messages, the tariff of which was reduced in 1891-92. The latter results go far to prove that further reductions in the tariff can be made without a loss accruing to Government, and that the public appreciate the concession and more readily take to telegrams. This reduction might equally apply to foreign messages, the charges for which are exorbitant or deterrent. A special feature in the report is the introduction of a new signalling apparatus, termed "the Melhuish transformer," which claims to improve the speed of transmission of messages over long distances and to decrease signalling operations to a minimum. It is said that by its use a reduction of establishment representing approximately Rs. 64,000 per annum has been effected. Further experiments are being tried with the quadruplex working, to see whether the new apparatus would be equally serviceable as in the duplex system, and for which purpose circuits have been fitted up at Calcutta and Agra and other large centres. Experiments with dry batteries, and the feasibility of transmitting simultaneously on a single wire two kinds of currents directly opposed to each other, so that the current may operate on the instrument intended without interfering with the other, are also pro gressing. The report on the whole is very satisfactory, and is a marked advance on previous records.

ELECTRIC LIGHTING IN GERMANY.

Messrs. Schuckert and Co. are going to erect a new central station in Hamburg. Mr. Oskar von Miller reports, in connection with the proposed scheme for the electric lighting of Nuremberg, that the private applications for current in response to circulars have been far more than was anticipated, amounting to 26,000 16 c.p. lamps and to 450 h.p. in motors. The original scheme will consequently have to be extended. The whole of the buildings of the municipal slaughter-house at Bomberg have been lighted electrically by the Allgemeine Elektricitäts-Gesellschaft, of Berlin. The local authorities of Königshütte have received applications for a monopoly for a central electric light station from the firms of Messrs. Stutzer, of Myslowitz, and Messrs. Ernst Sattler. A committee has been appointed to enquire into the whole subject. Tenders have been received from a number of firms for the electric lighting of Mayence Harbour, but none have been found suitable. The firms are to be asked to tender anew. A central electric light station is being erected at Rendsburg. The Municipality of Neurode are projecting a central station. Plans have been worked out by the Heidelberg Cement Works for utilising the power of the River Neckar, there being about 3,000 h.p. available. They propose to supply Heidelberg with the electric light. The supply station which is being erected in the Neuenstrasse, Brunswick, will shortly be put into operation. The mains at Hanover are being extended. The Liebfrauen Cathedral at Munich is the first Roman Catholic church in Germany to have been lighted electrically, though there was some clerical opposition on the theory that wax only should be burnt. However, there is now some chance that the Cologne Cathedral will be lighted by electricity. The Allgemeine Elektricitäts-Gesellschaft intend to erect in Harburg a central station for the supply of current for lighting and power purposes. Tenders have been received for the electric lighting of the chief Royal works at Wiesbaden from Messrs. Siemens and Halske, of Berlin; Messrs. Schuckert and Co., of Nuremberg; and Mr. C. Buchner, of Wiesbaden. The last named has obtained the contract. The Municipality of Linden have declined to accept the offer of Mr. Bremeyer to establish a central electric light station in the town, but the Hanoverian Bread Factory now propose to bring forward another scheme. There is a good demand for current at Flensburg. At first there was only one dynamo running, a second has since had a trial run, and a third is to be installed before the end of the year. The Frechener Elektricitätswerke have received a 25 years' concession for a central electric light station at Remagen. Messrs. Alioth and Co., who have 120 h.p. to spare at their works at Mönchenstein, have made an offer to light Dornach-Brugg electrically. Messrs. Lahmeyer and Co., of Frankfort-on-the-Maine, propose to erect a central electric light station at Diez, Naussau.

INSTITUTION OF ELECTRICAL ENGINEERS, Nov. 8.

MR. ALEX. SIEMENS in the chair.

The two papers announced in our last issue were read yesterday evening, and one is given in another column. There was no discussion, and the meeting was adjourned until the 22nd inst.

Telegraphy in India.—Orders have now been issued for the telegraph offices to be closed on the Gohna and Hurdwar lines, and for the line to be dismantled. At the request of the Postmaster-General (N.W. Provinces and Oudh), the executive engineer (Benares Division) has submitted a modified plan and estimate for constructing a new combined post and telegraph office at Korantadih, the headquarters of the Ballia district, at a cost of Rs. 5,150, for administrative sanction of Government. The Madras Chamber of Commerce has been asked to submit through the local government its address on the question of the reduction in the telegraph rates to and from England. It seems unlikely, however, that anything can be done in the matter.

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THOSE BOGIES.

The President of the Institution of Electrical Engineers, speaking at Bolton, mentioned two bogies which are continually flaunted in the faces of all and sundry by the opponents of electricity in their endeavour to frighten municipal bodies from dealing with the question. One of those bogies is of greater far-reaching importance than the other, in that it concerns every householder. The two bogies are: first, the cost of electric lighting to the householder; second, the fear of the gas shareholder that the development of electric lighting will ring the death-knell of the gas industry. Our interest is at present more concerned with the first of these bogies, and the weighty remarks of Mr. Siemens ought to be sent broadcast throughout the kingdom. Of course, opponents will still say they are the words of a deeply-interested party, but we can assure them that the facts can be corroborated on all sides. They are true, and cannot therefore be gainsaid. The difficulty is to bring them home to the minds of householders. Then we may be asked to reconcile two conflicting statements made on the same day—the one at the opening ceremony, by Alderman Miles, the energetic chairman of the Bolton Lighting Committee; the other, the one referred to above, by Mr. A. Siemens. Alderman Miles in his remarks referred to the cost of electricity being one and a half times that of gas. He was comparing the cost of equivalent amounts of electricity and gas, and meant that if a thousand cubic feet of gas cost three shillings, an equivalent amount of electricity would cost four shillings and sixpence. Assume that to be correct, Mr. Siemens, without controverting or in any way questioning the statement of Mr. Miles, said that his own experience with electricity at eightpence per unit, which is more than one and a half times the cost of gas in that particular district, was that his quarterly bills for electricity were not more than the quarterly bills had previously been when gas was the illuminant used in his house. In other words, he stated that though electricity might, compared unit for unit with gas, cost more, the actual bills for the light did not come to more—and that is the crucial test. We have always contended that if the bills were indeed more, the incidental advantages of electricity are so great that the total household cost for illumination would be less. Mr. Siemens, however, meets the question directly by saying the cost according to his household bills is not more, and he accounts for the fact in a simple manner. He maintains that for useful purposes the electric light has never been stinted, but that the gain is wholly derived from not wastefully burning it. The whole house is duly fitted with electric lamps, and the lamps are controlled by switches. The result is that when a lamp is wanted it is turned on, and when not wanted it is turned off. With gas the opposite is the case. There is more trouble in lighting. You do not turn a switch on or off at the doorway with gas, but you can, and do, with electricity. The whole of the gas lamps, or the larger part of them are lighted at the

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beginning of the evening, and turned up or down as required. Now, that is just the point which allows electricity to directly compete. Gas is being consumed whether the burner is high or low. To be put upon a favourable position, it should be completely turned out when not wanted and lighted when wanted. But that involves too much trouble. The more these facts can be brought home to householders the better it will be for the electrical industry. We think, then, that the statements of Alderman Miles and Mr. Siemens are easily reconciled, and that each may be perfectly correct. It must not be considered that the facts as given by Mr. Siemens are anything extraordinary. They are valuable from being the results of actual experience. Almost in the infancy of the industry the late Mr. J. E. H. Gordon brought forward similar figures. In his case, however, if we recollect rightly, the cost of electricity was actually lower than that of gas—"although," as the gentleman put it, "we have been entertaining at our house more liberally this season than last, and consequently have required more light." It is wonderful how largely the unutilised consumption of gas bulks out the gas bills. Let those interested in electricity gather together these experiences and place them before the public at every opportunity.

As regards the other bogie, it was hardly worth combatting. The introduction of railways has not lessened the demand for horses; and while all the chemical by-products of gasworks are so valuable, while it possesses admirable heating properties, there seems to be little or no prospect of adding gasworks to the lumber of old museums. We admit that progress in any direction may mean, and unfortunately too often does mean, individual troubles. Man is an adaptable animal, but too often he does not adapt himself to circumstances. Smith, Jones, and Robinson have troubles because of the introduction of machinery, but their troubles mean success to other artisans. The world is not to stand still in its illuminating process because gas takes a large place in the field, does not like to be turned out, and is somewhat troubled by the progress of its latest competitor.

REVIEWS.

The Slide Rule: A Practical Manual. By CHARLES N. PICKWORTH, Wh.Sc. Fifty-six pages. Price 2s. Emmott and Co., Limited, Manchester and London.

There are slide rules and slide rules, from the 6in. length of brass let into a mechanic's rule to the elaborate Gravêt appliance of mahogany and celluloid or the logarithmic calculating tables of Billeter; but all are based for any real service upon the use of logarithms in the simplification of the mathematical processes that involve the treatment of large quantities. The author of this little book rightly, therefore, takes first in hand the consideration not only of the mechanical principles upon which the ordinary slide rule is based, but also of the mathematical processes involved by the logarithmic calculations, and this first section ought alone, we think, to prove of value to many electrical engineers who either have not had the advantage of more than a rudimentary mathematical training, or through pressure of other things have let slip some of the knowledge they may long ago have acquired.

Under such conditions the author confines his attention largely to the Gravêt slide rule, as being, perhaps, the most modern type, and starting with this he takes up the various applications of the rule to solving mathematical problems of all kinds by logarithmic principles. Ranging from proportion, through multiplication, division, involution, evolution, the author follows with a vast mass of examples in technical computation, such as all engineers have to deal with continually. Of course for slide rule work it is necessary to employ a series of conversion factors, and a very complete set of these has been provided by the author. Taken on the whole, this little book has many points to recommend its use both for beginners in engineering and those who merely require a handy work for reference: whilst the few criticisms which we might conceivably make upon it in one direction or another are not in any way material except from a particularly captious point of view.

PROPOSED ELECTRIC TRAMWAY AT ACTON.

In a recent issue (see the *Electrical Engineer* of October 19 last, page 447) we suggested the desirability of the Acton District Local Authority taking immediate action to expedite the equipment of an electric tramway along the route between Shepherd's Bush and Acton, where the tramway company proposes to double the existing single track: and we then urged the serious consideration by the Local Board—conjointly with the tramway interests—of all the numerous advantages to be derived from the adoption of such a proposal.

On enquiring further into the matter we learn that the tramway management practically consists of the same progressive spirits that have so ably and successfully determined upon electrically operating the tramway systems at Bristol and Dublin, so that we may at once assume a ready acquiescence and willingness on their part in regard to adequate discussion of any proposal emanating from ourselves, the local authority, or other source having electric traction as its main object. We are, therefore, still more desirous of urging the powers that be to at once consider with the utmost favour the suggestions made in our previous article. There should be no need for us to further emphasise the importance of electric traction at the present time as evinced by the developments of the past 10 years in the United States and on the Continent: anyone who has followed its rise and progress will fully appreciate the enormous advantage of a trolley-wire system in improving, if not practically renewing entirely, the capabilities of street tramway transit consistently with modern ideas and requirements; and the same reasons that hold good abroad are quite as potent if not, indeed, much more so, for effecting a change in this country also.

From what we have been enabled to ascertain with respect to the interests that govern the London United Tramway lines, we should feel confidence in asserting that the matter may be very easily arranged favourably for all concerned, and in view of the possible ultimate adoption by the local authority themselves of the *electric lighting* powers for this district (instead of leasing them to a company), it would seem most distinctly advantageous for these facilities to at once be given for the equipment of an efficient and up-to-date electric tramway. Of course we hold no brief for the tramway company (other than by reason of their progressive spirit shown in being favourable to and even desirous of the adoption of electric traction), and we do not pretend to speak for them; but we make no doubt that if the electric line be, as we hope, fully sanctioned and approved by the local authority, the tramway company would be only too pleased to avail themselves of a supply of electric energy for working their line, derived from the electricity works employed for the electric *lighting* of the district.

Not only would such a course of action save the tramway company the expense of erecting an electric supply station (thereby enabling them to spend more upon wood paving or other desirable improvements in the tramway service), but it would also ensure to the local authority as the owners of the electric *lighting* works an immediate and constant source of revenue *throughout the daytime*, when,

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as everyone knows, the demand for a lighting current is practically nil.

Following on all these considerations, it is therefore abundantly clear that this line—if only as the pioneer electric trolley wire system in the Metropolis—deserves the fullest possible support from all concerned, and we are greatly pleased to think that a hearty and unanimous approval is being accorded to the proposal by all those who have the true interests of the district at heart.

CITY AND GUILDS OF LONDON INSTITUTE.

LECTURE IX.—THE CONSTRUCTION AND ACTION OF ELECTRIC BELLS—THE ARRANGEMENTS OF BATTERY CELLS, AND OF CIRCUITS FOR BELLS.

(Specially contributed.)

The Electromagnet.—We have seen that an electric bell circuit contains, besides the battery, a contact maker or push, the wire connections, the bell, and sometimes an indicator. Let us, for the time being, examine the bell, which from its name you will understand is worked electrically—that is, the hammer or striker is caused to strike the gong, or sounding portion, by means of an electric current.

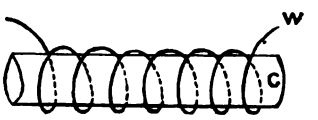

FIG. 1.

I have here a number of pieces of soft iron, cylindrical in shape, each piece having the well-known characteristics of iron. Around this piece of soft iron I wind an insulated wire, Fig. 1. The iron we call the core, and the wire the coil. By means of this silk thread, I hang the piece of iron, A, thus treated to this hook.

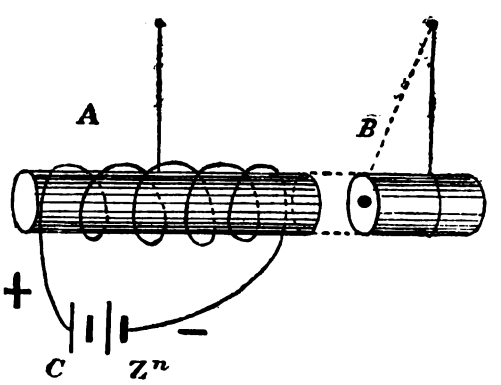

FIG. 2.

I take a second piece of iron, B, and hang it by a silk thread to another hook so that one end of B is near one end of A, Fig. 2. You see the two masses hang quite still.

I connect the ends of the wire on A to the terminals of the battery, and directly this is done you see the iron mass B moves till it touches A. We know that by connecting the wire of the coil to the battery an electric current is sent through the coil, and the action of this current has seemingly imparted to the iron core some property or properties which it had not before. The property immediately clear to us is that the iron of B is pulled or attracted to the core of A. The piece of iron around which the coil is wound, and round which a current is now going, is called an electromagnet. The properties pertaining to an electromagnet will be the subject of future investigation. The one shown is enough for our present purpose. The property of pulling a piece of soft iron is not restricted to one end of the core, as may easily be seen. First, I will break contact with the battery. You see B does not return to its original position, and that is because the core does not at once lose all its new properties. A slight pull, however, suffices to bring B away, and after a few gentle taps on A with this ruler, when I bring B into touch, it goes back to its old position at once. The core around which the current flows is said to be magnetised, and when the current is stopped a little of the magnetism is retained by the soft iron core, and this is called the *residual* magnetism.

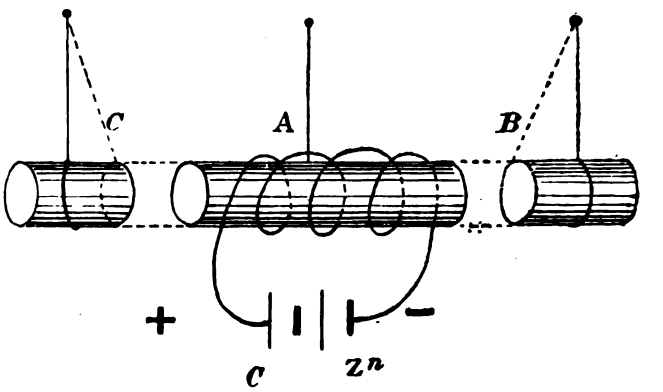

FIG. 3.

I hang another piece of iron, C, at the end of A, Fig. 3, opposite B, and make contact with the battery. Directly you see both pieces of iron are pulled into contact with A. Both ends then exert a pull on the other pieces of soft iron.

Horseshoe Magnet—In order to utilise this double pull electromagnets are frequently made bent into a U-shape, and because of their shape are called horseshoe magnets. The piece of iron, A (Fig. 4), opposite the ends of the magnet is called the *armature*, or keeper. The ends of the magnets are called its *poles*. The U-shape is not always easy to make, so that it is frequently modified, and the bent part is made straight, as in Fig. 5. The various parts of an electromagnet are then :

The armature, A ;
„ iron core, C ;
„ surrounding coil of wire, W.

The core again may be divided into
The arms ; and
The yoke, Y, or piece joining the two arms.

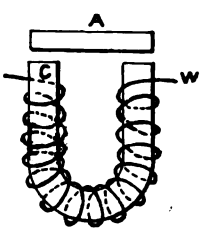

FIG. 4.

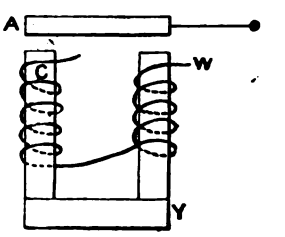

FIG. 5.

The ends of the core are called the poles, and the air-space between the poles is either called air-space or air-gap.

In Fig. 5 the armature is shown connected to a fixed point by means of a strip of steel which acts as a spring.

When a current is sent round the coil the armature is pulled to the poles, and when the current is broken the spring brings it back to its original position. The ends of the core are often covered with a little paper or thin brass,

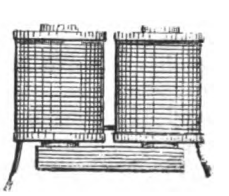

FIG. 6.

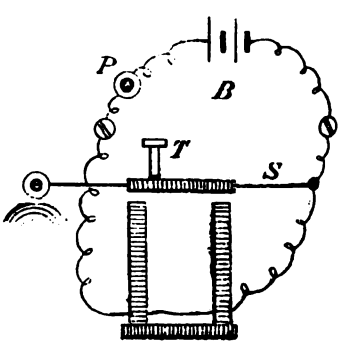

FIG. 7.

so as to do away with sticking caused by residual magnetism. With this apparatus you will see how easy it is to cause a bell to sound. I have only to fix a hammer to my armature and adjust this in connection with the gong of a bell, and then make contact with a battery. The

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electromagnet pulls the armature, causing it to move through a certain distance, and with it moves the hammer, and by such motion the hammer can be brought into contact with the gong, or, in other words, the bell is struck.

The electromagnets used with bells are a little better made than the rough one I just now wound. Here is one, Fig. 6, similar to those in these bells. First let us examine this

Single-Stroke Bell, so-called because when contact with the battery is made it gives one stroke. The diagram, Fig. 7, will show its action. When the connections are made the current goes from the C plate of the battery, through the coils of the electromagnet, to the Zn plate of the battery. On the side of the armature opposite the magnet poles is a screw, the position of which determines the distance of the armature from the poles. The armature is fixed at one end through a spring, S, and at the other end carries a hammer. Now, if the armature is pulled sharply down on the poles, the hammer is so fastened that it has a little play and goes, or should be adjusted to go, slightly beyond the line of the armature. It comes to rest, however, in the line of the armature. By this means when properly adjusted to the gong, and the armature falls, the hammer strikes the gong and immediately comes to rest at a very little distance from the gong. I am supposing the current flowing all the time, otherwise armature and hammer go back to the original position. The reason why the hammer is wanted to move away from the gong you will easily see. The bell sound is caused by the vibrations of the gong, and if anything touches the gong

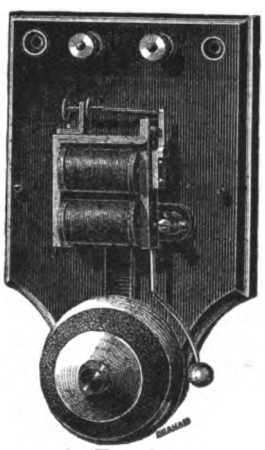

FIG. 8.

it stops, or damps, or muffles the vibrations, and instead of a clear distinct tone you get something of a sound of the nature of sharpening a saw. We make our contact and then break it; you see the armature move, the hammer strikes and you hear the sound. It is all very simple. It is not necessary, of course, to have hammer and armature in a straight line, for the adjustment can be made as in Fig. 8 quite as well. The single-stroke bell is very useful for many purposes, especially for certain parts of

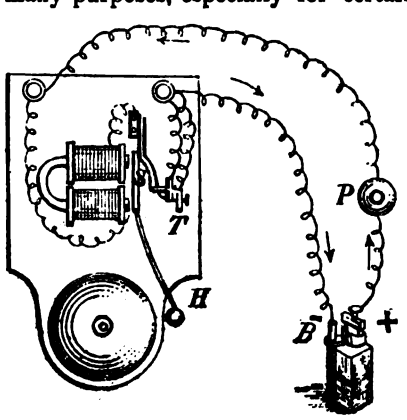

FIG. 9.

railway work. Here a single stroke means one thing—a train on line from A to B, for example; two strokes mean train on line from A to C; three strokes, one from B to A, and so on; but to rouse an hotel waiter or an ordinary servant a bell of another kind is usually employed, one that goes ting-a-ling-ling as long as the contact is made.

The Vibrating or Trembling Bell.—In this the connections are different to those of the single-stroke bell. They will be better understood by an examination of the diagram, Fig. 9. In this we have shown the battery, the push, P, the electromagnet, with its armature fixed to the spring, S. This spring, when the coils of the magnet have no current through them, rests against an adjusting screw, T. The adjusting screw is connected to the other pole of the battery, as shown in the diagram. When contact is made at the push, P, the current goes along the wire,

FIG. 10.

as shown by the arrows, to the coils of the magnet, through these coils to the spring, S, and screw, T, and so back to the battery. As soon, however, as this circuit is completed, the magnet pulls the armature, causing the bell to ring, but the movement of the armature breaks the circuit contact at the screw, T. There is now no current able to get through the circuit because of the break, and therefore the magnet ceases its pull. The armature goes back to its original

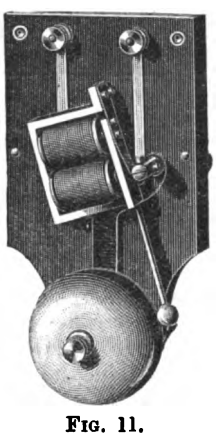

FIG. 11.

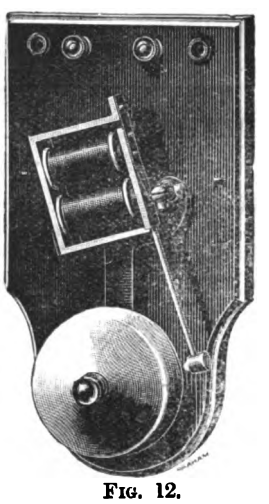

FIG. 12.

position again, makes the circuit complete through T. Again the magnet acts, the bell rings, and so the matter goes on as long as the push, P, makes contact. Of course, when P is released the circuit is absolutely broken, and cannot be made automatically. A section of the push, Fig. 10, shows how contact is made by pressing P. It usually consists of an ivory knob moving loosely through

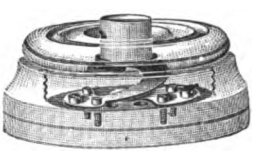

FIG. 13.

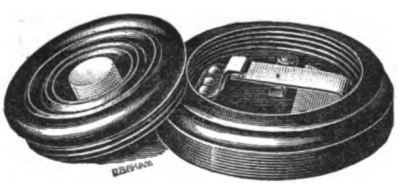

FIG. 14.

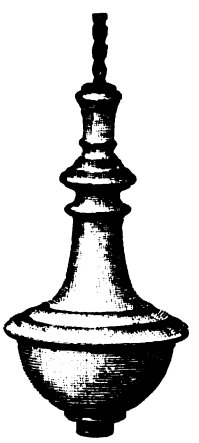

FIG. 15.

a hole in a support of wood or porcelain, which, when pressed, forces a spring against a metal disc, completing the circuit. Figs. 11 and 12 show forms of trembling bells, and Figs. 13, 14, and 15 show forms of pushes.

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The various points of contact are generally made of platinum; thus the tip of the screw, T, ought to be of platinum, as ought the part of the spring of the armature attachment that it makes contact with. One reason for this is that even in such contacts minute sparks, especially on breaking contact, are formed, which rapidly wear away iron. Then, again, iron soon rusts and gets eaten away, so that good contacts are difficult to make. Mr. Allsop tells us that to adjust a trembling bell it is necessary to make sure that all the connections are tight. Thus hold the hammer against the gong and set the screw, T, till its platinum point is just clear of the contact on the spring, S. Let the hammer go, and see if the spring draws the armature back to make good contact with T. The armature, when attracted by the magnet, should be just clear of the magnet poles when the gong sounds. If the screw, T, is screwed up too far, the spring will not break contact with it, while if not far enough the hammer may not reach the gong, or touch it only feebly so as to produce little sound.

Sometimes a bell rings badly from the spring either setting the armature back too strongly, or from being so weak that it does not bring it back with sufficient rapidity. To find out which is the true cause, take a piece of wire, or, better still, a piece of watch spring, and whilst the bell is ringing press the armature towards the poles; then, if the ringing is improved the spring is too strong, and must be taken off and set a little inwards. If, on the contrary, the ringing improves when the armature is pressed away from the poles, the spring is too weak, and must be set a little outwards.

THE EFFECTS OF HIGH-FREQUENCY ELECTRICAL DISCHARGES PASSED THROUGH THE BODY.*

BY ELIHU THOMSON.

The writer has from time to time conducted experiments that prove beyond question the conduction through the body of currents or discharges, the heating effect of which in a carbon filament, whether enclosed in a vacuum or not, is equal to that which is given by continuous currents of from ·3 to 1·5 ampere.

There is little or no sensation experienced in such passage provided the surface of contact of the electrode with the skin be not too restricted. It is needless to mention that with ordinary alternating or continuous currents the passage through the arms of so small an amount as 20 to 50 milliamperes may be quite painful.

The apparatus used in my experiments may be described as follows. Ordinary alternating currents of 125 periodicity are passed through the primary coil of a special transformer or induction apparatus, the secondary of which is wound to give currents of about 20,000 volts. The secondary terminals have attachments to the two sides of a large condenser, whose capacity may be changed at will. Its construction is such that it resists perforation of its insulating dielectric layers. Each dielectric layer is composed of two sheets of built up mica about $\frac{1}{8}$in. thick each. Between these double layers the foils are placed and the whole is covered with oil contained in a wooden box or receptacle. This condenser discharges across two air spaces or gaps, through which a strong air blast from proper jets is kept blowing. The gaps are formed between two sets of brass balls, and arrangements are made to connect to the outer ball of each pair any part of a circuit or path which it is desired that the condenser discharge shall take. A plain coil circle or loop of wire, bare or insulated, may form this discharge path. According to the self-induction of this loop and the capacity used in the condensers will depend the rate or frequency of oscillation of the discharges of the condenser crossing the air-gaps. A larger condenser gives a slower rate, as does also a loop or discharge circuit of larger area or self-induction. Hence, it is easy to make the discharges rapid enough to represent rates of 30,000, 50,000, 100,000 oscillations per second, as desired. It must not be supposed that in such an apparatus we can obtain a continuous unbroken set of waves of current like that of an ordinary alternating current, but of high rate. On the contrary, what we do get is a broken set of discharges in which the times occupied by the discharge itself, oscillating while dying out, is small compared to the periods of rest or no discharge.

A brief outline of some of the work may be of interest at this time. The first point to determine was the virtual resistance of the body from hand to hand and to secure, if possible, a passive substitute resistance which could be used instead of the experimenter himself in further tests where needed. Such resistance substitutes were made by taking boxes about 2ft. long 1ft. wide and 6in. deep, and filling them with sawdust dampened with a weak salt solution. Copper-plate electrodes with short heavy cables attached could be inserted into the sawdust at any point in the length of the boxes. Now, placing the body in circuit with an incandescent lamp burning at a given brilliancy it was easy to reproduce the same brilliancy in the lamp by using, instead of the body, the sawdust-box and adjusting its electrodes, all other conditions remaining the same in each experiment. A measurement of resistance of the box made at once after the substitution by passing through it a current due to 106 volts, and measuring the current which passed, gave a resistance of 750 ohms. A similar substitution of a water resistance gave 650 ohms, so that approximately the virtual resistance of the body of the experimenter could be taken at 700 ohms.

The contact with the palm of the hand was made by metal surfaces tightly grasped and having about six square inches contact with the palm and fingers. By substituting a water rheostat for the body and adjusting it to have the same resistance as indicated by the lamp brilliancy, the increase in temperature of the water during a given time could be made the means for determining approximately the rate of actual heat energy delivery to the body, assuming it to act simply as a resistance, an assumption which, so far at least as the conversion of current energy into heat is concerned, is doubtless well founded. It was found that the rate of heat delivery to the water was equivalent to 59 watts, or about 2,600 foot-pounds per minute. The significance of this delivery of heat energy is plain. Heat energy may be delivered to the body or a portion of it without exciting the muscles or sensation. Whether this method would for the purpose of the physician have any advantage over the application of warmth externally is not of course yet understood. On account of the dead spaces and the nature of the discharges in these experiments the maxima of current must be high. It is possible that the greatest wave amplitude may give 10 amperes or more as a maximum.

In some of the experiments, instead of shunting the discharge loop or coil as described, the arrangement was modified by using a secondary parallel loop or coil, the inductive relation of which to the first or primary could be varied. With a single circle of heavy wire the diameter of which was about 3ft., constituting the primary or condenser discharge loop, a secondary of three turns of heavy okonite covered wire coiled to equal diameter with the primary was sometimes used as the source of high-frequency discharges to be applied in the tests. By moving the secondary into more or less exact parallelism with the primary, the force of induced secondary currents could be regulated at will. From the terminals of such a secondary connections are made to the electrodes used in conveying the currents into the body.

By bringing the terminals of such secondary to a distance of about $\frac{1}{4}$in. apart a torrent of heavy brilliant sparks accompanied by a very loud roar would be obtained, yet, without altering the conditions, such secondary terminals could be bridged by the body, or short-circuited, so to speak, by the hands, with impunity, provided only that the contact surface was not too restricted. It was this coil which, when circuited through the arms immersed in salt solution, gave a current of heating effect equivalent to 1·5 amperes, as above described. The lamp used in this case was rated at 25 volts, 3·5 amperes, and was brought to redness by the current passing through it and the body in series. The brilliancy being carefully noted could be reproduced by an ordinary current of 1·5 amperes.

* Abstract of a paper read before the American Electro-Therapeutical Association, New York, September 25, 26, and 27, 1894.

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BOLTON ELECTRICITY WORKS.

In our last issue we gave a full description of these works, merely, however, stating that they were formally opened on October 31, so that a little more detail of the opening ceremony may not be amiss. Exactly at the time appointed, 4.30, the Mayor (Alderman Nicholson, J.P.), in his robes of office, came upon the switchboard gallery, accompanied by Alderman Miles, J.P., the energetic and painstaking chairman of the Gas, Street Lighting, and Electricity Committee, and the following members of the committee: Alderman Dobson, J.P., Councillors Finney, W. Cooper, J.P., Sherry, J.P., Kearsley, Tootill, Panton, and Holt, the town clerk (Mr. R. G. Hinnell), and Mr. Rider, electrical engineer. The town clerk read an official statement relating the rise, origin, and progress of the scheme. The Mayor then said it was a gratifying circumstance to him that he happened to be mayor on the occasion such as they had met that day to inaugurate. There was no doubt that the day was a very important one in connection with Bolton. No one could foretell what splendid results might arise from the introduction of that new lighting power into Bolton. He congratulated the chairman and his committee upon the result of their labours. There could be no question as to the suitability of Alderman Miles being chosen to perform the ceremony of turning on the current. He laid the stone of the building, and since the laying of the stone he and the committee had been ceaseless in their efforts to make the undertaking a success worthy of the town. He should be wanting in his duty if he did not refer to the admirable services of the electrical engineer, Mr. Rider. He was bound to say that from his introduction to the committee, when he made a most favourable impression, his intelligent devotion to duty and his untiring industry had earned for him the confidence of the committee. He rejoiced in the introduction into the town of lighting by electricity. It was brighter, softer, and more healthy than the ordinary gaslight. When it was introduced into their large workshops, following the example of their excellent Mayor-elect, Alderman Dobson, he felt sure that the healthy condition of the surroundings of the workpeople would be considerably increased. He felt sure they would share with the chairman of the committee in the hope that they would see some results of long, patient, well-directed, and persevering work.

Alderman MILES thanked the Mayor and his excellent committee for the great compliment they had paid him in asking him to perform that important ceremony. That day was an interesting one to him, and also particularly to two other gentlemen who stood on that platform. In the first place, his Worship the Mayor completed his twentieth year of service to the Corporation of Bolton and its inhabitants; that day also witnessed the completion of 20 years' service by the worthy Mayor-elect, Alderman Dobson; and also 20 years of happy service in the interest of the Corporation and the borough generally by himself. It was interesting also from the fact that that was October 31, when they were on the point of saying to the Mayor, "Well done, you good and faithful servant, for the splendid service you have rendered to the borough for the last three years." He was sure they would all join with him most heartily in wishing his Worship and his good lady long life, happiness, prosperity, and good health in the future, knowing that he would be in a position of greater freedom and less responsibility. It was interesting also because it gave him the opportunity of asking them to give a kindly mark of welcome to the Mayor-elect. He felt sure they would all rejoice in the choice which had been made, and they were all expecting great things from Alderman Dobson in the coming year. He hoped after the opportunity they had had of looking round the new works that they were pleased with them. He thought the building was a beautiful one, and although the committee had been determined from the first that they would have everything of the best, they had endeavoured to act wisely and economically, and he hoped they had succeeded. They would be glad to know that in giving out the contracts they had a strong desire to keep as much of the work in the town as possible. In regard to the engines and boilers, to have had these sent into Bolton from other towns would have been like sending coals to Newcastle. As regarded the building contracts, these had as far as possible been given in the town, and when they looked round he hoped they would be ready to say that the committee had been wise in their choice of contractors, and whilst saying this he was glad to have the opportunity of adding that the thanks of the committee, and the borough at large, were due to the contractors, who had striven to put in some of the best work they were capable of for the honour and good of that old town. It had been said that it was a rather anomalous position for the Gas Committee of the Corporation to take in hand the supply of the electric light. He did not agree with this opinion, although it might be contended that gas and electricity were two rival lights. The committee were imbued with one object only. They said, "We are the servants of the ratepayers, and if they desire a supply of the electric light in anything like reasonable quantities, their demands shall be satisfied," and acting on that principle the committee had tried to satisfy their demands as well as they could. They were determined that each concern should stand on its own individual responsibility, and if they had requisitions from customers in the borough for electric light, they would only be too happy to supply it. There were many places where the electric light was far more suitable than gas, and he thought those who adopted it would find a saving in many respects. He then paid a tribute to the zeal and energy displayed by the committee and the electrical engineer (Mr. Rider). He hoped the works would be a success. It would be idle to expect the concern to pay the first year, but another town, rather larger than Bolton, which commenced seven months ago with 1,000 8-c.p. lamps, expected to make a profit the second year. They at Bolton had started with 3,500 8-c.p. lamps, which he was sure would be acknowledged to be a splendid start. They did not want to make any great profit out of it, but in the future he felt sure it would become one of the great profit-making departments of the Corporation.

Councillor W. COOPER was then called upon to speak, and in doing so he said he deemed it no slight privilege to take a small part in the inauguration of a system of electricity for his native town. He was sure the energy displayed by the Gas Committee would be amply repaid. Electricity could do many things—it could cook them a chop, mature their wine, clear their sewage, and drive their trams.

Councillor HORROCKS followed, and alluded to the establishment of the gasworks, and now they were there to inaugurate a new scheme which he believed had a greater future than had the gas.

Alderman DOBSON said that from experiments made at his own works electric lighting was found to be much healthier to use in close-confined rooms than ordinary gas might be. He hoped that would be the universal experience of the town. It would save also in the effect on pictures and articles of furniture, there would not be the same amount of dust and dirt, and everything would last longer. He wished every success to the undertaking.

The MAYOR then presented to Alderman Miles a silver key, commemorative of the occasion, bearing a suitable inscription on one side and the borough arms in enamel on the other, and which was to turn on the light.

Alderman MILES, on receiving it, said it was an unexpected proof of the goodwill of his colleagues, and he tendered his hearty thanks. The engines were set in motion, after which he switched on the light amid great applause.

Subsequently, at the invitation of Alderman Miles, J.P., and the members of the Lighting Committee, a banquet was given in the Mayor's Banqueting-room at the Town Hall, when nearly 100 guests partook of their hospitality. Further speeches were made relating to the new departure, and judging from the remarks at the opening ceremony and at the banquet, the success of the Bolton station ought to be assured. We wish it every prosperity.

Kendal.—The Town Council have had on their minutes an application by the directors of the Windermere and District Electricity Supply Company, Limited, with regard to supplying electrical energy for use within the borough. The committee recommended that having regard to the absence of demand for electricity in the borough and to the fact that in the opinion of the Council it was desirable when such a demand arose that the Corporation themselves shall supply it, the Council be advised not to assent to the application. The Town Clerk stated that the company would wish to know the decision of the Council as the matter was urgent. Councillor Hargreaves was surprised the committee should say there was no demand for electric lighting. Councillor McKay said there were members who would do their best to oppose it. Councillor Jefferys thought they might get it from the company upon what terms they would be willing to hand over the lighting to the Corporation if desired at some future time. Councillor Monkhouse did not see the necessity of their going cap in hand to the company. Councillor McKay asked if the Gas and Water Committee were serious in objecting to the company? If it was a foregone conclusion that they did not wish to have anything to do with the lighting, it would be better to say so. They had had an offer made, and they themselves could never produce power so cheaply as it was offered to them. Councillor Cozens-Hardy suggested that they should have the representatives of the company present, and see what they were ready to offer. The Town Clerk said it ought to come voluntarily from them. The question was whether they would give the representatives the opportunity of meeting them and discussing the matter. Would Mr. Jefferys or any other gentleman in some informal way get their proposals in writing? After some few remarks, Councillor Jefferys said there would be no harm in asking them what they would do. He thought the committee had shown their hands as to the grounds on which any opposition might be raised. They had no authority from the Corporation Councillor McKay: And then to say that there was no demand! Alderman T. Wilson moved the adoption of the minutes. Councillor W. B. Thompson ultimately moved that the Corporation hear a representative, which was seconded and carried, the matter to come before the whole Corporation in committee.

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ELECTRIC TRACTION, WITH SPECIAL REFERENCE TO THE INSTALLATION OF ELEVATED CONDUCTORS.*

BY ROBERT W. BLACKWELL, FOREIGN MEMBER, AND PHILIP DAWSON, ASSOCIATE.

In conversation with Mr. Wilkinson a few days ago the suggestion was made that some supplementary memoranda relating to electric tramway practice—collected during the past six months, which we have passed in studying construction on the principal American lines, and in visiting the late large continental installations—might meet with your acceptance, and it was also thought that an exhibition of apparatus employed in erecting and working elevated conductor lines would be of interest at this juncture.

The marvellously rapid and successful introduction of electric traction in the United States is now an old story. That 600 electric tramways are there operating nearly 9,000 miles of track and 20,000 cars—that nearly three-fourths of the tramway movement of the country is electrical—that £45,000,000 is there invested in electric tramways, and that this tremendous result has been, to all intents and purposes, effected within five years, cannot but appeal pleasantly to the electrical engineer. Germany, France, Belgium, Austria, Switzerland, are already investing millions in electric traction, and there seems every reason to believe that England will shortly join the march of progress.

Probably no practical point in electric traction was less understood a few years ago than "rail-bonding," and a few words may be added to what has been said on that subject. Its importance has but recently been appreciated, and it is of first importance. It may be taken that the bonds connecting rails should be, as nearly as possible, of the same current capacity as the metals themselves. If a 70lb. rail be used, the sectional area of copper bonds should be as nearly as possible seven-sixths of a square inch, the ordinary steel rail having approximately one-sixth as much conductivity as commercially pure copper. This would exceed nine No. 0 copper wires.

When electric roads were first constructed a No. 4 galvanised iron wire was considered sufficient.

The contact surface of bond and rail should be as large as possible. With heavy bonding and insulated return-circuit feeders the danger of corroding gas and water pipes (a danger that has been greatly and unnecessarily exaggerated) is practically nil. The Toronto, Baltimore, Salt Lake City, and many other systems may be cited in support of this statement. In cities earlier equipped, where the lightest of rail bonds and return feeders were employed and very heavy current dealt with, serious results undoubtedly ensued, as at Boston, where electric traction was first installed on a large scale. By the use of modern appliances the trouble there has almost ceased to exist. The tramway company employs special workmen to accompany gas and water construction gangs, and to connect all water and gas pipes laid in the neighbourhood of the power-house to heavy bare copper cables returning to the stations. It must, however, be borne in mind that in that city an approximate total of 13,000 e.h.p. has to be dealt with by the three power stations of the West End Street Railway Company. The following are the figures of January 27, 1894, on which day 577 cars and 71 snow-ploughs were running:

Stations.	Hours run.	Mean current for the day.	Maximum current.
Aleston	16	1,203 amps.	1,580 amps.
Cambridge.....	18	4,088 ,, ...	5,425 ,,
Central	24	12,706 ,, ...	14 400 ,,

The average monthly car mileage of this line in 1893 was 1,325,000 miles.

Prof. Jackson, of the University of Wisconsin, has found by experiment that the chemical composition of the soil has a great influence on corrosion. The most favourable to it, and having the smallest resistance, is that in which there is the greatest proportion of chlorides. Nitrates come next, and sulphates last. If, after all ordinary precautions are taken, corrosion still continues, bare copper cables are connected to the negative terminal of the generators at the switchboard, and to all pipes in the neighbourhood of the station. So far as possible the use of earth for the return circuit should be avoided. In conversation lately with Mr. Sprague, he laid great stress upon the advisability of laying the rails upon good stone ballast, and coating all bonds and connections with insulating and preservative compound.

The practice of laying bare copper wires along the whole length of the track, once regarded as indispensable, is now practically abandoned. It has been found that wire so laid rapidly deteriorates and wastes away. All the copper is put into the bonds, the rails are cross-connected approximately every 90ft., and where the volume of current exceeds the economical carrying capacity of the bonded rails insulated return-circuit conductors are employed. A number of rail bonds of approved make are on the table. It is interesting to compare them with this galvanised iron-wire bond of a few years ago. This "Brooklyn" rail bond, as its name implies, has been extensively used in that city. It is a simple strip of copper, so bent as to provide for expansion and contraction. A drive-fit tapered iron rivet at either end holds it to the rails. This "West End" bond is largely employed by the Boston tramways. An iron taper is brazed on to the copper wire at the points where the bond is driven through the web of the rails, and a soldering sleeve connects the free ends of the wire. This "vail" bond is composed of flexible stranded copper cable, welded into heavy terminals, which are provided with copper riveting projections to be forced through the web. This "Chicago" rail bond is more elaborate and effective. The tubular terminals, with slotted ends, are passed through the rail and the tapering drift pins thoroughly driven home, so as to swage or swell the terminals to completely fill the space. It must be noted that the enlarged terminals are of sufficient diameter to avoid any choking of the current as it passes from the rail into the bond. As has been before said, the contact between rail and bond should be as near as possible seven times the sectional area of a bond wire sufficient to carry the given current. The sections shown exhibit the construction very fully. While the solid copper bond possesses all the flexibility found to be necessary, it is made, when desired, with flexible stranded copper cable between the terminals. Mr. Wilkinson has fully described and illustrated other types of bonds, to which it is unnecessary to again refer.

Whether electric welding will eventually take the place of all bonding is still an undecided question. It has not yet stood the test of practical use on a large scale for a sufficiently long period to pronounce an opinion. When first introduced in Boston it was not successful, many rails breaking near the joint after some months' use. The process has since been improved, and a trial section of line was in course of being welded when the "West End" Street Railway was visited last June. Seven miles of welded track have given satisfaction for some months in St. Louis. Over 100 miles are now being welded in Brooklyn, and the result of this trial will demonstrate, after a year or two, the value of welding. At present it takes from 10 to 15 minutes to makes a welded joint, and, on an average, a current of about 250 amperes at 550 volts is necessary, which is transformed into an alternating current at two to three volts pressure. Approximately, each joint costs 12s. to 15s. It is said that the pioneer company in electrically welding rails has already invested over £120,000 in experiments. It is worth mentioning that modern American practice is to butt the rails, allowing nothing for expansion, wherever the streets are paved. The result is a nearly perfect joint. With heavy cars, having at least four to five tons load on each axle, this is of the highest importance. A number of sections of standard American tramway rails are shown, and you will see from them that the highway authorities there are not quite so strict as they are in England, and allow of the use of a rail which presents much less obstruction to the easy running of a tramcar wheel.

Mr. Wilkinson refers to the possible adoption of the three-wire system for electric tramways. That system has been in satisfactory use in Portland, Oregon, for the past four years. Compound-wound generators, working at 500 volts without load, and 550 volts with full load, are used. The success of this system depends upon the load of the various sections being nearly balanced. At Milwaukee, where local conditions did not allow of proper balancing, the system was tried, and given up as a failure. The three-wire system was introduced at Portland because the generating station was three miles away from the nearest point of the line, and the cost of feeders would have been necessarily heavy. By the three-wire system 1,100 volts could be used, −550 and +550, between each two sections of trolley wire. The rails were connected to the neutral terminal at the switchboard. The average load on this station is 1,500 h.p. It is located near a huge lumber-mill, and the fuel is carried by automatic conveyers directly from the waste lumber-yard into the furnace. Several tramways derive their power from this station at a cost of about 25s. per horse-power month, 18 hours' daily work. Thomson wattmeters register the current used. The station pays about 40s. a day for its supply of fuel.

The enormous carrying power of an electric tramway at a pinch is an interesting feature. The following figures, given by Mr. Bowen, of the Chicago City Street Railway Company, show the work done by his electric line on "Chicago Day" at the World's Fair: 51 double-motor cars, 10 single-motor cars, and 73 trail cars were in operation over 26 miles of track. During the day 208,575 passengers were carried, and 11,271 car miles run. The maximum output at the power-house was 17,000 amperes, and the average for 20 hours about 1,050. The minimum current registered was 750 amperes, and the average station pressure 540 volts. The ratio of expenses to receipts on this line is 40 per cent.

The following figures we have already published in a communication to *Engineering*. They are, however, sufficiently

* Paper read before the Institution of Electrical Engineers last night.

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TABLE A.

To November 30 of	1888.	1889.	1890.	1891.	1892	1893.
Total miles of track	—	233·24	234·69	244 00	259·80	268·33
Miles electrically equipped	—	—	65·46	81·23	148 04	182·50 (e)
Number of horse cars	1,584	1,794	1,694	1,662	1,226	826
Number of electric cars	—	47	337	469 (a)	1,028	1,346 (f)
Total revenue miles run	15,431,758	16,573,831	17,665,360	17 462,572 (b)	17,498 660 (c)	18,669,809 (d)
Electric revenue miles	—	—	—	4,588 186	9,622,000	14,189,054
Percentage of expenses to earnings	82	82	77	74·4	70·8	68
Investment in electric dols.	—	412,600	1,510,321	—	5,752,694	7,608,069

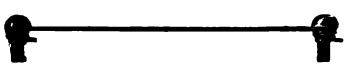
(a) The long cars introduced at this time, and now almost exclusively used on the company's electric lines, are almost twice the size of the regular two-horse car.

(b) Electric mileage ..... 26·27 per cent. Horse mileage ..... 73·73 per cent.
(c) ,, ,, ... 48·63 ,, ,, ,, ... 51·37 ,,
(d) ,, ,, ... 76 17 ,, ,, ,, ... 21·83 ,,

(e) And 25 additional miles partially electrically equipped.
(f) And 24 electric snow-ploughs.

interesting to be placed before you. The largest electric tramway equipment in the world is that of the West End Street Railway, in Boston, U.S.A. Its adoption of electrical motive power practically established the economic value of that method of operation. The figures extracted from its annual reports are shown in Table A.

Attention is specially directed to the decrease in percentage of working costs to gross receipts, which has varied almost directly in proportion to the introduction of electric plant. This reduction has been made notwithstanding the fact that the additional investment required for the introduction of electric plant had to be provided for, and that such part of the company's former plant as was rendered useless, or disposed of at a



Old-style Railbond.

The Brooklyn Railbond.

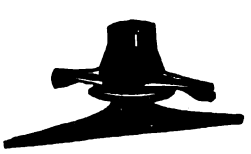
loss, had to be written off. A comparison between the tramways of London (population, 4,306,411 in 1893) and Boston (population, 417,720 in 1890) is interesting:

	London.	Boston.
Miles of street operated	125§	—
,, single track	250 approx.	268½
Number of cars	1,080 (a)	2 172
Car miles run	21,924,290 (b)	18,669,809
Total working expenses	£885 967	£910,147
,, receipts	£1,070,578	£1,338,515
Net receipts	£184,611	£428,368
Percentage of expenses to receipts	82·7 (c)	68
Total capital invested	£3,533,177	£4,435,000
Rate of interest paid on ordinary shares	3·32 per cent.	9 per cent.

(a) London uses top-seat cars, Boston does not. Boston has to keep a double set of cars—open for summer, closed for winter. (b) London has the greater number of car miles run. The majority of Boston cars are much larger than the London ones. (c) Boston investment includes £1,500,000 spent during the past five years on re-equipping electrically.

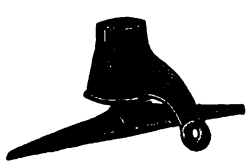
If London's percentage of expenses to receipts could be reduced from the present 82·7 to 70 per cent., net receipts would be increased to £321,174; if to 60 per cent., net receipts would be £428,231. It is almost unnecessary to call attention to the fact that the cost of material and labour involved in the re-equipment electrically of a tramway is much higher in America than in England.

Old-style Trolley Wire Hanger.



W. E. Straight Line Insulator.

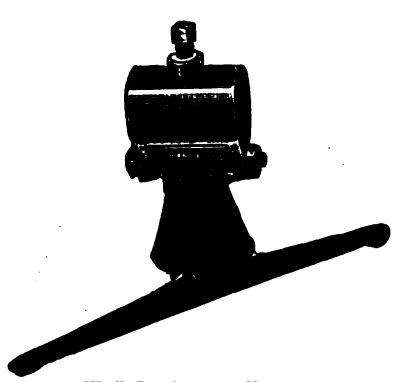
In the early days of electric traction no greater annoyances fell to the lot of the much-tried tramway constructor than those which seemed inseparably connected with the suspension and effective insulation of the conducting wire. No material was obtainable possessing the happy combination of strength, durability, and high insulation with inconspicuousness; interchangeability of parts was unknown, and unsightly, rough-and-ready expedients were used wherever difficulties in erection were encountered. From 1884 to 1889 no insulator better than paraffined wood or porcelain could be obtained. This is the best device the Bentley-Knight Electric Railway Company could evolve to support a bar copper conductor in its conduit system laid in Boston in 1888. As you will see, it is composed of a block of porcelain leaded into a malleable iron holder, and having a brass support for the conductor leaded into it. All of the earlier elevated conductor lines were dependent for their insulation upon the wooden poles by which they were supported, and in wet weather the resultant leakage was a very serious factor. With the introduction of iron poles, and the development of motors and power plant, something better and more permanent became a necessity. The wide extension of electric traction is largely due to the enterprise of independent manufacturers, who, seeing a great and



W. E. Single Pull-off.

W. E. Double Pull-off.

growing need, undertook the elaboration of a system of electric tramway supplies to meet the demand, and relieved the electrical companies of constant consideration of the details necessary for safe and economical transmission of current from power-house to car motor. The taut and workmanlike overhead line of to-day, in erecting which the lineman has had at hand a compact and appropriate device for every insulating or supporting point, differs widely from the unsightly webs which were the rule in earlier years. Your attention is called to the various appliances on the table. They fairly represent the best known and most widely used apparatus. You will note the strong external resemblance between the various makes wherever an appliance for a specific purpose is in question. We will not go into the question as to whether any one insulating material has greater merit than another. The specimens shown include several distinct makes of homogeneous and fibrous insulating substances, the composition of which is a manufacturers' secret; and also insulators of compressed mica, and



W. E. Bracket Arm Hanger.

of solid sheet mica ingeniously compressed between metallic parts, and supplemented externally by a special insulating compound.

Of that important factor, the trolley wire itself, little need be said. The universal American practice is to employ No. 0 hard-drawn copper. Many continental lines have employed lighter trolley wire—in some instances as small as 6mm.—and some use larger. It may be taken, however, that No. 0 is the size that gives the best all-round results. Phosphor bronze is of doubtful utility as a substitute for hard-drawn copper, the increased tensile strength being more than overbalanced by the reduction in conductivity. The manufacturer of the trolley wire should guarantee 98 per cent. conductivity or better, and perfect joints, and should deliver wound on special reels in mile lengths. Good running and a low rate of depreciation

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depend largely upon the exactitude with which the trolley wire follows the line of the metals, and pains taken to ensure a smooth and even path for the trolley wheel are always well repaid.

In the selection of the line of appliances to be used the nature and needs of the individual road must be borne in mind. For a suburban line and light traffic, where economy in first cost is a first requirement, this "Ætna A type" insulator serves the purpose well. You will see that the series in this type includes a straight line insulator, single and double pull-off for curves, and a bracket arm hanger. The construction is shown in this section.

In this type, the homogeneous mass of insulating material, while still in a plastic state, is forced under heavy pressure into a casting provided with internal flanges to hold it securely in place, and external points to which the span or strain wires may be attached. The threaded thimble is moulded into the insulating material at the same time. The threads are made to take 7-16in. or §in. screw studs, according to the strain they are to sustain. The metallic parts, which partially protect the insulating substance, are of either bronze or malleable iron. In this type the strain and weight of the trolley wire is taken by the insulating material itself. This is the type of insulated suspension employed by the South Staffordshire, Douglas and Laxey, and Guernsey lines, and many continental and colonial roads.

To supply the needs of tramways where constant and heavy traffic is to be expected, and where security to the service is of far more importance than small economies in first cost, the "West End" type of insulating material has been evolved. This series is more elaborate than the former, comprising a straight line insulator, single and double pull-off, bracket arm hanger and bridge, spring bridge, and car-house insulators. These are far more substantial than those first described. The essential difference in construction is that the insulation is wholly protected from injury from exposure or chance blows, by a metallic skirt, and that no part of the strain comes upon the insulating material itself, the load and strain being wholly taken under all circumstances by the heavy metallic parts of bronze or malleable iron. The insulating part is a bronze or steel bolt, heavily coated under pressure with non-conducting material, the head of which fits closely into a recess at the top of the protecting casting, and is firmly held there by a screw cap. These bolts are interchangeable throughout, and can be slipped in or out at any time. When it is desired to bring a feeder into the line the insulating bolt is slipped out and a metallic "feeder plug" of exactly the same size takes its place, this throwing the whole hanger into circuit and allowing an insulated feeder wire to be attached to it in exactly the same way as an ordinary span wire would be. A special tool is used in putting up "West End" straight line hangers, and much facilitates the labour of erection. The casting is held in the fork at the top of the tool. The span wire fits into the groove of the wheel, and a single movement of the lever snaps the wire into position. By the use of this "West End" type of apparatus, the span wires can be erected, and the castings inserted at the fixed points of suspension, before the insulating material is brought on the line. Ears can be soldered to the trolley wire and attached to the insulator afterwards, and there is a minimum of leakage through moisture. As an illustration of the care taken to supply each need, I would call your attention to the "spring bridge" insulator, used under bridges and elevated railway structures and in tunnels. As the fixture is of necessity rigidly attached to the structure above the line, a yielding support is provided in order that the trolley wheel, at high speed, may not strike a point without flexibility and have a tendency to jump the wire. The spring is protected by a galvanised iron case, and the insulating bolt within has a fluted metal covering, which preserves the insulation from injury by chafing, and prevents the bolt turning.

The use of high-class line material greatly facilitates both construction and operation, and in no part of the equipment can a little additional expense be incurred with such good reason. Note how carefully the makers of both the above types of apparatus endeavour to bring span wire and trolley wire close together. Earlier styles did not possess this virtue, the span wire being led over the top of the insulator. Experience quickly showed that it was an error to separate span and trolley wire more than absolutely necessary. To connect the trolley wire with its insulated supports ears or clips are used, of which a number of varieties are on the table. For efficiency, durability, and smooth running nothing quite equals an ear soldered to the trolley wire, and soldered ears are almost indispensable at curves or points of heavy strain. However, it takes skilled labour and quite one-third longer in time to erect a line using soldered ears throughout. I would especially call to your attention the fact that the blow-pipe must not be used in erecting a trolley wire with soldered ears, but instead heavy grooved soldering irons, like the one shown, must be employed. The use of the blow-pipe softens the wire, and renders it liable to break. A trolley wire must be "anchored" at least every mile of straight line, and always at either end of every curve. Special ears are provided to which the anchor wires can be readily attached. Special ears are also used for jointing together lengths of trolley wire. Joints should always be made at fixed points of support. A properly-soldered combination anchor and splicing ear is on the table. Other ears are used for points where it is desired to make connection with feeders. Trolley wire soldered ears are made 7in., 9in., or 15in. long. Samples are shown of the regular soldering and span wire work of the linemen of the Boston tramways.

The perfect mechanical ear has not yet been evolved, although improvements are constantly being made. Several types are on the table. The difficulty is that all mechanical ears interfere more or less with the smooth under surface of the trolley wire, and any obstruction, however slight, to the passage of the wheel is a disadvantage. This "Badger" mechanical ear is simple and effective. It is composed of two interlocking plates of malleable iron and bronze, which, when placed together, leave a groove into which the trolley wire is clamped by the wedge-shaped stud of the insulator being forced into the jaws formed by the upper portion of the two plates. A pin through the stud hold the ear and stud together. Another exhibit shows the same clamping principle applied to a hinged ear, a screw stud set in the insulator being substituted for the wedge, and the pin being dispensed with. Another type shows the clamps held together by screws. The "Anderson" mechanical ear is composed of a bronze casting grooved along its lower surface to fit the trolley wire, and a plate of hard-rolled copper bent to fit over the trolley wire, and furnished with eyes which close over slotted projections on the casting. The whole is bound together by forcing the eyes into the slots by the small screw-bolts at the top of the casting. A special clamp is used to force the copper plate into position and hold it until the screws have been set up. The number of mechanical clips is legion, but none are quite up to the soldered ear. Mechanical ears are good or bad in proportion to the extent to which they interfere with the smooth running of the trolley wheel and necessitate bending of the wire. The latter is always a mistake, because, if it happens that the position of an ear has to be changed, a kink is left in the wire. It is also an error, frequently made in early days, to allow any play or joint between the insulator and the ear.

By the courtesy of Mr. I. Everson Winslow, we are enabled to exhibit to you a series of the Thomson-Houston insulated suspensions employed by him in the erection of the elevated conductors for the Roundhay tramway line at Leeds. In the straight line insulator, and single and double pull-offs, the strain is taken by malleable iron or bronze castings, which spread out sufficiently to protect the insulation from accidental blows from the trolley, and to form a water-shed. A cap of insulating material, from which projects a screw stud, fits closely over the top of the casting, and the recess beneath receives a cone of the same insulating substance, through the centre of which the stud passes. When the ear is screwed up on the stud the whole is bound tightly together. Some of the insulators shown have been in regular use at Leeds for three years and show no sign of deterioration. A bracket arm insulator, anchor ear, splicing ear, and an aerial frog, as used at Leeds, are also before you. Earlier Thomson-Houston forms, showing porcelain insulation instead of the material now used, are also exhibited.

Dr. Edward Hopkinson has been kind enough to send us this insulator and mechanical ear used by the Isle of Man Tramways. It is somewhat similar to the "Anderson" ear already described, but of stronger construction. It must be borne in mind that the Douglas and Laxey line employs a sliding contact, and not a wheel. We have been unable to obtain one of the Douglas collectors for exhibition to you, as no spare ones were at hand. Double insulation is an essential feature of first-class overhead line work. This is effected by supplementing the insulated trolley-wire supports by an additional insulator at the pole-head. The "Brooklyn" strain insulator and turnbuckle combined is the best device for this purpose. Aside from its insulating qualities, a pair of the smaller size shown will take up 6in. of slack in the span wire. This is extremely useful in adjusting tension when the span wires have become stretched by constant use. The larger size is adapted for terminals, and for corner poles to which a number of curve pull-off wires are carried. The "King" insulated turnbuckle is a device of similar nature, and strain insulators of the various types are also frequently used. All globe and strain insulators, by the way, are constructed so that, should their insulation be entirely destroyed, their interior metallic parts would interlock and prevent the line falling. Sections and parts of insulators by a number of makers are on the table.

In cases where the trolley wire is supported by bracket arms, double insulation is obtained by the use of a tube of insulating material within the sleeve of the bracket arm hanger. In this connection we would warn you against the frequent mistake of fixing bracket arm insulators to predetermined points of the bracket. A sleeve which will slide along the projecting arm easily should always be used, as nothing but observation of the trolley wheel as it passes under each bracket can determine the exact point at which the hanger can be most advisably fixed. This feature is also apparent in the Thomson-Houston type of

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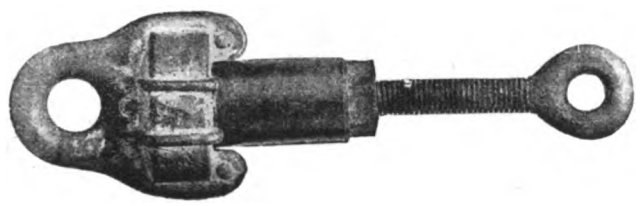
bracket arm hanger from the Leeds line. In this appliance double insulation is obtained by washers and tubes of insulating material, which prevent metallic contact between the upper casting in which the sleeve is formed and the lower casting from which the ear depends. A trolley wire of any considerable length should always be divided up into sections, so that an accident could not cause the whole line to be thrown out of service. Several types of section insulators are before you. Connection between the two sections of trolley wire is made or broken through a switch contained in a box on the nearest pole. The earlier type shown, made of brass sections insulated from each other by mica, is somewhat clumsy. You will note that the insulation of the two later forms is effected by bolts similar to those used in the "West End" hangers, and that the latest and most improved type has the great advantage of being "straight under-running," allowing the trolley wheel to pass under it without the slightest "dip." This device is strong and durable. The wooden piece between the terminals is renewable, and can be changed while on the line. A convenient clamping device renders it possible to leave enough trolley wire coiled on top of the section insulator to allow of its being let out to repair the line in case of a break.

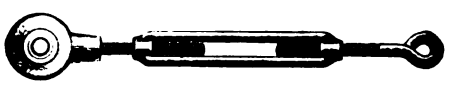
Another part of this combination clamp holds the feed wire in such a way as to obviate the necessity of stripping the insulation from the wire, except at the part held by the clamp. By this arrangement the feed wire is left insulated from the poles to the section insulators, and between the lines (where there is a double track). A number of frogs and crossings are on the table, and you can see how greatly the later types are improved over those used a year or two ago. All the newest styles have the "straight under-running" feature, and require no solder, the trolley wire being clamped into the casting. You see that in all cases the trolley wire is carried over the casting, so that the excessive wear at these points is taken by the heavy metallic flanges, and not by the conductor. Right and left hand, "Y," and three-way frogs are used, and they are insulated and supported by frog pull-offs. The operation of right and acute angle crossings is easily understood, and an insulated crossing is employed whenever one trolley wire crosses another from which it must be insulated. The wire-stretching machine shown is an extremely useful tool in all cases where it is necessary to take the tension off the trolley wire, as in splicing, or inserting switches, frogs, etc. Several styles of feeder insulators are shown. The best has a metallic yoke, into which the feeder cable is laid and firmly held by a screw cap. This greatly economises labour in the erection of an aerial feed wire. Where guard wires are used, they are insulated by small porcelain insulators. The utility of guard wires is extremely doubtful, and many lines have discarded them. On the Continent, a strip of wood is often attached to the upper side of the trolley wire, whenever any danger from falling telegraph or telephone wires is apprehended. A number of special tools and appliances are on the table, to which we will not refer at length. They are self-explanatory, and we should be glad to have you examine them.

The trolley itself next claims our attention. As in the case of all electric tramway supplies, the earlier types were comparatively clumsy, and the old form of trolley base occupied a great deal too much room on the roof of the car. It is shown in an illustration. The latest "Boston pivotal" type is fixed to the table. You note how easily the trolley moves in every direction. This base is of simple construction—neat, compact, and designed to allow of passing under low bridges. Experience has proved it to be smooth-running, easy of adjustment, strong, and durable. It lies close to roof of car, and can be swung around to change direction. With pole laid down flat, the highest point on the base is but 6in. above the roof. To avoid overtaxing the springs so that they will set or break, a very large safety factor is allowed. A special construction ensures an even pressure of the wheel against the trolley wire in the different positions. This trolley received the highest award at the World's Columbian Exposition at Chicago. The steel trolley

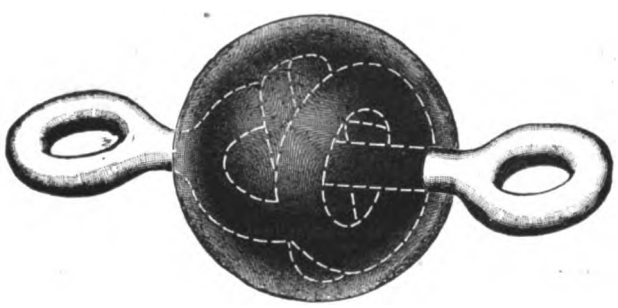


"Brooklyn" Strain Insulator.

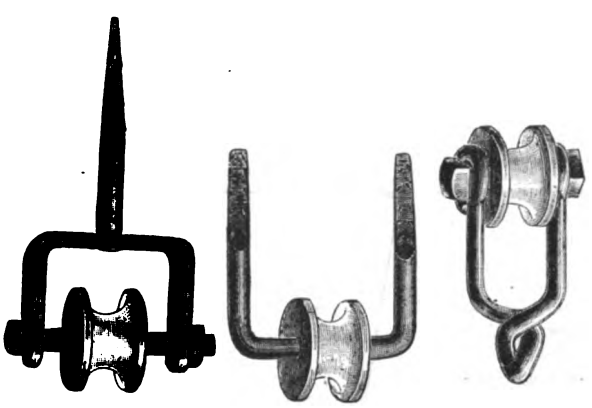
Pole Strap.



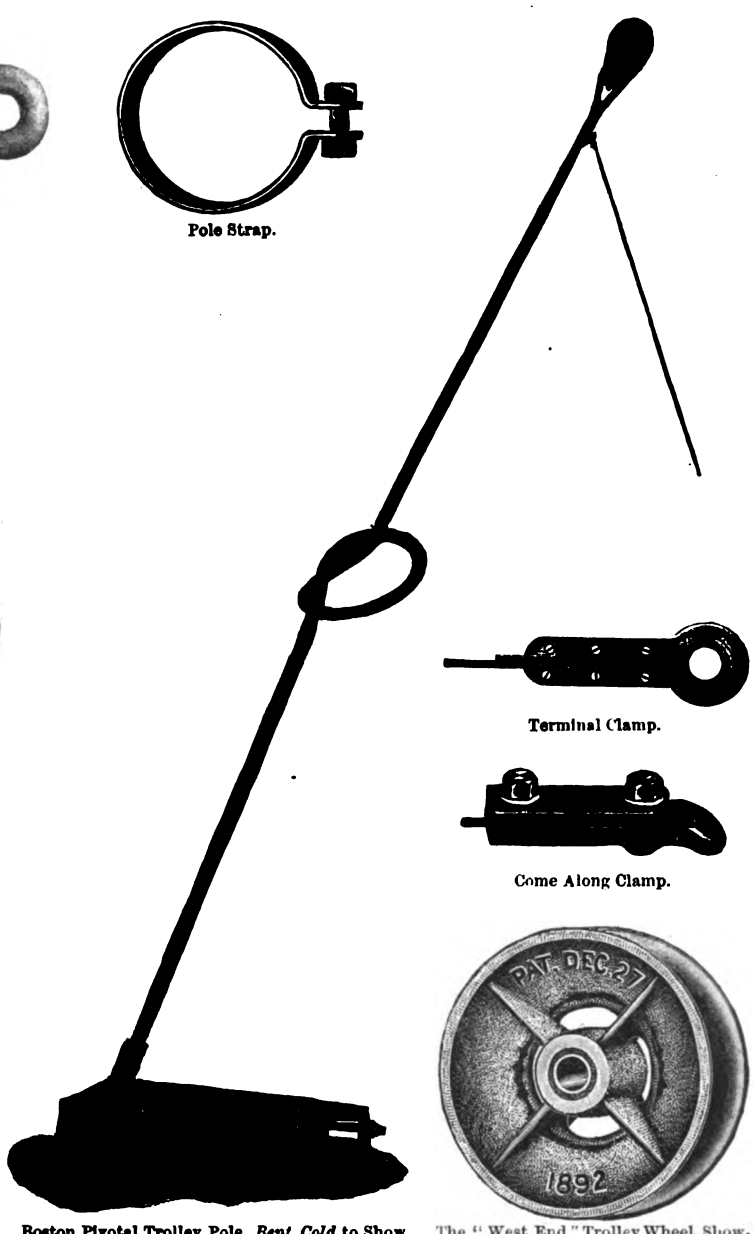
The King Insulated Turnbuckle.



Globe Strain Insulator—Ætna Insulation



Tree Insulators.



Boston Pivotal Trolley Pole, *Bent Cold* to Show Strength of Material.

Terminal Clamp.

Come Along Clamp.

The "West End" Trolley Wheel, Showing Wear from Trolley Wire.

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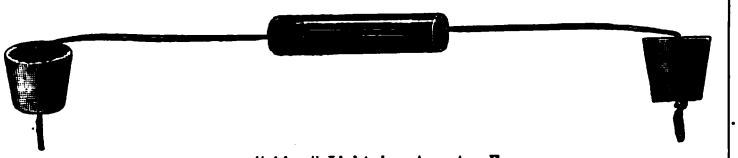
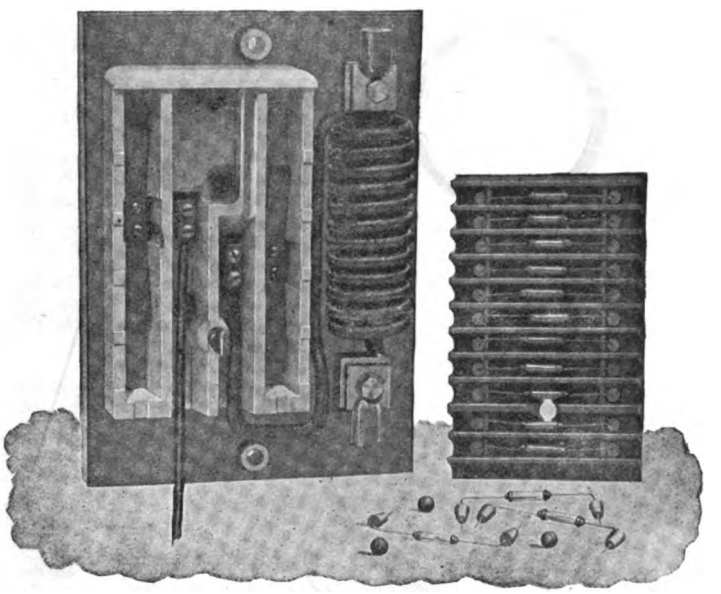
pole is of one piece of steel with a continuous taper, and without joints, shoulders, or other points of weakness. It is light, strong, and stiff. If bent by an accident, it can be straightened cold. The steel trolley fork is of a new pattern, tapering in



"Ajax" Lightning Arrester Fuse.

form, of sheet steel, light and strong, provided with phosphor-bronze contact springs and washers, which have proved far more durable than those of copper. The spindle is of hardened steel. We are again indebted to Mr. Winslow for the loan of



"Ajax" Lightning Arrester for Motor Car (cover removed).

the Thomson-Houston trolley base, which is also fixed to the table. Its operation is practically the same as the other pivotal trolley, but you will see that the construction, especially as regards the arrangement of springs, is somewhat different.

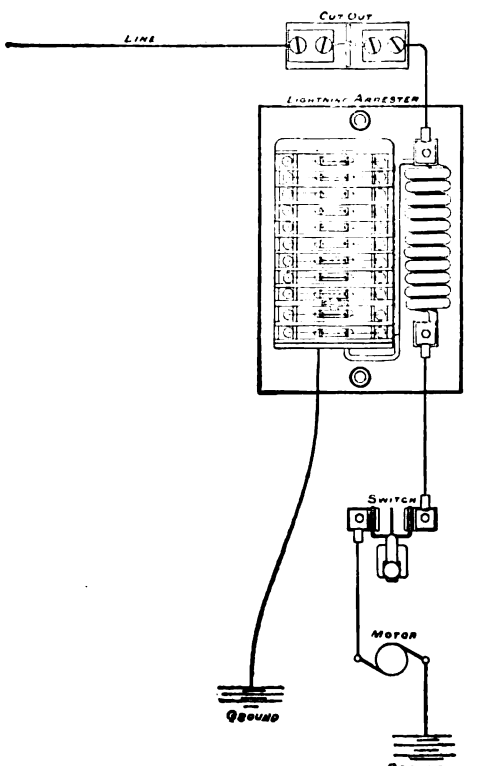
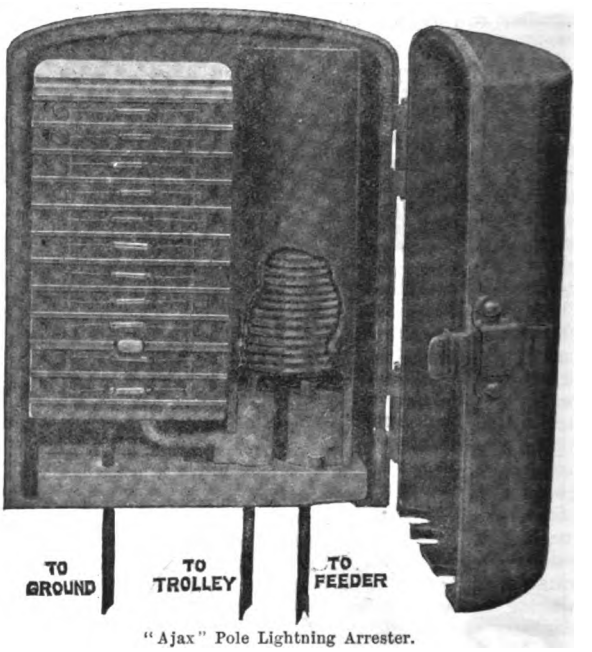


Diagram showing Connections of "Ajax" Motor Lightning Arrester.

Great attention has been paid to the development of a first-class trolley wheel, and several types are exhibited, showing the evolution of the present approved type now universally used. This is the earlier form of wheel, made, as you will see, of a single bronze casting, and with the V-shaped groove then considered best. A substantial improvement was made upon the earlier form in the "Boston" wheel before you. In this a very substantial hub was provided to take the spindle. Iron guard plates were riveted on either side to prevent the trolley jumping the wire. The wear was taken by a contact ring which could be removed and replaced as needed, but at considerable expenditure of time and trouble. You will see how the shape of the groove has changed.

Spoked wheels are now universally used, like this "West End" wheel. These are made of a single bronze casting, having a wide and highly-polished groove, and being furnished with either graphite or self-oiling bushings to receive the spindle. When the older form of brass trolley wheel is used, the flanged drops off when the groove which receives the trolley wire wears through to the outside. By using the "spoked" trolley wheel this difficulty is entirely obviated by a simple and effective



"Ajax" Pole Lightning Arrester.

method of construction. The ribs serve to hold the flange in position after the sparking of the wheel indicates that it is worn through, and therefore should be discarded. This warning is timely, for the wheel may be used after the flange is cut through

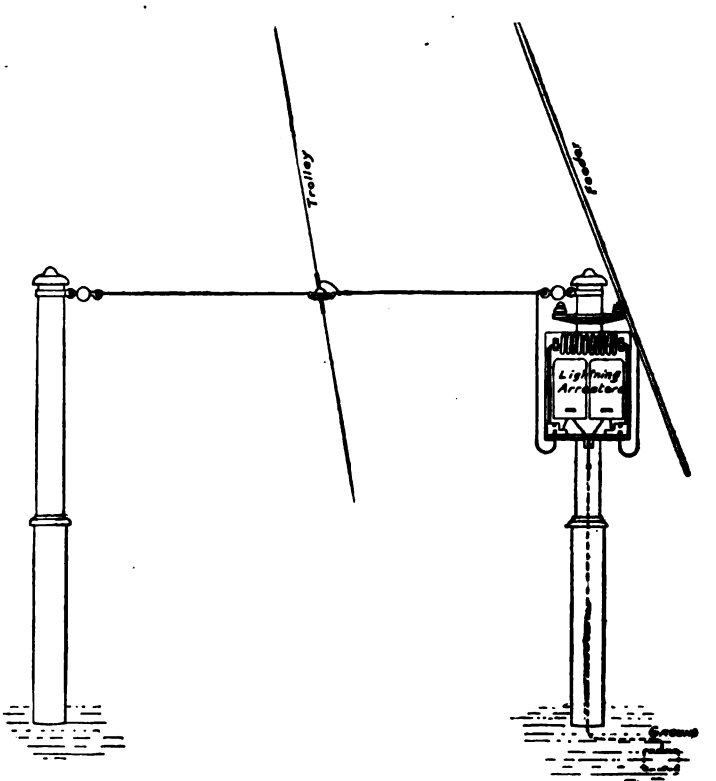


Diagram showing Connections of "Ajax" Pole Lightning Arrester.

by the trolley wire long enough to get to the car-house, where a new wheel can be put in. With the old form of brass wheel, when the flange wore through and dropped off, the car was disabled, and had to be pulled to the car-house or removed from the track. If this breakdown occurs in a crowded thoroughfare, or in an out-of-the-way place where it is not easy to obtain

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assistance, as is often the case, the awkwardness of the situation and the annoyance resulting from it are obviously great. You can see how thoroughly these ribs fulfil their mission by inspecting this "West End" wheel, which has run about 4,000 miles upon an English line. A great deal of care has lately been devoted to the elaboration of a trolley more suitable for use with the English top-seat car than any of the American types shown. We hope to be able to exhibit it, as one is on its way to us as this paper is being written. We regret that we have been unable to secure for exhibition one of the trolleys of the South Staffordshire line.

One of the most interesting appliances to which your attention is directed to-night is this "Ajax" lightning arrester. The rest of the apparatus is merely a support for holding a succession of these fuses, so that one after another is brought into operative position automatically by the action of the current as it consumes each fuse in turn. The fuse consists of two pieces of No. 26 brass wire, each 3in. long, having a single silk insulation, and laid side by side for about 1in., as do consecutive coils in an armature. This 1in. lap of the wires offers abundant surface for the discharge gap, which is formed by the two thicknesses of silk, and amounts to little more than 0·002in. Small pellets of a highly insulating wax secure these wires in the above position, and a small glass tube is hermetically sealed over this part of the fuse to keep the dischargers clean and dry until used. The extreme sensitiveness of this part of the apparatus is made possible by its being called upon to act but once. The soft rubber plugs serve to hold the fuse in the corrugated cover of the arrester, and the bare ends of the wires project through the cover, ready to be brought into contact with the line and ground terminals. This is the type of arrester used for protecting stationary motors or isolated plants. The regular size is made with a 100-ampere coil, having coil and arrester mounted on a marble slab 7⅞in. by 11in. by ⅞in. Pole-boxes are cast iron, asbestos lined, and so constructed as to exclude rain. This is the more general form of pole arrester. In this the choke coil is contained in the arrester-box; but it may be made by turning the insulated span wire on itself a sufficient number of times to make the choke coil, thus making a cheaper construction and a smaller pole-box. The warming of tramway cars by means of electric heaters is now universal in America wherever the climate is at all cold. This is the simplest form, of which any number desired may be screwed under the seats of a car. More elaborate forms are also made.

A word may be said in support of what Mr. Wilkinson has said as regards the appearance of overhead conductors. Undoubtedly some aerial lines have been put up with an utter disregard of appearances, and inexperienced or careless constructors have erected webs of trolley strain and feeder wires which were most obnoxious. This is especially true of many hastily-built American lines, pushed through at high pressure, and at the smallest possible expenditure. Now that the first rush is over, and the tramway operator, the manufacturer, and the contractor have had time to take breath the weight of public and Press criticism has had its effect, and no pains are spared to perfect the entire plant and apparatus. A carefully designed and erected line, with sub-surface feeders, handsome poles, etc., has but few objectionable features; and in the great majority of cases public convenience is so greatly enhanced by the overwhelming advantages that closely follow upon the introduction of improved and more rapid transit facilities, that opposition to the extension of a trolley line is almost unknown. The Siemens line at Guernsey, the line that crosses the great piazza on which Milan Cathedral stands, the Brussels, Hamburg, Bremen, and a dozen other continental installations, are European examples of line construction to which no reasonable objection can be urged. The electric tramway has a future as great in Great Britain as elsewhere, and in no other country in the world has it failed to already secure universal acceptance.

The English tramway operators, and the able executive officers of the Tramways Institute of Great Britain and Ireland, are keenly alive to the possibilities that lie in electric traction, and, under most adverse conditions, are doing their best to smooth the path of progress. It remains with you, gentlemen, to supplement their endeavours, and to do your best to stimulate and encourage the growth of public opinion in its favour.

ELECTRIC METER TESTING BY THE LONDON COUNTY COUNCIL.

The Highways Committee of the London County Council reported on Tuesday as follows: "We have had under consideration the question of the fees to be charged for the testing of meters at the Council's electric meter testing station at Cranbourne-street. The Council is no doubt aware that only one meter has as yet received the provisional approval of the Board of Trade as required by the various Acts and orders, but there appears to be a strong desire on the part of both the companies and the consumers for the testing of electric light meters. We are of opinion that, as the Council has competent electricians in its service and every necessary appliance for the purpose, it should meet this demand, and should lay down a scale of fees which may be charged until the arrangements as regards meter-testing shall have been definitely settled. We therefore recommend that until further order fees according to the following scale be charged for the testing of electric light meters by the Council's officials:

For testing single meter of any description up to 50 amperes capacity	10s. 0d.
Ditto of capacity of 50 to 100 amperes	20s. 0d.
Ditto of capacity of 100 to 200 amperes	30s. 0d.
Ditto of capacity of 200 to 400 amperes	40s. 0d.
Ditto of capacity of 400 to 600 amperes	60s. 0d.

For testing meters, delivered at and removed from the testing station free of cost to the Council, any work necessary for adjusting defective meters being charged for extra:

Ferranti Hookham, and all similar meters without shunt coils and not requiring to be fixed for testing, up to 50 amperes capacity, if sent in in batches of not fewer than 10 of the same size and make, each	6s. 6d.
Ditto from 50 to 100 amperes capacity, each	9s. 0d.
Ditto from 100 to 200 amperes capacity, each	12s. 0d.
Shallenberger, Thomson, and similar meters with shunt coils or requiring to be fixed for testing, up to 50 amperes capacity, if sent in in batches of not less than 10 of the same size and make, each	7s. 0d.
Ditto from 50 to 100 amperes capacity, each	10s. 0d.
Ditto from 100 to 200 amperes capacity, each	13s. 0d.
Aron and other meters requiring fixing and synchronising, up to 50 amperes capacity, if sent in in batches of not less than 10 of the same size and make, each	8s. 0d.
Ditto from 50 to 100 amperes capacity, each	12s. 0d.
Ditto from 100 to 200 amperes capacity, each	17s. 6d.

A reduction of 10 per cent. from these prices to be allowed if 20, and of 23 per cent. if 50, meters of the same make and capacity are sent in at the same time.

For examining in position after fixing any single meter within a radius of three miles from Cranbourne-street	2s. 6d.
Ditto any distance from three to six miles	3s. 6d.

In addition to travelling expenses.

For examining in position after fixing, where a number of meters in the same district and within a reasonable distance of each other can be inspected on the same day, £1 for the services of the inspector for the entire day, or 15s. for half a day."

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

St Pancras.—The St. Pancras Vestry invite tenders for works under the following two contracts: (*a*) supplying and laying armoured cable mains; (*b*) extension of underground sub-station building. The drawings can be inspected, and specifications, schedules of quantities, and general conditions can be obtained, at the offices of Prof. Henry Robinson, C.E., 13, Victoria-street, Westminster, on payment of 5s. for each contract. Tenders to be sent to Mr Albert E. Pycraft, chief clerk, Electricity and Public Lighting Department, Vestry Hall, Pancras-road, London, N.W., on or before 22nd inst.

Donnybrook.—Offers are invited for the whole of the electric lighting plant and stores used in the lighting of Donnybrook Fair at the close of the fair, either the whole or in parts as it stands, or erected as complete installations, to suit the requirements of purchasers. The plant consists of one 12-h.p. portable steam-engine; two 160-ampere 100-to-110-volt dynamos; one 45-ampere 100-volt ditto; one 15-ampere 100-volt ditto; six arc lamps 1,000 incandescent ditto; 800 Ediswan bayonet holders; several miles of wires and cables, of various sizes; 400 white silk shades, etc. Apply to the manager, Electrical Installation Company, Limited, on the premises, Donnybrook Fair.

RESULTS OF TENDERS.

Aberdeen.—The following tenders have been received for fitting up the new police offices with the electric light. Mr. John Rust, 224, Union-street, Aberdeen, city architect:

Shirras, Laing, and Co., Aberdeen (accepted)	£143 18 0
New and Mayne, Aberdeen	186 0 0
Faraday Electrical Engineering Company, Limited, Glasgow	265 0 0

For electric lighting of Aberdeen Coffee Company's buildings, Shiprow, Aberdeen. Mr. John Rust, architect:

Northern Electric Supply Company, Cults, Aberdeenshire (accepted)	£94 0 0
Shirras, Laing, and Co., Aberdeen	94 11 0
New and Mayne, Aberdeen	110 0 0
Faraday Electrical Engineering Company, Limited, Glasgow	120 0 0

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BUSINESS NOTES.

Folkestone.—The parish church has been lighted by electricity.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,861.

Blackburn.—It is anticipated that the central station will be completed by the end of the year.

Great Northern Telegraph Company.—For the month of October the receipts were £27,200.

Windsor.—A provisional order is to be applied for by the Town Council for both Windsor and Eton.

Formoy.—The question of electric lighting is still under the consideration of the Town Commissioners.

Cuba Submarine Telegraph Company.—For the month of October the receipts were £242 more than for the corresponding period.

Eastern Telegraph Company.—The receipts for the month of October were £67,754, as against £61,409 for the corresponding period.

Scarborough.—An account received for lighting the Town Hall by electricity has been referred to the Finance Committee for payment.

Direct Spanish Telegraph Company.—For the month of October the receipts were £2,101, as against £2,121 for the corresponding period.

Dover.—The Town Council have received notice from the electric light company of their intention to extend their mains to Buckland Flour Mills.

Eastern Extension Telegraph Company.—For the month of October the receipts show an increase of £1,141 as compared with the corresponding period.

Montrose.—The Town Council have sanctioned an agreement with the Scottish House-to-House Company for the introduction of a supply of the electric light.

Canterbury.—A correspondent writes to a local paper suggesting that a canvass of the citizens might be adopted with advantage by the Canterbury supporters of electric lighting.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 4th inst. amounted to £884, as compared with £608 in the corresponding week of last year.

Birkdale.—The chairman of the Gas Committee of the Local Board thinks that the town should be provided with the electric light. And so do we. Why not approach the Southport Corporation on the matter?

Mill-Lighting.—Messrs. Lowden Bros., Dundee, have secured the contract for the electric lighting of the Seebpore and Howrah Jute Mills Calcutta. The installation will be similar to that fitted in the Dundee Mills.

Newport Electrical Engineering Company, Limited.—This Company has been registered with a capital of £2,000 to carry on at Newport, Mon, or elsewhere, the business of mechanical engineers in all its branches.

Rotherham.—Complaints have been made at a meeting of the Town Council as to the quality of the gas supplied, and Mr. Jenkins stated that unless some changes were effected, manufacturers would be obliged to introduce electric lighting into their works.

Huddersfield.—Messrs. Pearson Bros., of the Commercial Mills, have already adopted electricity as a means of lighting their premises. In addition, another firm of manufacturers in Slaithwaite have under consideration a similar undertaking, and a third firm may resort to electricity after the winter.

Birmingham.—Subject to the consent of the City Council, the Birmingham Technical School Committee have accepted a tender of the Walsall Electrical Company, Limited, for the installation of the plant, fittings, and appliances for both the lighting and provision of power in the new school, for the sum of £6,375. 18s.

Cardiff.—In the course of a discussion by the members of the Town Council on the subject of the purchase of the tramways, Alderman Carey mentioned that the Blackpool Corporation had recently taken the bull by the horns, and without specially obtained powers had commenced to work the electric tramways

City and South London Railway.—The receipts of the Company for the week ended November 4 were £939, against £874 for the corresponding week of 1893, or an increase of £65. The total receipts for the current period of the present half-year amount to £15,750, as against £14,680 in the corresponding period of 1893, an increase of £1,070.

Chelsea.—Mr. T. W. Higgens, surveyor to the Vestry, reported on Tuesday that the London Electric Supply Corporation had so altered their connections at the Pimlico station that the Chelsea circuit would now be fed separately. The Board of Trade have formally approved of the alteration, and notified their approval to the Chelsea Vestry.

Derby.—The Electric Lighting Committee reported to the Town Council yesterday (Thursday) that the present installation is designed for 7,500 lights, that 7,450 are already attached, and that there are signed applications for 3,000 more. The expenditure is still within the amount granted by the Council (£35,000), but a further grant will be necessary.

Stafford.—The Electric Lighting Committee of the Town Council have reported that the expenses in connection with the laying of the commemoration-stone of the electric supply station amounted to £20. 7s. Alderman W. H. Peach proposed the adoption of the report, stating that the works were proceeding satisfactorily. The report was carried.

Newport (Mon).—Although the lighting of the public streets at Newport by electricity is not likely to be an accomplished fact until January next, the supply of electricity from the Corporation station to private premises will, according to arrangement, commence in the third week of the present month. The demand at Newport has been encouragingly large on the part of private consumers.

Swansea.—A special meeting of the Electric Lighting Committee of the Swansea Corporation has been held for the purpose of receiving a report from a sub-committee which recently visited Liverpool, Warrington, Oldham, and Leeds with the object of obtaining information as to the question of lighting the town by electricity. The committee decided to invite Mr. Manville, electrical engineer, to visit the town, with a view of advising on the scheme.

Birkdale.—In moving the adoption of the minutes of the Gas Committee of the Local Board, Mr. G. Atherton complained of the quality of the gas supplied to the district. He said that when they did not require the gas to the extent they did at the present time, the Southport Corporation were able to conform to the stipulation of the Act of Parliament. He hoped that when the new district council was formed it would consider the advisability of adopting the electric light.

Sheffield.—The Sheffield Electric Light and Power Company are fixing the electric light at the new Assay Offices, at the new rooms of the Literary and Philosophical Society, and of the Sheffield Society of Architects and Surveyors; also at the Church Institute; at the Weston Park Museum; at Oakbrook, for Mr. W. S. Laycock; at Elmfield, for Mr. George Senior; and at Mr. Hides's new premises in the Shambles. These are in addition to a large number of other important installations that are nearly ready for the current to be turned on.

Colliery Lighting.—Messrs. Ernest Scott and Mountain, Newcastle on-Tyne, have at the present moment in hand an order for the Ashington Coal Company for a dynamo to run 1,000 incandescent lamps of 16 c p., and they have also arranged with the Harton Coal Company, of South Shields, to supply a machine of the same size for the lighting of their Whitburn Colliery. In each case the extensions have been decided upon after lengthy experience with electric lighting, when its many advantages and great economy for colliery work have been fully demonstrated.

Sale of Plant.—Messrs. Fuller, Horsey, Sons, and Cassell will sell by auction at their offices, 11, Billiter-square, E C., on Wednesday, November 28, electric generating plant, comprising two 40 nominal horse-power loco.-type boilers, with super-heaters, by Marshall; three 80-i.h p. Armington-Sims engines; three 60-unit Elwell-Parker shunt-wound dynamos; 52 31-plate "K" type E P.S cells; three ampere-meters, Cardew voltmeter, switchboard, switches, resistance coils, 11in. double leather belts, and other effects. This plant has been in use at Billiter-buildings.

Kingswood.—Mr. Bridges, having alluded to the need of more light being acquired, said he would move at the next meeting of the Local Board, "That, seeing the urgent want of better lighting in populous places in Kingswood, and the easy facility by which it may be obtained either by electricity or gas, our Board be asked to take early means of obtaining the same by putting a light at the opening of Laura-street, New-street, Bright-street, Hanham-road, London-street, Park-road, Tabernacle-road, Johnson's lane, and any other such populous places requiring lighting."

Halifax and Bermuda Cable Company, Limited.—A circular has been issued on behalf of the trustees of the £120,000 4½ per cent. debentures of the Halifax and Bermuda Cable Company, Limited, asking for the assent of the debenture-holders to an application to Parliament during the coming session for a modification of the trust deed. This deed, by an oversight, did not provide for the application of the sinking fund to the redemption of the bonds by drawings or purchases, while unless it is so applied there will be a deficiency of about £30,000 on the maturity of the bonds. Parliament is to be asked to sanction this method of redemption.

Brighton.—Good progress is being made with the new parochial offices, which are to be lighted by electricity. The Works Committee of the Town Council have reported to the Council that at a meeting of the committee, held on October 19, a letter was read from Councillor Evans with reference to the payment of wages to the surveyor's workmen engaged at the electric light station who were suspended in consequence of a dispute between workmen there. The committee resolved that Mr. Evans be informed that the men will be paid. On the motion of Alderman Botting, seconded by Alderman Brigden, the proceedings of this committee were confirmed.

Chelmsford.—Last week the electric light went out. Messrs. Crompton and Co., the contractors, wrote stating that the cause of this serious breakdown was the failure of one of the cables. They had taken immediate steps to remedy the defect, and to prevent any such occurrence in the future. Alderman Duffield said he found four of the incandescent lamps on the Broomfield-road out the other evening, and Councillor Gepp and others spoke of complaints in regard to the lighting from New-street, Cottage-place, Coval, and other roads. It was agreed to place lamps in South-road, Barrack-square, Railway-square-road, Seymour-street, and Wolsey-road.

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Glasgow.—It is apparent, an Aberdeen paper states, from the action of the Watching and Lighting Committee that electric lighting for street purposes in Glasgow is doomed. The committee has decided upon an extension of the system of street-lighting by incandescent lamps. In a given area electricity was found to cost £78; ordinary gas, £39. 13s. 10d.; and incandescent lamps, exclusive of the initial cost of burners, £17. 3s. 3d. The new Conservative Club has been lighted by electricity by Messrs. D. and G. Graham, of Sauchiehall-street, Glasgow, and for this purpose a gas-engine and dynamo have been installed.

Wolverhampton.—In their annual report the Lighting Committee of the Town Council refer to the acceptance of tenders relative to the introduction of the electric light into the town. The loan for the work was £30,000, and the buildings are now approaching completion. The committee had anticipated that the whole of the works would have been completed and the plant in running order by the end of last September, but regret that circumstances have arisen which have caused some delay. However, no effort will be spared to furnish a supply of electrical energy to any person desiring the same as soon as possible. Up to the present time 37 applications for a supply of electrical energy have been received.

West India and Panama Telegraph Company.—The report for the six months ended June 30 show that the amount to credit of revenue is £40,598, and that expenses have been £24,488, leaving a balance of £16,109, which, with £718 brought forward, makes a total of £16,827. Dividends of 6s. per share are proposed on the first and second preferences, and 6d. per share on the ordinary capital, leaving a balance of £2,850. The traffic receipts for the six months show a decrease of £6,504, due to the continued depression of West India trade. The cost of repairs during the half-year amounted to £11,374. The Danish colonies have renewed their subsidies for five years. The receipts for the two weeks ended October 31 were £10 less than for the corresponding period.

St. Pancras.—The Vestry at their meeting on Wednesday, held under the presidency of the vicar (the Rev. H. L Paget, M.A.), approved of a scheme of the Electricity Committee for supplying the remainder of the parish with the electric light, the commercial success of which has been proved in the south-west district. The estimated ultimate cost of the entire new works is £48,565. The committee were authorised to proceed forthwith with the laying of mains in a large area to be served by the King's-road station, which is rapidly approaching completion. When these works were originally planned in July last it was calculated that the expense would be £28,000, but having regard to the present reduced price of copper it is anticipated that a saving of £6,000 will be effected in the estimate with respect to this material alone.

Appointment Vacant.—The Corporation of Cardiff are about to appoint a practical man able to take full charge of the machinery at the electricity works, Canton, Cardiff, and invite applications for the post. Applicants must be experienced in electrical work and engine fitting, and have had actual experience in the charge of a high-tension alternating system at an electric lighting station. Age not less than 25 nor more than 40 years. Salary £3 per week. Applications, in candidates' own handwriting, stating age, whether married or single, past and present employment, with particulars of experience as above, and accompanied by copies of not more than three recent testimonials, to be delivered at the office of Mr. J. L. Wheatley, town clerk, Town Hall, Cardiff, in a sealed envelope, marked "Electric Light," by 14th inst.

Belfast.—The Town Council have approved of the minutes of the Electric Lighting Committee, which contained the following: "Your committee have to report that satisfactory progress has been made with the works for electric lighting since last meeting. The mains in the streets have been laid, the central-station building is approaching completion, the batteries and three of the engines have been delivered, and the overhead crane has been placed in position, and been tested by your engineer. Your committee have also to report that they have received applications for current for 2,360 8-c.p. lamps, which will about utilise the fourth of the generating power of the plant, and they anticipate a much greater demand." Approval has also been given to the appointment of Mr. Frederick Wilson as resident electrical engineer.

Aberdeen.—To meet the increasing demand for the electric light in Aberdeen, the Town Council have adopted the recommendation of the Gas and Electric Lighting Committee to double the present capacity of the electric lighting plant, as suggested by Prof. Kennedy. The total cost of the extension to plant and mains is estimated at £4,350. This, added to the amount already expended or contracted for, brings up the total capital cost of the electric lighting scheme to about £29,000. The distributing mains will be extended along both sides of Union-street, from their present termination at Bon-Accord-street to Holburn-street, at an expense of £950, making the total outlay for the present extensions £5,300. Prof. Kennedy reports that the demand for lighting has increased far more rapidly than he expected, and already nearly 7,000 lamps are connected to the mains, although the station has only been at work for six months.

Duplex Cables.—On Saturday last, in the Court of Appeal, before the Master of the Rolls and Lords Justices Lopes and Rigby, there was heard the case of Muirhead and others *v.* the Commercial Cable Company. This was an action to recover royalties involving about £45,000. The plaintiffs—John and Alexander Muirhead and Herbert Arnand Taylor—were patentees and proprietors of certain patents for a system of duplexing cables, known as Muirhead's duplex system, by means of which messages can be sent both ways simultaneously through a single cable. The defendants pleaded that the plaintiffs' patents had run out. The case was tried before Mr. Justice Kennedy without a jury, when he found for the plaintiffs for £3,000 odd. The defendants appealed. Sir R. Webster, Q.C., Mr. Moulton, Q.C., and Mr. A. J. Waller appeared for the appellants; and Mr. Finlay, Q.C., Mr. Bousfield, and Mr. E. H. Pollard, for the plaintiffs. At the conclusion of the arguments, which lasted for four days, the Court reserved judgment.

Dalton.—The minutes of the Highways and Lighting Committee of the Local Board presented at the last meeting of the Board bore that the clerk reported having, with Mr. Wardley, attended the conference of district local authorities at Ulverston on the 4th ult., when, as it appeared, notice by the electric company of intention to apply to the Board of Trade for an order to supply electricity been served on all the authorities represented, except that of the Dalton Local Board, and that the matter did not therefore materially affect the Board's district, they took no part in the resolutions adopted at the conference Mr. Wardley, in moving the adoption of the report, said there was not much in the report calling for comment, with the exception of the meeting on the electric lighting which was held at Ulverston. As instructed by the Board he attended, and when they had been in the meeting for a while, they found out that the electric lighting matter did not apply to Dalton at all, and so they retired from the meeting.

Reading.—The Town Council have approved of a report of the Highways and Lighting Committee in which it was stated that a sub-committee had conferred with Mr. McMullen, the electrical adviser of the Council, and were enabled to submit to him a section of the main which is being laid by the Reading Electric Supply Company, Limited, for the supply of electricity in this borough under the provisional order of the company, and they inspected with him the manner in which the mains were being laid, and the sub-committee had the satisfaction of stating that Mr. McMullen advised them that the main corresponded with the description in the rules and regulations prescribed by the Board of Trade relative to this borough, and that the main itself and the manner in which it was being laid were such as to ensure perfect safety to the public It appeared that the mains now being laid were low-pressure mains, and the sub-committee had requested the acting borough surveyor to obtain sections of the high-pressure mains proposed to be laid by the company, and when such sections were obtained the sub-committee would, if necessary, advise further with Mr. McMullen.

Norfolk.—Houghton Hall, the historical seat of the Walpole family, and one of Inigo Jones's finest works, has recently been furnished with a complete installation of electric light for the present occupier, Viscount Grey de Wilton, by the Planet Electrical Engineering Company, of Victoria-street, Westminster, and 67, Piccadilly. Over 500 lamps of 16 c.p. are used for the hall, which has a frontage of some 400ft., and for the stables, which are about 100 yards distant, where, in addition, a powerful arc lamp is used to light the yard. An outstanding portion of the mansion formerly used as a brewhouse has been altered to contain two complete sets of generating plant, consisting of two 16-h.p. oil-engines, two shunt-wound dynamos with heavy flywheels, and two sets of accumulators of large capacity. Each set of plant is capable of independently supplying the greater portion of the lighting, so that in case of a stoppage of one set of plant for repairs the second set will still continue in work, and the chances of a total failure of the lighting are almost nil, the accumulators alone being of a sufficient size to keep the light going for a considerable period. The whole of the work, including the designing of special fittings and shades and the adapting of the valuable chandeliers and other existing fittings, was carried out by the above company, under the supervision of their engineer, Mr. A. L. Shepard, and was successfully completed under contract within 10 weeks from the commencement.

Carlisle.—The Gas Committee of the Carlisle Town Council are now taking steps to obtain a provisional order to supply electric light in the city. The following resolutions have been passed: "That the site for the proposed electric lighting installation be Brockbank's yard or Boustead's grassing, and that the permissive area be the same as in the Carlisle Electric Lighting Order, 1883, and that the compulsory area be English-street, Market-place, Castle-street, Court square, Victoria-viaduct, Devonshire-street, Bank-street, and that part of Lowther-street from Bank-street to Devonshire-street; and that the engineer be instructed to undertake the engineering part of the application for the above order, with authority to engage the services of such consulting engineer as he may deem advisable in the event of its being necessary to do so." In the order of 1883 the area defined was as follows: "Within so much of the city of Carlisle as lies within the following boundary: Caldew Bridge, Annetwick-street, Finkle-street, West Tower-street, Scotch-street, the Market-place, a line thence to Lowther-street, at the junction of Victoria-place, Lowther-street, the Crescent, Botchergate, Crown-street, Currock-street, James-street, the Victoria-viaduct, to the River Caldew, and thence along the northern bank of the River Caldew to Caldew Bridge, the houses on both sides of such streets being included within the area." The compulsory area in the order of 1883 was English-street, Market-place, Court-square, and Victoria-viaduct (between James-street and English-street).

Snyers's Elastic Clutch.—In our last issue we referred, in an article on "Gas-Driven Alternators," to the use of Snyers's clutches used at Calais for coupling together alternators and gas-engines in the central station in that town. We now learn that the sole

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licensees and makers of this coupling are Messrs. Cowlishaw, Walker, and Co., Limited, engineers, Etruria, Stoke-on-Trent, who supplied two clutches of this type to the Worcester water-power and electric light station, which was illustrated and described in this journal a few weeks ago Among the advantages claimed for the Snyers clutch may be mentioned: (1) total absence of shock, whether in running or starting the machine; (2) ability to start or stop the machinery at a very high speed without slowing down the engines—as an instance of this, the two clutches of 250 h p. each, running at 200 revolutions per minute, which transmit power to the dynamos which light Messrs. Cockerill's (Seraing) works, are started with the engine at full speed, the clutches slipping for about five seconds, when they bring the large dynamos up to full speed; (3) less wear and tear on the machinery and belting, owing to all sudden shocks and strains being taken up by the steel brushes; (4) wear and tear almost nil, the only wear being whilst the parts are being engaged; (5) immunity from breakdown, owing to the elasticity of driving, and to the clutches being made only slightly in excess of the power specified, which allows of the clutch slipping if any additional strain is thrown upon it, acting in the same way as the safety-valve of a steam-boiler. The makers state that Snyers clutches to the extent of transmitting upwards of 50 000 h.p. are now working successfully, and are being used for the transmission of power, shaft coupling, driving dynamos, hoists, pumps, steam and electric cranes, saw-mills, etc.

PROVISIONAL PATENTS, 1894.

OCTOBER 29.

20693. **An improved acoustic device for telephones.** Albertus Maseland, 45, Southampton-buildings, Chancery-lane, London.

20703. **Improved telephonic switch and indicator.** George Lee Anders, 33, Peak Hill-gardens, Sydenham, London.

20716. **Improvements in and connected with portable electric lighting circuits and illuminating devices.** Percy Tilt Letchford, 22, Southampton-buildings, Chancery-lane, London.

OCTOBER 30.

20746. **An electrical prepayment gas-meter.** Frank Villiers-Stead, 44, Gutter-lane, Cheapside, London.

20783. **An improved telephone transformer.** Joseph William Ray, 10, Waterloo-place, North Shields.

20784. **Improvements in electric incandescent or arc lamps.** Hector Joseph Bonaventure Thiroux, 70, Palace-chambers, Westminster.

20807. **Improvements in telegraph transmitters.** Herbert Arnaud Taylor, 24, Southampton-buildings, Chancery-lane, London.

OCTOBER 31.

20827. **An improved telephone switchboard jack.** James Taylor, Helsby, Warrington.

20842. **Improvements in propelling road and railway vehicles by electricity.** Thomas Machin, 36, Temple-street, Birmingham.

20843. **Improvements relating to road or railway vehicles propelled by electricity.** Thomas Machin, 36, Temple-street, Birmingham.

20886. **Improvements in and relating to telegraphic relays.** Archibald David MacDonald, 191, Fleet-street, London. (Complete specification.)

NOVEMBER 1.

20917. **Improvements in or connected with incandescent electric lamps.** Herbert Hampton Hall, 15, Water-street, Liverpool.

20959. **New or improved regulating switch for electric lamps and other electric apparatus.** Albert Edward Williamson, Edward Lionel Joseph, and the Electric Light Regulating Syndicate, Limited, 115, Cannon-street, London.

NOVEMBER 2.

21043. **Improvements in the method of damping marine and other mirror galvanometers making them absolutely dead beat.** Thomas Clark and Thomas Edwin Weatherall, 66, Jerningham-road, Hatcham, London.

21045. **Improvements in alternate-current dynamo-electric machines.** Maurice Hutin and Maurice Leblanc, 28, Southampton-buildings, Chancery-lane, London.

21080. **Improvements in secondary batteries.** Charles Laugier, 4, South-street, Finsbury, London.

NOVEMBER 3.

21098. **A novel or improved process and means for obtaining electrical energy from fuel gases.** Wilhelm Borchers, 57, Barton-arcade, Manchester. (Complete specification.)

21104. **Improvements in grooved mouldings or casements for the concealment of electric wires and the like, in combination with picture rail and such like mouldings.** George Grant, 103, Wickersley-road, Lavender-hill, Battersea, London.

21140. **Apparatus for controlling electrical illumination.** Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Messrs. Siemens and Halske, Germany.)

21141. **Improved means for controlling the induced currents in short-circuited windings of the armatures of electromotors worked with rotary-phase alternating currents.** Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Messrs. Siemens and Halske, Germany.)

21142. **Improvements in apparatus for starting and reversing the motion of electromotors.** Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Messrs. Siemens and Halske, Germany.)

SPECIFICATIONS PUBLISHED.

1893.

3572. **Printing telegraph receiving instruments.** Wright. (Second edition.)

19283. **Electric heater.** De Segundo and Derham.

20793. **Recording instruments for electric telegraphs.** Muirhead.

22817. **Electric meters** Aron.

23083. **Recording electric currents.** Aron.

23221. **Incandescent electric lamps.** Lake. (Hussey and another.)

23366. **Phonographs.** Lioret.

24285. **Electroliers, brackets for electric lamps, etc.** Edmunds.

24790. **Dynamo-electric machines.** Crompton.

1894.

8654. **Electric light chandeliers.** Grenville and Terry.

13749. **Electric signalling apparatus.** Allison. (Standard Electric Signal Company.)

13750. **Electric signalling apparatus.** Allison. (Standard Electric Signal Company.)

13751. **Electric signalling apparatus.** Allison. (Standard Electric Signal Company.)

15082. **Magneto-electric machines for cycles, etc.** Tillman and Lexow.

16695. **Electric lighting and extinguishing devices for gas lamps.** Bruck.

16825. **Electromagnetic car brake and traction device.** Murray and Allen.

17284. **Transforming and distributing electric currents.** McElroy.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	5	5½-6
Bournemouth Electric Company	—	—
Brush Company, Ordinary	3	2⅝-2⅞
—— Nom. Cum, 6 per cent. Pref.	2	2⅝-2⅞
—— 4½ Debenture Stock	100	111-114
Charing Cross and Strand	5	4½-5½
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	12¾-13¾
—— 6 per cent. Cumulative Pref.	10	14½-15½
—— 5 per cent. Debenture Stock	115	131-133
City and South London Railway, Consolidated Ordinary	100	37-39
—— 4 per cent. Debenture Stock	100	120-122
—— 5 per cent. Pref. Shares	10	13½-14
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2¼-2¾
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	95-100
Electric Construction, Limited	2	⅜-½
—— 6 per cent. Debentures	—	87-92
—— 7 per cent. Cumulative Pref.	2	1½-2
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1¼-1⅝
Elmore's French Company	2	⅜-½
Elmore's Wire Company	2	1¼-1⅝
Fowler-Waring Cables	5	¾-1¼
W. T. Henley's Telegraph Works, Ordinary	10	8-9
House-to-House Company, Ordinary	5	2¼-2½
—— 7 per cent. Preference	5	6¼-6⅝
India Rubber and Gutta Percha Works	10	25-26
—— 4½ per cent. Debentures	100	102-104
International Okonite, Ordinary	—	—
Kensington and Knightsbridge	5	4¾-5½
—— 6 per cent. Pref.	—	6¼-6⅝
Liverpool Electric Supply, Ordinary	5	6¼-6⅝
—— Pref.	—	—
Liverpool Overhead Railway	10	8-8½
—— Pref.	10	13-13½
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric	5	¾-1¼
Metropolitan Electric Supply	10	9¼-9¾
—— 5 per cent. Reg. Debentures, 1-10,000 in Bonds of £10, £20, and £40	—	—
National Telephone, Ordinary	5	4¾-5¼
—— 6 per cent. Cum. First Pref.	10	15-16
—— 6 per cent. Cum. Second Pref.	10	14½-15½
—— 5 per cent. Nom. Cum. Third Pref.	5	5¼-5¾
—— 4½ per cent. Deb. Stock	—	110-113
Notting Hill Company	10	6-7
Oriental and Electric Company, £1 shares	1	1-1½
—— £5 Shares	—	6½-7½
—— £4½ shares	—	5½-6½
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7¾-8¼
—— 7 per cent. Pref.	5	8¾-9¼
Swan United	—	—
Telegraph Construction and Maintenance	12	41-43
—— 5 per cent. Bonds	100	106-109
Westminster Electric Supply, Ordinary	5	7-7½
Yorkshire House-to-House	4½	4½-4¾

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NOTES.

Telephony in Hungary.—The Oedenburg town telephone system will shortly be connected with the interurban system.

Electric Traction in France.—A line of electric tramways is projected by M. Claret between Néris and Montluçon, Allier.

News.—The *Sun* has just made the astonishing discovery that on the Nelson column nightly advertisements are worked by means of a small limelight!

Electric Traction at the Cape.—The Town Council of Cape Town have approved of a scheme for providing electric tramways for the town.

Electric Lighting in France.—The Vire electric lighting company have announced that until their works are completely finished they cannot supply current during the day, but only at night.

Electrical Trades Union.—Owing to the office of general secretary being vacant, all communications are to be addressed to Mr. R. Steadman, general secretary *pro tem.*, Club and Institute Buildings, Clerkenwell-road, E.C.

Institution of Junior Engineers.—The inaugural meeting of the fourteenth session of this institution will be held to-night (Friday), at the Westminster Palace Hotel, when the presidential address will be delivered by Mr. Alexander Siemens.

Electric Traction in Russia.—Mr. F. A. Gerle, a Moscow contractor, has offered to construct an electric tramway from the fair-ground at Nishni-Novgorod to the Moscow-Nishegorod railway station at his own expense without any Government subsidy.

Lighting Circuits and Electro-Therapeutics.—In *L'Electricien* of the 3rd inst., M. E. Meylan contributes an illustrated article dealing with the system devised by MM. Gautier and Larat for utilising current from town lighting circuits in connection with electro-therapeutics.

Trafalgar-square Search-light.—At the instance of the St. Martin's Vestry, a communication has been forwarded to her Majesty's Office of Works protesting against the desecration of public monuments and buildings in Trafalgar-square by means of search-light advertisements.

Telegraphy in India.—A proposal made by the Deputy Commissioner of Dera Ismail Khan for doubling the telegraph wire at once from Dera to Tonk, and also to arrange for a full field telegraph to accompany the Afghan-Waziristan delimitation party, will be adopted by the Government of India.

Northern Society of Electrical Engineers.—A ballot for new members of this society took place on Monday, when the following were elected: Mr. J. D. Bailie, of Leeds; Mr. A. H. Gibbings, of Hull; Mr. W. J. Hide, of Liverpool; Mr. C. F. McInnes, of Leicester; Mr. W. D. Reid, of Nottingham; and Mr. Joseph Tinker, of Newton, near Hyde.

Institution of Engineers and Shipbuilders.—The second general meeting of the present session of the North-East Coast Institution of Engineers and Shipbuilders will be held in the Athenæum, Church-street, West Hartlepool, on Saturday, the 17th inst., at 6 p.m. A paper on "A Brief Outline of the Theory of the Rolling of Ships," by Mr. Andrew Young, will be read and discussed.

Electric Transmission in Austria-Hungary.—Messrs. B. Egger and Co. have received an order to establish an electric power transmission plant at the gold-mines of Messrs. Stantien and Becker at Nagy Almas. There will be six electric motors of a total of about 150 h.p., the pressure being 500 volts. The motors will be used for the working of hauling machines, pumps, and ventilators.

Cost of Lighting Calcutta.—There were 5,952 gas lamps and 1,647 oil lamps in Calcutta at the close of 1893-94. The actual cost of lighting the gas and oil lamps was Rs. 3,58,966-8-9 against Rs. 3,44,326 in the previous year, showing an increase of Rs. 14,640-8-3 on account of the increased number. This gives an average of Rs. 60-5-0 per lamp per annum. Electric lighters, says the *Indian Engineer*, will please note.

Joint-Stock Companies.—The Board of Trade have appointed a committee to enquire what amendments are necessary in the Acts relating to joint-stock companies incorporated with limited liability, especially with a view to the better prevention of fraud in relation to the formation and management of companies, and to consider and report upon the clauses of a draft Bill which will be laid before them for that purpose.

Madras Electric Tramway.—We referred to this concern last week. The *Indian Engineer* now says: "The Madras Electric Tramways Company does not seem to be making progress. According to the terms of the concession, and making due allowance for the six months' extension granted to the company by Government last year, sections No. 1 and 2 of the tramways should be substantially complete and open for traffic on this date. But they are not."

Light Railways.—The President of the Board of Trade has appointed Thursday, December 6, as the date for the assembling of the proposed conference on the subject of light railways. The conference will meet at 8, Richmond-terrace, Whitehall, S.W., at eleven in the morning, and will sit till half-past one in the afternoon. It will then adjourn till half-past two, and sit till half-past four. The question of adjournment will be considered at a quarter-past four.

Society of Arts.—Among the papers to be delivered after Christmas are: "The Use of Electricity for Cooking and Heating," by Mr. R. E. Crompton; and "Electric Lighting of Ecclesiastical Buildings," by Major-General C. E. Webber, C.B. Prof. Silvanus P. Thompson will also deliver three Cantor lectures on "The Arc Light." On Wednesday next, at 8 p.m., the opening address of the one hundred and forty-first session will be given by Major-General Sir John Donnelly, K.C.B., chairman of the council.

Direct Calculator.—We have received from Messrs. Crosby Lockwood and Co. a copy of the "Direct Calculator (Es)," compiled by Mr. M. B. Cotsworth, Holgate, York, who has previously issued other calculating tables. The present book is simple and well arranged, and shows at a glance the values of all weights from 1lb. to 1,000 tons at all rates to £100 a ton, by penny gradations from a penny to 40s. per ton, and thence by £2 gradations, so that only one addition is required to cover every penny rate to £100 per ton.

Symbols for Physical Quantities.—Our contemporary the *Electrical World*, of New York, has issued a reprint of the symbols for physical quantities and abbreviations for units as recommended by the Committee on Notation of the Chamber of Delegates of the International Electrical Congress of 1893. To the card containing these symbols, which has been corrected by M. E. Hospitalier, have been added in italics the names of the practical mag-

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netic units provisionally adopted by the American Institute of Electrical Engineers.

Royal Meteorological Society.—An ordinary meeting of this society will be held at 25, Great George-street, Westminster, on Wednesday next, the 21st inst., at 7.30 p.m. Papers on the following subjects will be read: "Methods of Determining the Influence of Springs on the Temperature of a River, as illustrated by the Thames and its Tributaries," by Mr. H. B. Guppy, M.B.; "Some Effects of the Gale in the Highlands of Scotland on November 17th and 18th, 1893," by Mr. Eric S. Bruce, M.A., F.R.Met.Soc.; and "History of a Waterspout," by Mr. Alfred B. Wollaston.

Institution of Electrical Engineers.—A meeting of this Institution will be held at 25, Great George-street, S.W., on Thursday next, the 22nd inst., commencing at 8 p.m. A paper on "Electrical Steep Grade Traction in Europe," by Mr. Charles S. du Riche Preller, M.A., Ph.D., member, will be read, and discussion will take place on the papers entitled "Notes on Electric Tramways in the United States, Canada," by Mr. H. D. Wilkinson, member; and on "Electric Traction, with Special Reference to the Installation of Elevated Conductors," by Messrs. R. W. Blackwell, foreign member, and Philip Dawson, associate.

Bordeaux Exhibition.—A meeting of members of the London Chamber of Commerce and others has been held, at which the following motion was adopted: "That the London Chamber of Commerce should be requested to form a committee (with power to add to its number) for the purpose of ascertaining whether adequate British representation, either general or special, can be secured, and, in such case, to lend its advice and aid for the purpose, subject to its being reasonably satisfied with the conditions upon which the exhibition is to be held." Information may be obtained at the offices of the Chamber, Botolph House, Eastcheap.

Mahatmas and Electricity.—Mr. Herbert Burrows, having been interviewed on the subject of whether the Mahatmas are humbugs, has said: "I see Mrs. Besant recently stated in Australia that she had seen a Mahatma. This probably meant she had seen what is called his astral body, which again means simply that she has so trained herself as to be receptive of the vibrations of which this astral matter is composed. Here we have only a development of Tesla's wonderful experiments with regard to electricity and its rapidity of vibration. There is no miracle, nothing supernatural; nothing miraculous or supernatural is claimed." The analogy is not very evident.

Utilisation of Water Power.—An interesting installation of the utilisation of water power is just being completed at the works of M. Andrieu under the superintendence of M. Juppont, of Toulouse. The station, which is to be operated by the water power of the Lot, is equipped with two Fontaine turbines giving 200 h.p. under a head of 17ft. The total power available is 600 h.p., but only the two motors in question will be worked for the present for the operation of the Capdenac Works, and for the lighting of the principal streets in that town and for the supply of light to private consumers. As the generating station, which contains three Thomson-Houston dynamos (of which one is reserve), is situated 700 metres from the district to be supplied, the three-wire system of distribution at 240 volts has been adopted. After providing for the above requirements, the surplus power will be used in connection with neighbouring industries.

Lecture.—Sir H. Roscoe, M.P., in distributing prizes at the Sheffield Technical Schools last week, remarked that hitherto we had been raising only starving clerks, and had ignored the means by which to make the intelligent and able artisan. England had now, however, learned from France and Germany the importance of technical education, and the House of Commons had awakened to the national danger created by our neglect of that duty. On the whole, he thought the money granted to local authorities for technical education was being well spent. The county councils were learning their business, and he was surprised that they were learning it so quickly. Upon the successful solution of the problem of technical education depended not only our commercial supremacy, but also our national existence. What we now needed in our schools was a continuous system of object lessons from the kindergarten until special scientific subjects were begun.

Accident in Cannon-street.—The daily papers this week announced that on Saturday afternoon a horse was killed by an electric shock in Cannon-street at the corner of Walbrook, that two or three persons received slight shocks, and that three explosions occurred in the locality about the same time. As a public enquiry into the accident will be held by the Board of Trade on Monday next, the 19th inst., commencing at 11 a.m., in No. 174 hall, Winchester House, Old Broad-street, E.C., the City of London Electric Lighting Company, Limited, desire us to state that pending such enquiry they do not consider it advisable to make any statement on the matter. In the meantime, the British Insulated Wire Company, of Prescot, ask us to mention that their cables are in no way responsible for this accident. The daily papers also stated erroneously that a similar event occurred some time ago either at Brighton or at Eastbourne, but this is now being corrected by different correspondents to Bournemouth.

Electric Lighting in Germany.—The buildings of the Reichstag, Berlin, have been lighted by electricity. There are 62 arc lamps, of which 16, of 15,000 c.p., are placed in the large hall. There are also about 5,000 incandescent lamps. The question is being considered whether the subject of the electric lighting of Brunswick could not be settled at the same time as the introduction of electric traction on the tramways. The Municipality of Bayreuth have decided not to establish a central electric lighting station owing to other heavy liabilities incurred for next year. At Landshut applications have been received for about 1,150 lamps. This is more than was anticipated. The premises of the Kleinhammer Brewery Company, Dantsic, are to be lighted electrically. Mr. W. Reisser, of Stuttgart, has received authority from the Minister of the Interior to establish a central station at Horb. A central electric light station is to be opened this month at Reisslingen. There has been a good demand from private consumers, and the streets are to be lighted electrically. The Trade School, Leipsic, is to be lighted by electricity.

Catalogue of Electrical Plant.—It has now become a recognised course to pursue, in issuing new catalogues, to embody in them useful information to elucidate the questions which arise in the minds of the public when considering the subject of laying down private plant for the supply of electric light. This policy has been adopted in the new catalogue brought out by Messrs. Henry F. Joel and Co., of 31, Wilson-street, Finsbury, E.C., who first discuss the suitability of steam, gas, and oil engines for particular cases, and then give plans showing the positions of lamps in West-end and other houses. This is followed by information concerning the fixing and operation of dynamos, motors, arc lamps, and accumulators, and which is of value to residents in the provinces and the colonies. Illustrations and details are next given of vertical and horizontal steam-engines, boilers, gas and oil engines, and turbines. Joel's slow-speed dynamos and alternating-current motors,

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the latter with a guaranteed efficiency of 40 per cent. for small ¼-h.p. motors, occupy a prominent position, together with the Joel-Pilsen arc lamp and photographic arc lamps. The list concludes with references to storage batteries, switchboards and switches, voltmeters, ammeters, incandescent lamps and accessories, and electric cooking and heating appliances.

Electric Transmission in Agriculture.—Messrs. Ganz and Co. have this summer carried out an interesting electric installation on the lands of Count Ugarte-Lowaletti at Jaispitz, in Moravia, which is used purely for agricultural purposes. On the estate a steam sawmill has been erected, and here 30 h.p. was reserved for the purpose of the electrical transmission plant. From this generating station two circuits are carried in different directions. One of these leads to a mill and dairy, with a branch to a neighbouring barn; while the second circuit leads to another barn. In the secondary stations there are two 12-h.p. electric motors in the two barns, and a 10-h.p. motor in the dairy. At the primary station there is a continuous-current dynamo of 35 amperes and 620 volts regulated by a Blathy automatic pressure governor. At the dairy two centrifugal machines, a pump, and other machinery are driven. Near here there is a mill which formerly could only be worked for a short time in the year owing to insufficiency of water power. This mill has now been so arranged that it can be driven by the motor in the dairy. In the two barns the motors are used for driving thrashing-machines. The motors are portable, being mounted on carriages, and can be taken out into the open field, connection being made by branch conductors with the main overhead cables.

Electrocution in America.—Things are coming to a pretty pass if the following blood-and-thundery Dalziel's cablegram is to be credited. It runs: "The question of the possible survival of criminals who have been executed by means of electricity has been frequently discussed in America, and as opinions are greatly divided on the subject, the Hon. Roswell P. Flower, Governor of the State of New York, announces that he will permit an experiment to be made to settle this point. A man named Wilson is now under sentence of death and will be electrocuted next month. The doctors who attend the execution in order to certify to the cause of death and make the *post-mortem* examination are, in accordance with the governor's decision, to be allowed to attempt to resuscitate him, and if they succeed Wilson will be pardoned. In the first executions by means of electricity as prescribed under the change of law in New York State, about four years ago, the public was greatly shocked by published statements that the criminals breathed and even groaned after the first shock had been passed through their frames. Later, with improvements in the apparatus, these phenomena were not observed, but in order to ensure that life should be absolutely extinct, the current has been applied for a certain number of seconds, then shut off and turned on again, although the first application was really considered sufficient."

Electro-Harmonic Society.—The first ladies' night of this society for this season will take place on Friday, the 30th inst., at the St. James's Hall Restaurant (Banquet-room), Regent-street, W., commencing at eight o'clock. The following is the programme—Part I.: trio, "A Wish" (M. B. Foster), Miss Mary Harris, Miss Vena Galbraith, and Mr. Reginald Groome; berceuse, "Angels Guard Thee" (B. Godard), Mr. Reginald Groome; aria, "Nobil Signor" ("Les Hugenots") (Meyerbeer), Miss Mary Harris; recitation, "The Road to Heaven" (with music) (G. R. Sims), Miss Charlotte Boucher; whistling solo, "Should He Upbraid" (Bishop), Mr. Charles Capper; song, "The Magic of Thy Voice" (Meyer Helmund), Miss Vena Galbraith; original musical sketch, "Seaside Recollections" (R. Henry), Mr. Roland Henry. Part II.: pianoforte solo, "Andante and Rondo Capriccio" (Mendelssohn), Mr. Alfred E. Izard; songs (*a*) "If my Verses had the Wings," (*b*) "O, my Love's like the Red Red Rose" (H. Lohr), Mr. Reginald Groome; song, "Because I Love Thee" (E. Ford), Miss Mary Harris; recitations, (*a*) "The Duett" (with music), (*b*) "Answered" (Ella Wheeler), Miss Charlotte Boucher; whistling solo, "Chaconne" (Durand), Mr. Charles Capper; song, "When We Meet" (Hope Temple), Miss Vena Galbraith; and original humorous selection (R. Henry), Mr. Roland Henry. The musical directors are Messrs. T. E. Gatehouse and Alfred E. Izard.

The Million Battery.—A bronze medal has been awarded by the jury of the Lyons Exhibition to the Million battery, which is a modification of the bichromate battery. According to the *Bulletin International de l'Electricité*, the battery consists of a porous annular vase containing a solution of sulphuric acid, in which is placed an amalgamated zinc plate forming the negative pole. Around this vase are arranged carbon rods connected together at the top and bottom by means of two lead crowns, to which they are soldered, and constituting a large depolarising surface and the positive pole. The central part of the porous vase is occupied by a small crown of carbon rods connected to the external crown, and allowing of the zinc being worked on both sides. The whole is contained in an external vessel of glass, enamelled iron, or lead according to circumstances, which serves as the receptacle for a depolarising solution of bichromate of soda in acidulated water. A cell of this kind is said to have a capacity of from 160 to 180 ampere-hours, the discharge being varied at will. Moreover, it is claimed by the separation of the liquids that polarisation is overcome. The E.M.F. of the cell is given as follows:

2·1	volts on open circuit.			
1·9	„	with a discharge of	5	amperes.
1·8	„	„	10	„
1·7	„	„	15	„
1·6	„	„	20	„
1·5	„	„	25	„

It is mentioned that this type of battery has been employed for a variety of purposes.

Traction on Canals.—A communication referring to electric and mechanical propulsion on canals was presented recently by M. Maurice Lévy to the French Academy of Sciences. The author, in pointing out how mechanical engineering had progressed and been applied in all branches of industry, stated that it was strange in the case of canals that we had adhered to the primitive method of haulage by horses, a system that had been in use for over three centuries. No doubt its continued employment was due to the fact that this method was simple and economical, and because the traffic handled was small. This system, however, no longer met the requirements of modern canals. With a view to solve the problem, M. Lévy has investigated the matter for four years, and he believes he has discovered a practical solution. The method devised by him consists in haulage by means of a teledynamic cable, and which system has been successfully experimented with on a three-mile length of the Saint-Maur and Saint-Maurice canals. This idea has been tested in Germany on the canal from the Oder to the Spree, and if the results were not as satisfactory as they should have been, the author states that this is attributable to an incorrect reproduction of his arrangement. He mentioned that the experiments with the system made in France were so conclusive that the

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method has been adopted on a large scale on the canal from the Aisne to the Marne, where it will be in regular operation by the end of the present year.

The Pacific Cable.—The tenders for the construction of the proposed Pacific cable were opened at Ottawa on the 9th inst. They are six in number, and all have been sent from England. The figures have not been made public, but it is said that all are lower than the estimate furnished by the engineers. A *Times* correspondent, cabling from Ottawa on the 9th inst., says: "Mr. Mackenzie Bowell and Mr. Fleming to-day opened tenders for the proposed Pacific cable. Six were received, covering each of the eight routes proposed. In all cases they were below Mr. Fleming's estimates, and were much more favourable than was thought likely by some of the delegates to the recent Intercolonial Conference. Before the details are announced Mr. Mackenzie Bowell will communicate them to the different colonial Governments." A cable message, received in Ottawa on Tuesday, according to the same correspondent, stated that Lord Ripon has in contemplation the calling of another inter-colonial conference. Mr. Mackenzie Bowell, in the course of a speech on the same day, said that he saw no necessity for the immediate gathering of another conference, when the Governments interested were already in possession of all the necessary facts respecting the proposed Pacific cable. A conference, he thought, might be necessary to make final arrangements. The delegates of the Imperial and colonial Governments would then require to be in a position to pledge their respective Governments on the question of liability. Mr. Mercer left for England on Tuesday. Before his departure he had an interview with Mr. Mackenzie Bowell on Hawaiian and cable questions, and expressed much satisfaction at the fact that the cable can reach land without touching the Hawaiian group.

Electric Traction in Germany.—Two new electric tramways are about to be opened in Hamburg—namely, the "Blue Ring"—from Rathausmarkt *viâ* Rothenbaum-Chaussée to Eppendorferbaum, and half of the Alster line from Rathausmarkt to Eppendorf (Friedenseiche). The line from Zeughausmarkt to St. Pauli, etc., will also be shortly completed. At present the central electric supply station has not sufficient machinery in place to supply power for this additional demand. About February a line between Barmbeck and Ohlsdorf (Hamburg) will be opened. Negotiations are on foot in Halle between the Allgemeine Elektricitäts-Gesellschaft and the Halle Tramway Company for the purchase by the latter of the electric tramway belonging to the former, and the extension of electric traction to the lines of the horse tramway company by the electrical company. It is proposed to build an electric tramway between Wiesbaden and Walkmühle. It is expected that the working of the electric tramway between Heinersdorf, Pankow, and Gesundbrunnen (Berlin) will be commenced before the New Year, at any rate on the stretch between the corner of the Badstrasse and Prinzenalle to the Breitenstrasse in Pankow. There is a good deal of work being done in connection with electric traction at Barmen-Elberfeld. The Municipality of Barmen have commissioned Messrs. Siemens and Halske to construct an electric tramway to Wicklinghausen, while the Elberfeld authorities have instructed the Berliner Elektricitäts-Gesellschaft Union to build a new electric line running from north to south. At the same time, some horse tramway lines, owned by a Belgian company, are to be turned into electric lines. Messrs. Siemens and Halske have received a concession for the construction of an electric tramway between Schalke, Gilsenkirchen, and Wattenscheid-Bochum. An electric tramway is to be built at Lupree by the Allgemeine Elektricitäts-Gesellschaft.

Institution of Civil Engineers.—The seventy-seventh session of the institution was opened on Tuesday evening, when a short address by the president (Sir Robert Rawlinson, K.C.B.) was delivered to the members. Alluding to the works in progress for the construction of the new building, Sir Robert Rawlinson recapitulated briefly the several stages of development as regards accommodation through which the institution had passed since its foundation in the year 1818. Referring to the library, he reminded the members that they were the possessors of a most valuable collection of books treating of or bearing upon every branch of civil engineering. Upwards of 50,000 volumes were now upon the shelves, and it was a matter for congratulation that such arrangements had been made as would permit the members to have access to these works during the building operations. Nor would the transition from the old to the new premises be suffered to interfere with the work of publication carried on by the institution. Already the series of *Minutes of Proceedings* had reached to 118 volumes. Of each one of the four volumes annually issued 7,000 copies were printed and distributed, and those important records of fact and experience might be consulted in every civilised country in the world. The president then sketched in outline the rise and development of civil engineering in Great Britain. On the motion of Mr. James Abernethy, past president, seconded by Sir Frederick Bramwell, Bart., past president, a hearty vote of thanks was accorded to the president for his address, which he was requested to allow to appear in the *Minutes of Proceedings*. The president then presented the medals and premiums awarded to the authors of original communications dealt with during the preceding session. A students' meeting will be held this evening, when a paper will be read on "The Economics of Direct-Current Central Stations" by Mr. John F. Snell. Prof. A. B. W. Kennedy will occupy the chair.

Rapid Transit in Europe.—An investigation of the European systems of rapid transit has been made by Mr. Wm. Barclay Parsons, A.Mm.S.C.E., on behalf of the Rapid Transit Commission of New York City. Mr. Parsons, pursuant to a resolution of the commission, inspected the several railways in operation and under construction in London, Glasgow, Liverpool, and Paris. Pending the writing of such a report as the importance of the subject demands, he makes a preliminary statement giving the leading constructive features of the several foreign lines. After describing the lines in those cities, the writer says: "This report is, of course, but a description of the several railways which were inspected during the past summer, and it is not intended in any way to suggest or recommend any particular form of tunnel for use in New York. As the local conditions of no two cities are the same, it is impossible to select any one type, however successful it may be under its particular conditions, as the type to be produced elsewhere. In the study of the foreign systems, however, much information has been gathered, and many fruitful suggestions gained, which will hereafter be of value to your Board in the carrying out of your future work, although that work may differ from, and it is hoped be an improvement on, any of the above-described railways. The conclusions arrived at from such an investigation, both from the study of the actual works and from personal interviews with their designers, are: (1) that an underground railway operated by steam, even with the most approved system of mechanical ventilation, would be intolerable to the people of the city of New York; (2) that a railway with a steady, frequent service can be operated successfully and economically by electricity; (3) that an underground railway operated by

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electricity has a comfortable atmosphere, and that it can be arranged so as to avoid great changes in temperature; (4) the advice and experience of foreign engineers lean toward keeping the rail level as close to the surface as possible, and that excavating from the surface is cheaper and safer than tunnelling; but (5) if conditions demand, a deep tunnel can be constructed, for which the circular form is best; (6) that an underground road can be so designed as to be attractive in appearance; (7) that the work can be carried on through a busy street without endangering the houses, and without seriously impeding travel."

The Perfect Incandescent Lamp.—A series of articles by M. A. Bainville dealing with the manufacture of incandescent lamps, is being published in *L'Electricien*. The author having passed through the various operations in the production of these lamps, commences in the pages of our contemporary of the 10th inst. to consider the perfect incandescent electric lamp. It is very evident, he observes, that the present types of lamps are far from reaching the ideal. In what way shall we go to attain better results, and what are the most imperfect points which it is most desirous to remedy? Some of the imperfections possessed by the incandescent lamp are inherent, belonging to the principle upon which its construction lies; others depend upon the manner in which this principle is applied. Dealing first with the latter, the author states that the filament is a bad transformer of electrical energy into luminous energy since existing lamps have barely an efficiency of 5 per cent., and by increasing their working temperature we cannot expect to obtain in luminous energy more than 10 per cent. of the electrical energy consumed. We may from now consider that the most progress realisable lies in increasing the efficiency of this transformation. The principal other defects of the filament are caused by the wear of the filament; they are due to the variation of the electrical resistance, and also to the variation of the nature of the surface of the filament, which has equally a considerable influence upon the value of the lighting power. The more or less transparency of the bulb, and especially the modifications it undergoes during the life of the lamp, are also comprised in the imperfections of manufacture. This transparency is, moreover, intimately connected with the quality of the filament, since the layer of carbon which produces this diminution in transparency of the bulb arises solely from the filament. M. Bainville contends that the perfect incandescent lamp can be defined as that in which the physical properties of the filament remain constant during the whole of its life; this duration is tolerably long, such, for instance, as that of existing lamps; the filament would be enclosed in a bulb of perfect transparency and constant during the life of the lamp; the vacuum in the bulb should be accomplished in such a manner as to be as near as possible an absolute vacuum, and it should be maintained in such a condition all the time the lamp is in operation. A lamp of this kind should, moreover, automatically terminate its life as soon as one of the conditions enumerated becomes unfulfilled. The question naturally arises, how can these requirements be met? Passing on to a consideration of this matter, with special reference to the composition of the filament, the author concludes that investigations into the improvements to be introduced in incandescent lamps should be devoted to a realisation of filaments formed of a single substance, and not of a mixture. This substance should possess the properties of infusibility at least equal to that of carbon, a higher specific resistance, large emissive power, and be very elastic. Apart from this solution, the author observes it might perhaps be possible to effect the transformation of electrical energy into luminous radiations in a more perfect way than by the method of incandescence. The luminous phenomena which accompany discharges in vacuum, and the illumination presented by rarefied air-tubes placed in the magnetic fields of high frequency, as, for instance, those of the Tesla kind, may be the point of departure of new and fruitful investigation.

Contiguous Gas and Electric Mains.—Before a general meeting, held last week in London, of the Southern District Association of Gas Engineers and Managers, a paper by Mr. S. W. Durkin, of Southampton, having the peculiar title of "How an Electric Current introduced Gas into an Electric Culvert," was read. The author first referred to the commencement of the operations of the Southampton Electric Light and Power Company, and to the protection afforded by the latter to the gas-mains laid in the same streets as the electric light conductors. Proceeding, he said: "The electric company have now been supplying current for several years from a low-tension plant, and it appears to be a very good example of central-station lighting. Up till October 16 last the two underground systems for supplying each kind of artificial light had gone on without molesting each other, or disturbing person or property. On the evening of October 15, however, there was, it seems, a leakage on one section of the electric mains. On the following morning the electric light inspector went into the High-street to localise it. After opening up one or two covers, the man detected gas, and soon after telephoned to the gasworks for our inspector to come to his assistance. The latter, on arriving on the scene of action, had the whole of the traps over the section opened up, and as they went down the street gas was scented more and more strongly, until they came very near to what proved to be the source of the mischief. I was sent for, and the question was what to do in the emergency to prevent any mishap and to stop the gas leakage. The gas-main was under the kerb, so that the service pipes were short in length. These latter I determined to strip and examine. Another precaution was to isolate the main; but, fortunately, this became unnecessary, as the second service we opened, and which passed under the floor of the culvert, revealed the cause of the mischief. The electric mains, as previously stated, are laid for the low-tension system, and are strained up to bridges placed at intervals across the culvert. These mains are formed of copper bars about 1in. by ¼in. in section. The gas service was supposed to be insulated by a stoneware tile, semi-circular in section, embedded in Portland cement rendering on each side, but the centre was above the culvert floor. This insulation might have continued had the copper main kept its original position, but from some cause it sagged (perhaps from a holdfast breaking) and rested on the insulating tile. Then the electric current, anxious to leave its copper-bound lodging, made a crater-shaped hole through the tile. The fused portion of the tile and the perforated service pipe are now before you. The opening is about 0·75in. in area, and of irregular form. The copper main was fused and fell asunder, dropping far enough away to prevent further short-circuiting. There was evidence of the gas having been lighted, there being a deposit of carbon found on the stone cover of the culvert. But for some reason the flame went out; the presumption is that it was for want of air to support combustion. It was very satisfactory that no explosion had occurred. At the same time this incident shows the culvert system to be one likely to lead to disaster when in close proximity to gas-mains in public thoroughfares. In this instance there were 360 yards of culvert charged with gas. The damage was soon made good by those concerned, and a new form of insulator inserted, which, I trust, will prove more reliable than its predecessor."

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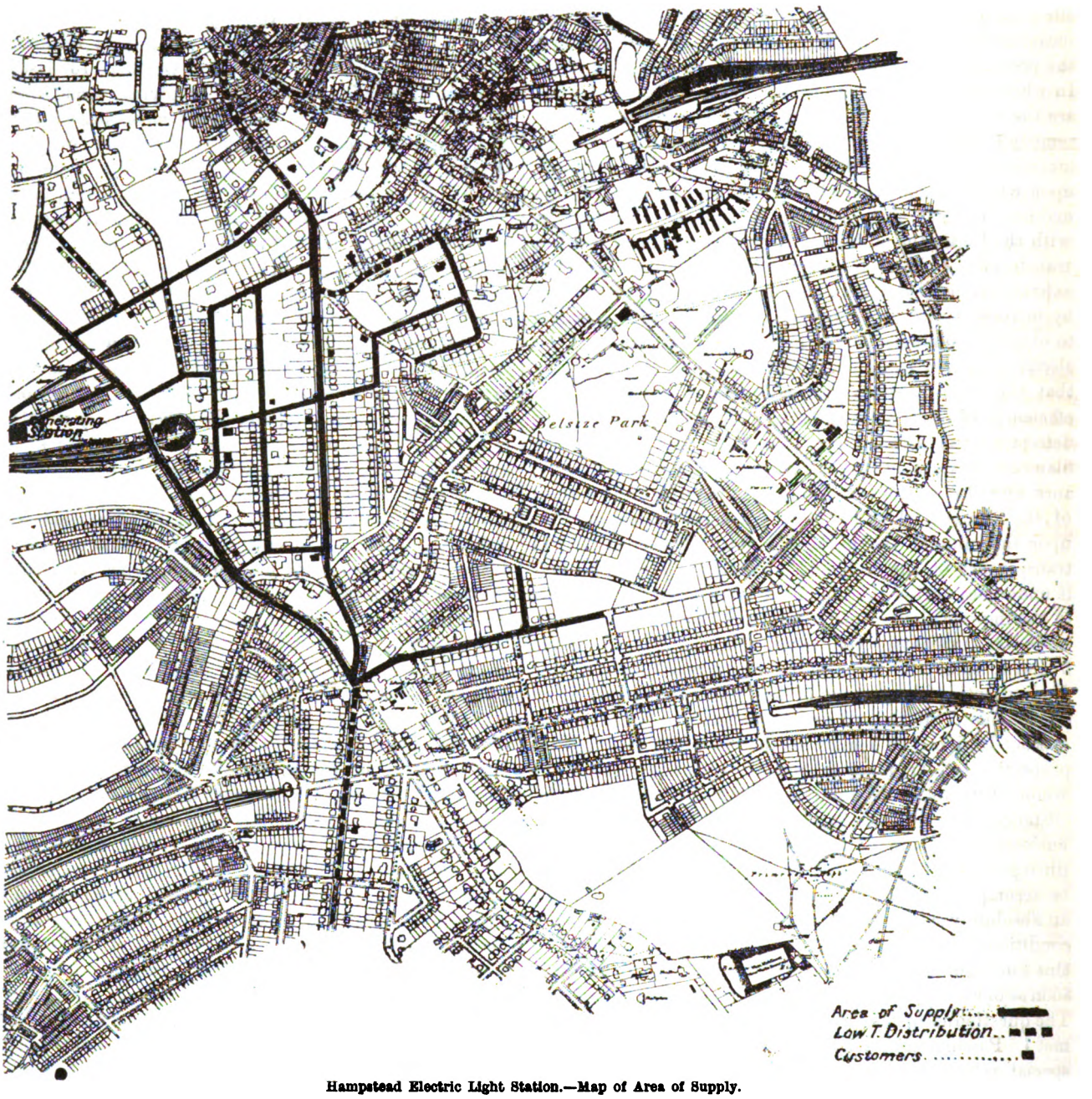
MUNICIPAL AND COUNTY ENGINEERS.

On Saturday, November 3, among other visits, the Association of Municipal and County Engineers went to the Hampstead central station to inspect the works and hear a paper on the station by Mr. W. H. Preece, C.B., F.R.S. The paper was descriptive of the station. Our readers must be pretty familiar with the arrangements of this station from our description of October 5 last. We are, however, now able to supplement that description with a few more illustrations and details.

Hampstead Central Station.

SUPPLEMENTAL DESCRIPTION.

The accompanying plan of the district will give an idea of the position of station and area wherein current is now being distributed or arranged for.



Hampstead Electric Light Station.—Map of Area of Supply.

The dynamos are direct driven by Willans engines, and, speaking of these engines, Mr. Preece said they had had with them considerable experience. They had upwards of 30 in different post offices, which were found to work with absolute perfection, and he had never known of any trouble with them. They gave immense satisfaction, were direct driving, and for compactness were far preferable to any system of rope or belt driving. These engines were coupled direct to Siemens alternators. The combination is illustrated in Figs. 1 and 2.

The switchboard, Fig. 3, was well werth attention. They would observe from the elevation of the switchboard (the connections on which are shown diagrammatically) that three arc light panels were arranged on the extreme left. The middle one was for ammeter and voltmeter, voltmeter switch, and series regulating resistance. The side ones had fuses and double-pole switches to put either dynamo on to the arc circuit, an exciting circuit switch so as to prevent extra current in the magnet coils, and field regulating resistance switch. For the private lighting there were five alternator panels, as shown on the right-hand board. The first four each had an ammeter, fuse, double-pole switch to connect any alternator to the omnibus bars, fuse, field-magnet switch, and field-magnet regulator. The latter could be clutched to a horizontal shaft, so that all four fields could be regulated together after preliminary independent adjustment. The fifth panel carried a main ammeter and a voltmeter in the omnibus bar, machine voltmeter and switch for connecting it to any machine, and synchronising switches. There were seven feeder panels, carrying an ammeter, fuse, double-pole switch, and fuse. There were two exciter panels to the right of the smaller boards; each carried two ammeters, a voltmeter and its switch, two double-pole switches to put either dynamo on to exciting circuit, shunt breaking circuit,

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regulating switch, and fuses. The instruments, with the exception of two Swinburne electrostatic voltmeters on the high-pressure alternate-current circuits, were of the Siemens type.

The feeder mains were carried to seven sub-stations in different parts of the parish. The feeders were of Siemens's concentric type, insulated with specially-treated fibrous material, cased in cold-drawn continuous lead pipe, served, sheathed with iron bands, served and compounded, and laid direct in the ground. The iron armour was so strong that a pick could not go through it. The cable was as cheap and as good as any in the market. There were six sizes of feeders, cross-sections of each of which are shown in Figs. 4 and 5, the conductors varying, according to length, from ·075 square inch to ·02 square inch. The

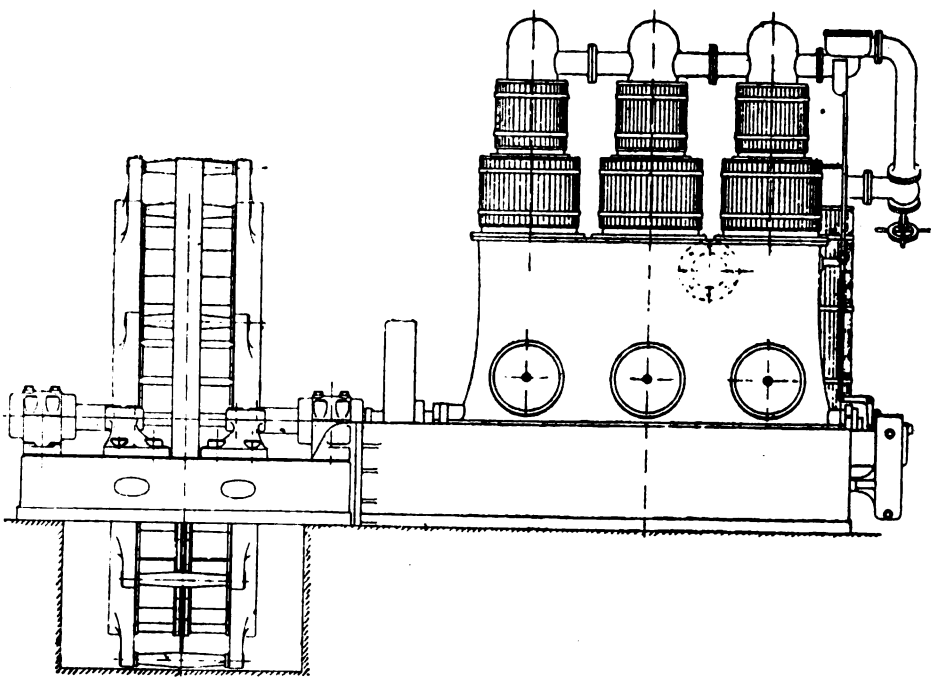

FIG. 1.—Front Elevation of Siemens Alternator and Willans Engine.

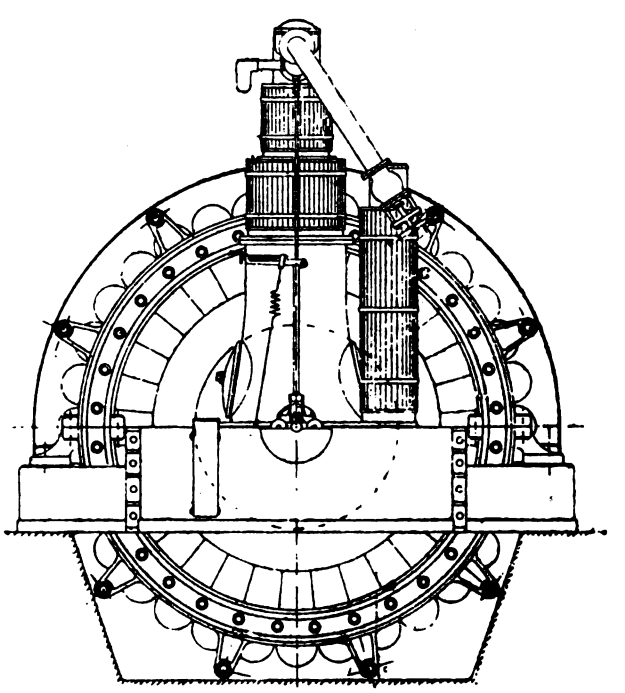

FIG. 2.—End Elevation of Willans Engine and Siemens Alternator.

feeders were connected in the sub-station to Siemens transformers, which converted the current from 2,000 to 105 volts, at which pressure customers were supplied from low-tension mains, similar to the high-tension mains, but not so highly insulated. Sections of these mains are shown in Fig. 6. The insulation resistance of these mains was 1,000 megohms per mile at 60deg. F. The arc lamps were of Siemens band type, double carbon for 10 amperes. They were arranged in globular lanterns with drooping bracket on the top of ornamental iron posts, the centre of the lantern being 22ft. from the ground. A double-pole switch was provided in the base of the post for disconnecting the lamp.

The sub-stations, one of which is shown in cross-section in Fig. 7, consist of small brick chambers, 6ft. by 5ft., built under the pavement, access being obtained through a small manhole in the top. Each sub-station contained two 25-kilowatt transformers, a high-tension fuseboard, and a low-tension switchboard. The two primaries of the transformers were in parallel on the feeder, the current passing through the switch and fuses shown on the right of the cross-section. The two secondaries were in series across the extreme conductors of the network, the middle point being joined to the neutral wire. The number of distributing mains passing out of the sub-station varied from three to five, according to the situation of the sub-station, the current passing through double-pole switches and fuses. The reduction of the current is from 2,000 volts to 105 volts between the outer and neutral wires. The distributing mains from the low-pressure switchboard were so arranged that the supply to any length of distributing-main between two sub-stations could be cut off for the purpose of connecting customers without interfering with any other part of the system. Each sub-station would supply 1,430 8-c.p. lamps. The total length of feeder main was a little more than 3½ miles, and would carry current for the supply of 17,000 8-c.p. lamps. The total length of low-tension main was 3½ miles, and this was sufficient to energise 10,000 8-c.p. lamps.

"Turning now to the question of public lighting," Mr. Preece said, "I may mention that we have erected 26 arc lamps in the main thoroughfare—Finchley-road. I have always been an advocate of street-lighting, but only on a limited scale, and then as well as you can. The great advantage of the use of the electric light for street illumination is that it is an excellent advertisement; it attracts people. In Bristol it is remarkable. The whole of the main thoroughfare from the road leading to the railway station from the town to Victoria Hotel, Clifton, has been lighted by 100 lamps. Now there are 33 per cent. of the shops on that route lighted by electricity; in other parts it is scarcely 5 per cent. That is due very largely to the introduction of the electric light on a brilliant scale. We intend to do the same here.

"I am perfectly certain that this industry in Hampstead is going to be financially a very great success, and I am quite satisfied there will not be any demand upon the rates for any assistance. I think we shall pay our way for further expenses on the borrowed money the first year. We have only been open four weeks. We commenced with 2,176 lamps fixed, we have since added 1,218, and we have orders and authority, and have given instructions, to carry out mains and arrangements for a further 4,475 lamps. Thus, in one month we have got a load of 7,869 lamps, and we only started with the idea of getting 10,000 lamps in two years. I am, however, now impressed that we shall have 20,000 lamps in 12 months.

"The curve, Fig. 8, which indicates the load on October 29, shows the way in which the current is distributed. This is the greatest difficulty. You have between the hours of 4 p.m. and 12 p.m. a very good load—a paying load—but during the rest of the 24 hours you have practically nothing. Now, at Worcester we are trying very important experiments. We have some water power, and we are going to use this water power during the day in work-

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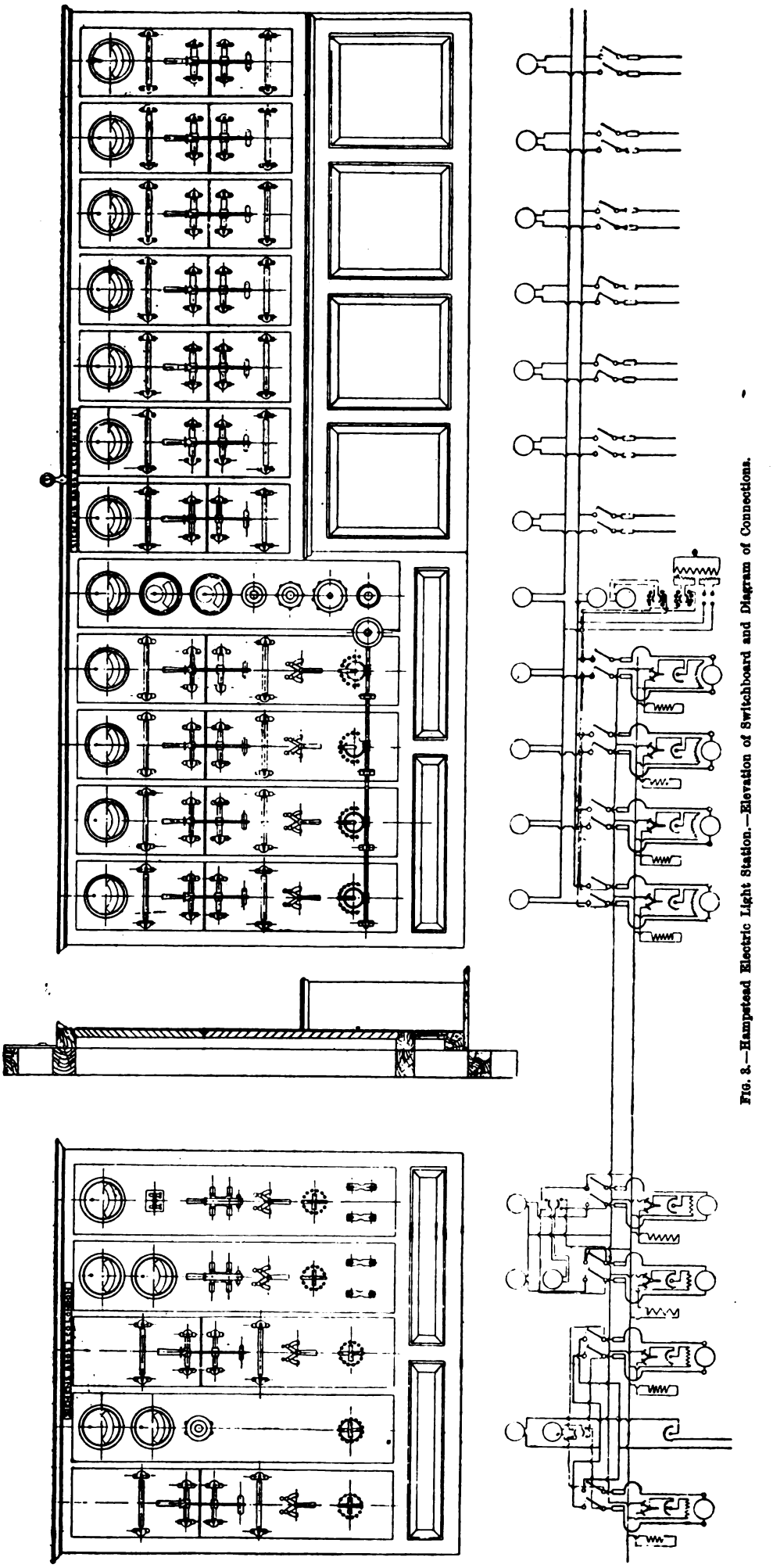

FIG. 3.—Hampstead Electric Light Station.—Elevation of Switchboard and Diagram of Connections.

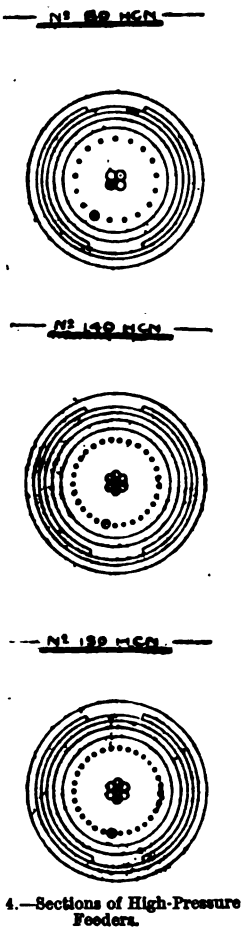

FIG. 4.—Sections of High-Pressure Feeders.

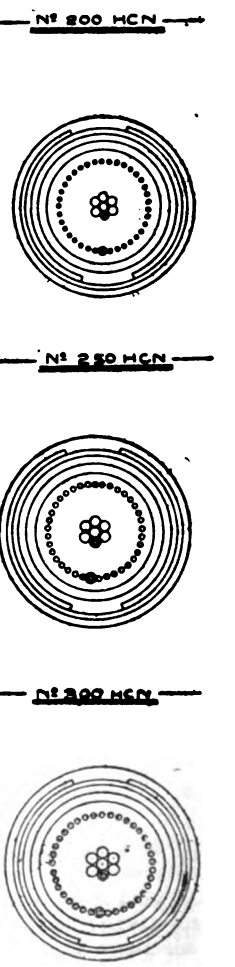

FIG. 5.—Sections of High-Pressure Feeders.

ing pumps at the waterworks and also in pumping sewage to a higher level. The result will be this—that we shall have during the day a load that will compare very favourable with a night load, and we shall have a long continuous curve

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that will enable us to pay our working expenses night and day. The point is this—whether it is not possible to utilise the current for power purposes during the day and reduce the cost of the light; because if you reduce your expenses during the day you relieve the night load of the cost of this heavy expense. We are quite as successful in

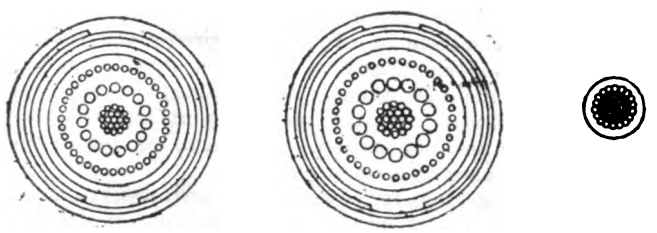

FIG. 6.—Sections of Triple Concentric Distributing Mains, and Section of Arc Light Cable

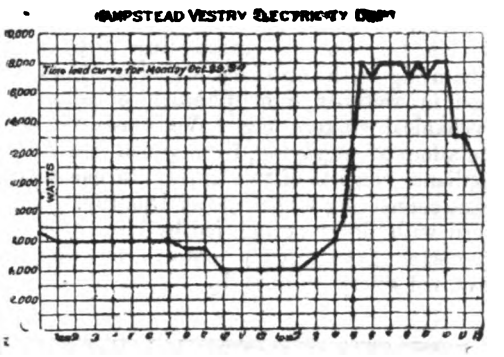

FIG. 8.—Time Load Curve for Monday, Oct. 29, 1894.

Worcester as here. They started Worcester with an exhibition, and with that and the street-lighting and the local exhibits, the station was thoroughly well advertised, and the people are rapidly making applications for the light. You will be glad to hear we have been within our estimates at Hampstead; more than that, we are under our

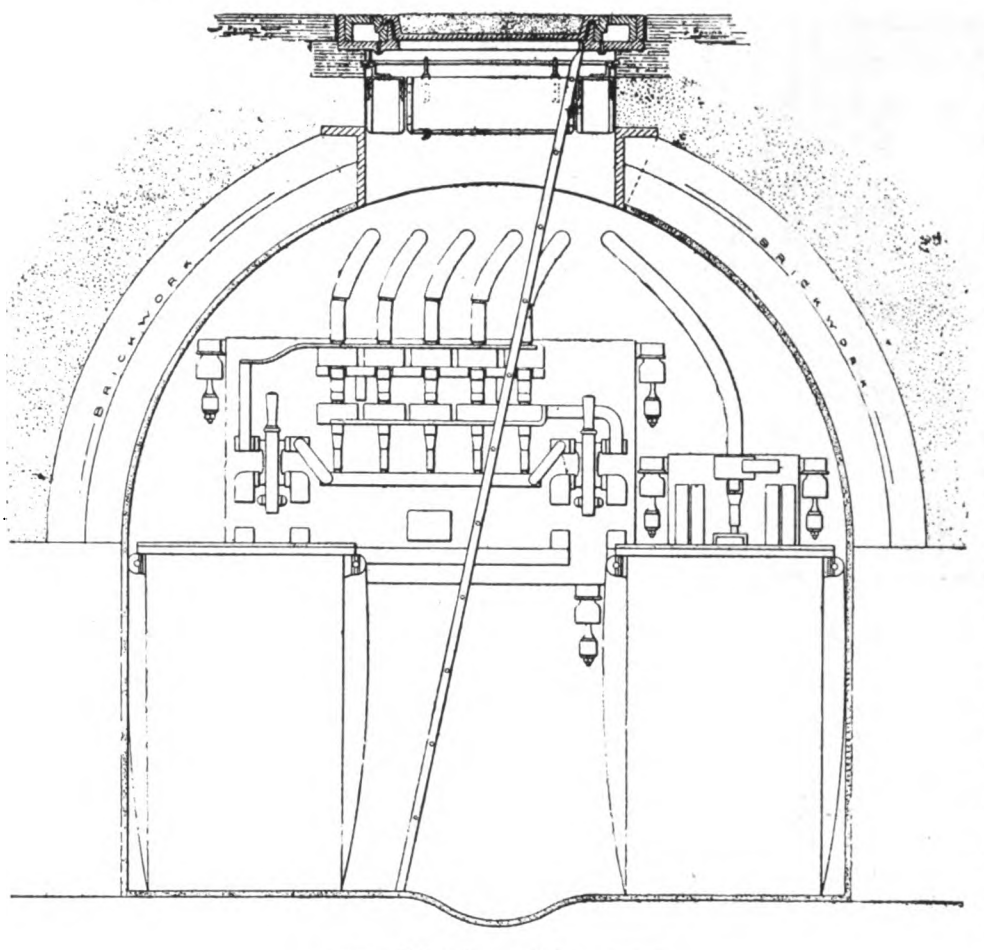

FIG. 7.—Elevation of Sub-Transformer Station.

estimates. The cost of the station has approximately been £30,000, and the charge for current is on a sliding scale, ranging from 6d. to 4d. per unit."

The PRESIDENT (Mr. A. M. Fowler, C.E.) proposed a vote of thanks to Mr. Preece for his interesting paper, which was given unanimously.

The members then inspected the station, and subsequently adjourned to the next meeting at Middlesbrough.

Birmingham.—The new meat market and slaughter-houses are to be lighted by electricity.

ELECTRICITY FROM GAS.

At more than one electric supply station or electricity works the total cost of developing energy has already been brought down to a point but little in excess of Mr. Crompton's ideal figures, allowing a fair but not extortionate amount for management and other standing charges: the item of fuel consumption, however, has yet maintained an excessive degree, and appears likely to do so for ever, if the present system of steam generating be employed. The prospects and capabilities of gas motors are therefore well deserving of examination with a view of ascertaining the development which they might attain under careful use when properly designed and worked.

Our readers are, of course, familiar with the ingenious and far-sighted project planned out by Mr. B. H. Thwaite some time ago with the idea of developing electric energy at the coalfields of South Yorkshire or Derbyshire, and transmitting to the Metropolis at high pressures for service in the thousand and one directions capable of employing electric light and power in London. The gigantic nature of this project—gigantic at least to our somewhat stunted ideas of to-day—is alone sufficient to cause hesitation on the part of the various interests concerned with regard to its adoption, though at no distant date the matter will without doubt come up for serious consideration and discussion of detail.

At present, however, the field of gas generation and use appears to offer more opportunities for development on a reasonably large scale. There is, unfortunately, perhaps, no immediate prospect of turning our coalfields into vast gasworks, where gas-engines and dynamos supply the leading centres of population with electric energy for all purposes, and Mr. Thwaite has therefore concentrated his attention upon proving to the satisfaction of electrical engineers that they may effect a considerable saving in their coal bill by turning it into gas for use in gas-engines rather than burn it under steam-boilers, which even at their best are excessively inefficient.

We have just lately had an opportunity of inspecting the system and apparatus devised by Mr. Thwaite for this purpose, and now publish a brief notice of the same, with the intention later on of giving our readers full details in

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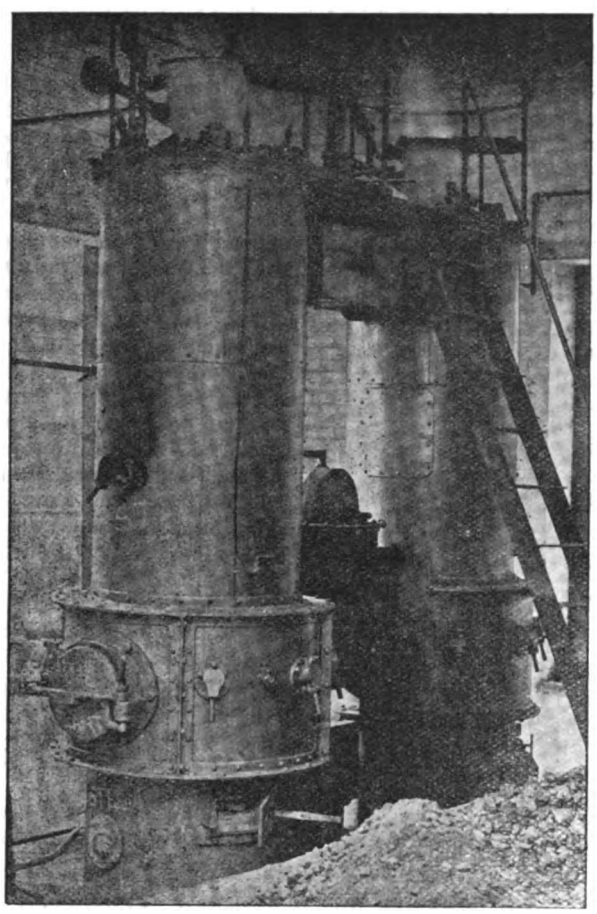
an illustrated account of a typical plant in actual work. At present the matter must be deal with more or less theoretically.

It is, of course, tolerably easy to make good gas from anthracite fuel, and Mr. Thwaite some time ago developed an experimental plant for showing this, and proving the great economy in fuel to be obtained from using gas motors rather than steam-engines: he has now added to this by similarly completing plant suitable for gas generating with ordinary steam coal, such as would be used in water-tube or Lancashire boilers, equipped with mechanical stokers, etc. We illustrate the generator in the annexed engraving, from which it will be seen that the appliance consists of two upright furnaces with a horizontal cross connecting chamber at the top. The furnaces are lined with firebrick and fed by blast from a fan operated by means of an electric motor. The direction of blast is reversed every minute by means of an automatic valve



The Thwaite Steam Coal Gas Generator, for driving Gas-engines.

arrangement, based on the principle of balanced water-tanks. There are no bottoms or grates to the furnaces, but the inner fireclay lining is widened out near the base so as to constrict the interior space. Underneath each furnace is a water seal, through which the gas passes, and into which fall the cinders or pieces of unburnt fuel. The latter are raked out from the front, and used again. The furnaces are fed through hoppers at the top.

We append an analysis of the gas produced in this apparatus, as determined by Prof. Vivian B. Lewes a few weeks ago, from ordinary steam coal.

	From generator.		From main after purifiers.
Sulphuretted hydrogen ..... Carbon dioxide	11·16	.....	11·83
Oxygen	0·00	.....	0·00
Unsaturated hydrocarbons	0·16	.....	0·00
Saturated hydrocarbons	4·20	.....	4·10
Carbon monoxide	18·00	.....	17·16
Hydrogen	7·25	.....	7·33
Nitrogen	59·23	.....	59·58
	100·00	.....	100·00

Other analyses have given a proportion of 21 per cent. for the carbon monoxide, whilst the average of the carbon dioxide has been 4½ per cent., one determination by Mr. H. Allen showing only 1·5 per cent. In the experimental plant the gas is taken through the usual series of purifying and scrubbing devices, and stored in a holder, whence it is drawn for use in a gas-engine of 20 b.h.p. operating one of Clarke, Chapman, and Co.'s dynamos. The producer illustrated, however, would serve for three or four such plants, and Mr. Thwaite claims actual results twice or three times those obtainable from a given weight of coal burnt in a good boiler supplying a compound condensing engine.

Certainly the arrangements for testing the plant at every possible stage—both chemically, mechanically, and electrically—are as complete as could be desired; the results from this arrangement may be depended upon as being reliable, and such as should be obtained under good management under ordinary conditions at any time or place. They are not merely theoretical, or based on laboratory working on a small scale.

Two other ingenious improvements at least deserve mention as being employed in this plant. One consists of a flat sawdust scrubber, placed vertically on edge to catch the tar which would otherwise foul the pipes leading the gas from the producer to the holder. This appliance somewhat resembles a sandwich, where two strainer-plates represent the bread and a layer of sawdust the meat; it is very easily taken down for renewal of the sawdust at regular intervals, and seems to fulfil its purpose admirably. The amount of tar actually passing into circulation is not very great, however, as the reversal of blast through the producer furnaces carries the gas through incandescent fuel, and practically burns out all the tar and other heavy compounds.

The second item worth notice is a little arrangement attached to the gas-engine, by means of which a tiny piston, acting in a small cylinder connected with the main engine cylinder, actuates a needle so as to punctuate a paper strip at every cylinder explosion. A record is kept of all the explosions, showing at once when the engine misses—an important matter for carrying out complete and satisfactory tests.

As stated, we hope later on to give more particulars of the plant with the results of tests undertaken by independent and responsible authorities.

CITY AND GUILDS OF LONDON INSTITUTE.

LECTURE X.—THE CONSTRUCTION AND ACTION OF ELECTRIC BELLS—THE ARRANGEMENTS OF BATTERY CELLS, AND OF CIRCUITS FOR BELLS.

(Specially contributed.)

Bell Circuits.—The different requirements in practice makes electric bell circuits a somewhat interesting study. It will be impossible for me here to describe many of the problems which arise, but a careful study of the simpler cases should enable you to solve questions relating to more complex cases.

Simple Bell Circuit.—The simplest case of all is when one push is used with one bell in circuit, Fig. 1. Here

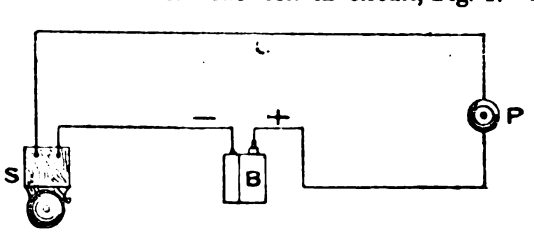


FIG. 1.

battery, bell, and push are in series in the circuit. As soon as the circuit is completed the bells rings.

It is often convenient to be able to ring a particular bell from any one of two or three or more pushes. Suppose, for example, you have to provide for a large dining-room. The object being to save trouble, you may put two or three or more pushes in parallel with each other, as in Fig. 2, and the bell will ring by making contact with either push.

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It is quite common to arrange a push on the dining-table. So long as such a push is in parallel with the ordinary wall push it will ring the same bell. You can see from the diagram how the circuit is completed by pressing any one of the parallel pushes.

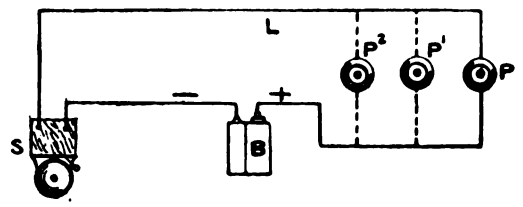

FIG. 2.

Here, then, we have several pushes to ring one bell, but the ringing of several bells from one push is as convenient as what we have just mentioned. Suppose a number of workmen's rooms, or, better, suppose a fire station with men in several rooms, it requires a bell in each room to rouse the men, and to rouse them as quickly as possible the bells should all ring together. There are two ways of arranging such bells—in parallel and in series—whereby each bell is rung by pressing one push. Let us arrange them in

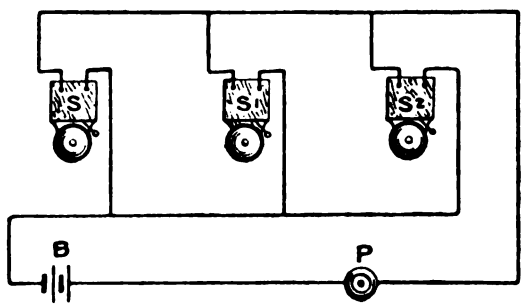

FIG. 3.

parallel first, as in Fig. 3. On pressing the push, P, you see the circuit is completed and the bells, S, S_1, and S_2, ring.

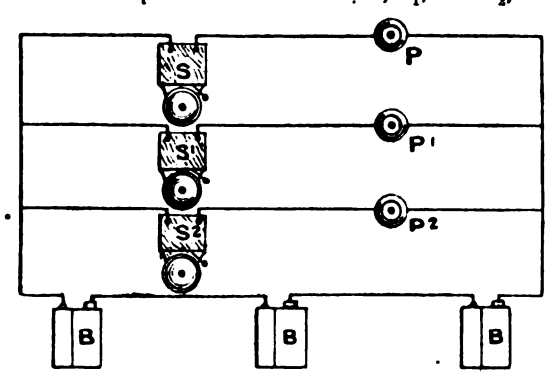

FIG. 4.

If we arrange a bell and its push in parallel with another bell and its push, and so on, as in Fig. 4, then the bell S answers to its own push, P, but not to P_1 or P_2, and bell S_1 answers to its push, P_1, and not to any other, although the whole of the bells may be worked from one battery. The number of cells in the battery indicated on the diagram is of no import. The number will always depend upon the particular circuit you are dealing with.

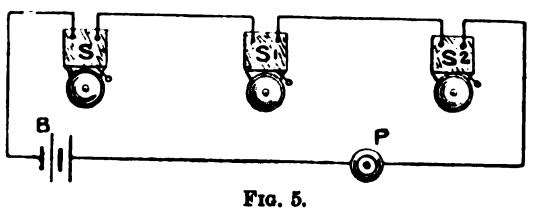

FIG. 5.

I have just said several bells can be placed in series and worked from one push, Fig. 5. This arrangement necessitates more battery power, and ofttimes a different type of bell. A single-stroke bell, however, does very well for series work. You at once see that if we add these in series the resistance of the circuit is increased, hence the necessity for greater battery power. If we try to use trembling bells in series we may by a lucky accident get a result, but a good result will not be obtained by design. The cause of a variable result is that the bells are not usually exactly similar, and do not break circuit at the same time. To meet this difficulty, special bells are made, and when these are used in series the circuit is never broken, but a shunt circuit of much lower resistance than the magnet circuit is obtained, as will be seen by an examination of Fig. 6. Here the line wire W may come from another bell, as line wire W_1 may go to another bell. When the current comes to terminal T it has no road by C, A, G, E to T_1, because of the air-space between C and the screw E, but the

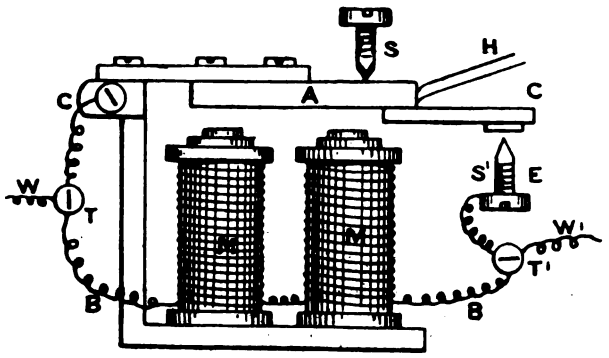

FIG. 6.

magnet cores becoming magnetised by the current pull the armature, A, and cause C to come into contact with E, thus providing a path of low resistance from T through the armature and screw S_1 to T_1. The larger part of the current goes through this path, and so on to the next bell. On the armature going back to its original position to the stop-screw, S, the branch circuit is broken, so that no current can go in that direction. The armature is again pulled by the magnet, and the cycle of operations goes round once more, and so on till the push is freed altogether.

Earth.—Sometimes, instead of having the whole apparatus connected by wires, a part of the circuit is completed by means of the earth. It has long been known that earth, and especially damp earth, is a conductor, and because of its saving metal it is, as I say, often used in place of part of the metallic circuit. One difficulty in using earth is to get a good contact, and to ensure this the metallic portion of the circuit is connected to the gas or water pipes whenever this can be done conveniently. These pipes come into contact with the surrounding earth over large surfaces, and so make good contact. When pipes are not available the wires are fastened to metal plates, which are buried in the most suitable ground that can be found. Fig. 7 shows a circuit thus completed. On the diagram, E E represent the earth connections, whether to pipes or plates. It is very seldom that a circuit partly completed by earth is as good as one wholly metallic.

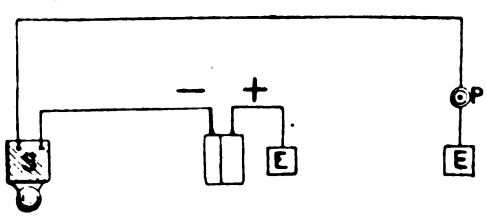

FIG. 7.

Relay.—You will readily understand that the motion of the armature of an electromagnet may be utilised for many purposes besides actuating the hammer of a bell. In the bell just mentioned, its motion is used to form a second path for the current. Similarly, the motion of an armature may be utilised to complete the circuit of a perfectly independent battery, and is so in the apparatus, Fig. 8. Here we may suppose the original circuit to have too great resistance, and too great leakage (for, as we shall see later on, the current leaks whenever it has a chance), for one battery, and so we arrange a local battery having the bell to be rung in its circuit. The push of the local circuit, or what answers to it, is worked by the armature of an electro-

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magnet. In the diagram, Fig. 8, we can trace the two circuits. We have first the circuit of battery B, which goes through push, P, along the line to the magnet, M, and back from the magnet to the battery. Suppose the circuit completed by pressing P, then a current goes round the magnet coils, and the armature is pulled from the upper stop terminal, which is insulated from the pillar on which it is fastened, to the lower terminal, which is not so insulated. Consider now the circuit of the second battery. When the armature is against the upper terminal, the circuit is incomplete. Trace the course of the circuit: it goes from the carbon terminal by the line through the bell to the post carrying the two terminals, upper and lower.

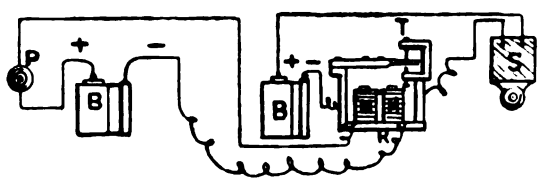

FIG. 8.

The post is also insulated from the framework of the relay, so that the circuit is incomplete either way of the post when the armature is up, for above it is insulated from the armature, and below from the frame. With the armature down the case is different, and the circuit is closed through post and armature to the other pole of the battery. In this arrangement the original battery, whose circuit is completed by the push, P, merely acts to complete the local circuit, and the local battery is the one that causes the bell to ring.

Signalling in Two Directions.—Fig. 9 shows one method of connecting two bells so as to be able to ring in

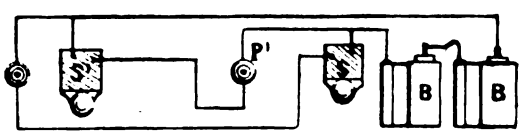

FIG. 9.

either direction with one battery only. In this case we employ three wires, but a careful study of the drawing will show that this is merely a modification of the arrangement in Fig. 4. The length or the position of the wires makes no difference to the system of arrangement, though it may make a difference as to the battery power required. Thus to signal in two directions with one battery, all we have to do is to be careful to arrange one push and its bell in parallel with the second push and its bell. One push may be at Charing Cross and its bell at Oxford, while the second push may be at Oxford and its bell at Charing Cross. Fig. 10 shows another way of

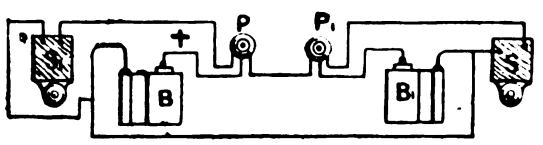

FIG. 10.

signalling in two directions, but here we have two batteries, and must also have special double-contact pushes. I think, however, a careful study of the various bell circuits mentioned will now give you a fair idea of how this kind of work is done.

MECHANICAL TRACTION FOR TRAMWAYS.

(Concluded from page 502.)

From the question of capital outlay, M. de Marchena proceeds to consider the working expenses of tramways operated on the overhead wire system; the chief examples upon which he bases conclusions are drawn from the United States, where, of course, the greatest experience of these lines has been obtained. He finds, however, enormous differences in financial results, owing without doubt to the varied circumstances under which the lines are operated, involving fundamental differences in extent of network, amount of traffic, price of coal and labour, etc. He ventures to give several tables showing the apportionment of working cost—the first of these is based upon official reports from the Cincinnati Tramway Company and the New York Edison Company, and it is as follows:

	Pence per car mile. Cincinnati Tramways.	Edison Company.
Maintenance of line and station	·064	·240
Maintenance of rolling-stock	·704	·976
Motive power	1·632	1·056
Staff	1·152	1·072
Totals	3·552	3·344

These figures refer to the smaller type of cars weighing four tons empty, from 15 to 20 being on the line simultaneously, making from 100 to 115 miles each per day.

In a second table the author quotes some figures from the well-known trolley system of Boston, though his information is no more recent than the year 1891. At that time there were 125 miles of track operated, with 500 cars in service, of a larger and more powerful type than those already dealt with, since they weigh from six to eight tons empty, and attain a daily average journey of about 100 miles each.

	Cost in pence per car mile— April.	May.	June.	July.
Motive power	3·840	4·256	3·648	3·488
Maintenance	·688	·656	·592	·576
Staff	3·648	3·664	3·616	3·456
Repairs	·368	·448	·080	·064
Miscellaneous	2·304	2·272	2·224	2·624
Totals	10·848	11·296	10·160	10·208

The third and last table which the author quotes from American sources is based upon the figures presented to the Street Railway Convention at Pittsburg in 1891, and gives the results shown on 22 overhead trolley-wire systems, having a total length of nearly 200 miles. The various lines were said to range from 3½ to 50 miles in length, having from five to forty cars in operation at a time, and attaining a daily car mileage of from 70 to 150 miles.

	Cost in pence per car mile. Maximum.	Minimum.
Total expenses	11·4032	3·8640
Maintenance of line and way	·9232	·0496
,, overhead system	·4720	·0048
,, station	·4272	·0256
,, rolling-stock	2·5984	·2928
Motive power: labour and fuel	2·4560	·2384
Staff and supervision	4·6976	1·3584
General expenses	1·4640	·3920

According to these figures, the average amount of traction expenses properly so called would be as follows:

	Pence per car mile.
Maintenance of line and station	·24
Motive power: wages and fuel	·976
Maintenance of rolling-stock	1·056
Staff	1·056
Total	3·328

The cost of coal varies in these examples from 4s. 2d. to 15s. 10d. per ton, and labour is taken at 5d. to 10d. per hour. No sinking fund is allowed for in the figures, either to cover the outlay upon fixed plant or rolling-stock. In practice an amount of 10 per cent. on the boilers, engines, overhead conductors, and motors would prove sufficient for this purpose, whilst an allowance of 5 per cent. only need be made for the dynamo generators. This would bring up the cost per car mile to about 4·4d.

Turning to the chief European lines, the author considers rightly that they have as yet been established for too short a period to draw adequate conclusions of their real possibilities from a financial standpoint, but still the figures derived from three conductor wire systems are, he thinks, worth noting. These relate to the lines at Vevey-Montreux, Clermont-Ferrand, and Budapest. The first of these is operated by water power, the others by steam, and the Budapest line, as will be remembered, has an *underground* instead of *overhead* conductor.

	Cost per car mile in pence. Vevey.	Clermont.	Buda.
Maintenance, etc., of way and station	·144	·192	·114
Motive power	1·216	1·648	1·136
Maintenance, etc., of rolling-stock	·912	·704	1·152
Staff	·992	1·296	·736
	3·264	3·840	3·168

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As a final instance of the financial results obtained from electric traction, the author gives some figures of working costs, etc., on the Halle tramways, where horses were replaced by electric motors in the year 1891. The length of line involved only amounts to about 4¾ miles, but numerous grades of 2·5 up to 4·8 per cent. require to be traversed. Comparing the costs of animal *versus* mechanical traction, the author obtains the following results :

	Horses.	Electric motors.
Number of car miles	472,200	499,652
	Working expenses in pence per car mile.	
Staff	1·4288	1·3424
General charges	·3088	·3632
Maintenance, etc., of line and fixed plant	·0512	·0656
Maintenance of rolling-stock	·1232	·2144
Horses and harness	1·5552	—
Motive power	—	·4704
Total	3·4672	2·4560

In the first case, the receipts per car mile were only 3·3d., leaving a debit balance to show that the lines were worked at a loss by horse traction, but since the introduction of electric motor cars the receipts have gone up to considerably over 4d. per car mile, thus proving the change to be extremely profitable. The cars used at Halle weigh about six tons empty, and have a seating capacity for 34 passengers.

At Marseilles the total cost of working ranges from 4d. to 4½d. per car mile. The rolling-stock consists of cars weighing about 6½ tons empty, with seats for 50 persons each. The Milan tramway is worked at about 4½d. per car mile; whilst at Dresden, where the line is tolerably level throughout, and where current is obtained from the central electricity works, the cost is only about 3·12d. per per car mile for small cars containing 28 or 30 individuals. On the Liverpool Overhead Railway it is stated to vary from 3·36d. to 3·84d. per car mile, each car holding 56 persons.

None of these rates, it will be understood, include an allowance for amortisation or sinking fund. The usual cost of working ranges between 4d. and 5d. per car mile, including maintenance, etc., of the generating station, the line, motors and cars, drivers' and conductors' wages, etc. Provision for a sinking fund would add at least 1·3d. per car mile to this total, allowing 10 per cent. for the fixed plant and car equipments on a total outlay of £1,200 to £1,400 per car on line with an annual service of, say, 30,000 car miles, and 5 per cent. on the overhead line equipment with an annual mileage of 100,000 per mile of line. The entire question of amortisation, however, can hardly be settled as yet, the experience of electric tramway authorities in Europe being still too limited to enable a satisfactory conclusion to be drawn.

The author then follows with a similar treatment of electric accumulator traction, but in view of the admittedly imperfect condition of secondary batteries for tramway use it seems hardly necessary to deal with the matter at serious length. We may, however, do so when occasion allows, in order to bring the matter up to date and arrive at some useful results.

SOUTHPORT ELECTRICITY WORKS.

The opening of the municipal electricity works, which we described in our last issue, was celebrated by a luncheon given at the Town Hall. Subsequently a visit was paid to the works at Crowlands for the purpose of putting the machinery in motion. The Mayor and Mayoress were accompanied in carriages by a number of ladies and gentlemen present at the luncheon. There were also present, among others, at the works, Mr. A. Siemens (Messrs. Siemens and Co., London), Dr. Hopkinson (Messrs. Mather and Platt, Manchester), Mr. J. B. Atherton (British Insulated Wire Company, Prescot), Mr. Hesketh (electrical engineer, Blackpool), and others. The works were designed by Mr. G. Wilkinson, M.I.E.E., electrical engineer to the Corporation, who, however, had to resign through failing health, and his place was taken by Mr. Arthur Ellis, M.I.E.E., by whom the work has now been brought to a successful issue. Both these gentlemen were present at the ceremony.

The **Mayor**, standing in front of the switchboard, said they were met to start the machinery in the Southport electrical works. Electricity was becoming more and more sought after, and was becoming more and more useful. It was used for house-lighting, street-lighting, and illuminations; it was used for cooking by the Queen at Osborne, and in other places; it was used for motive purposes, and for medical and dental purposes.

Alderman Hacking said that two years had been spent over that work, and although it might seem a long time, if they looked they would find other towns in pretty much the same position as Southport. When an electric installation was decided upon two years ago very few of the members of the committee knew anything at all about the matter; they had to grope their way, but now the work to be done by the committee would be very much easier. They appointed an electrical engineer, Mr. Wilkinson, and the plan they had carried out was his plan, except that the committee decided on one high-tension cable, where Mr. Wilkinson recommended two, so that one might be ready for use if any accident happened to the other. They had started with an expenditure of £13,000; that was not a large sum when they considered the miles of cable laid, the size of the buildings boilers, engines, and dynamos, and he wished to say that in every particular the contractors had given the utmost satisfaction, while the work of their own men had been most praiseworthy. The installation plant gave an equivalent of 4,200 8-c.p. lamps, though the cables and boilers were sufficient for a production of twice the present quantity. They had applications from private customers for 3,586 lights, and 1,445 for the Municipal Buildings, making 5,031 in all, so that it would be necessary for them to get more engines and more power very soon. As for street-lighting, the committee would be quite ready to take up that question if the ratepayers, after reckoning the cost, desired it.

Councillor Hesford supported Alderman Hacking's remarks as to the excellence of the work which had been done by the contractors and the Corporation electrical engineer.

The **Mayor** said it was greatly to be regretted that Mr. Wilkinson had to retire from ill-health, and their thanks were due to Mr. Ellis for his exertions to get the installation ready that day.

Dr. Hopkinson said it was very satisfactory to know that many of the Lancashire towns, although they had been rather slow in taking up the electric light, now possessed their own installations. There was an enormous scope for electricity in the future.

Mr. A. Siemens (London), speaking of the comparative cost of gas and electricity, said he had kept his accounts very carefully for five years, three with gas and two with electricity, and the total bill each year did not vary more than 10s. per light with gas at 3s. per 1,000ft., and electrical energy at 8d. per Board of Trade unit. The great point was to have the switch near the entrance to a room, and for the current to be turned on only when actually required.

Alderman Hacking then started the engines, after which the current was switched on to the mains, and the lamps lighted amid cheers. This over, the party returned to the Town Hall for tea.

A large concourse of people assembled to witness the turning on of the electric light in front of the Municipal Buildings. Punctual to the hour—six o'clock—the Mayor, wearing his robes of office, escorted the Mayoress from the mayor's parlour to the Town Hall steps, the members of the Council and others following. They were cordially greeted by the crowd.

Alderman Hacking (the chairman of the Gas Committee) briefly introduced

His Worship, who, pointing to the switchboard before him, said that there were six handles there with which to turn on the electric light. He would first turn on the two arc lights in front of the Town Hall. Having done so, he then turned on the lights on the front of the Town Hall.

The illumination of the front of the Municipal Buildings was on a scale commensurate with the importance of the occasion. As to the number of lights in use, there were 350 16-c.p. lamps on the front of the Cambridge Hall, 250 on the front of the Town Hall, and 450 scattered over the fountains and grounds. On the Town Hall there was a line of lights on the level of the first storey, with a double line on the balcony over the entrance, while on the top of the building were two lines. On the Town Hall steps were two 500-c.p. lamps. Seeing that only nine days had been allowed for this work, it was carried out with dispatch. The contract was in the hands of Messrs. Calvert and Co., of 24, Exchange-buildings, Manchester, and the execution of the work was supervised by Mr. Chas. Alcock.

In the Town Hall the work was practically completed in the Council-chamber, the mayor's parlour, the town clerk's offices, the main staircase, the committee-rooms, and the large hall. In the Council-chamber there are 48 16-c.p. lamps fitted in the gas pendants; in the mayor's parlour are 12 ornamental cord pendants; in the town clerk's office there are five lights on one pendant; and in the deputy town clerk's office one three-light electrolier and two cord pendants. The offices throughout will be fitted with the electric light, mostly by means of cord pendants. In the large hall of the Cambridge Hall, suspended from the centre line of the ceiling, there are seven electroliers, each furnished with 12 16-c.p. lights. In addition, there are five cord pendants of 16-c.p. under the gallery, and eight of similar capacity under the balcony—four on each side. The work in the Town Hall and in the Cambridge Hall has been carried out by Mr. Albert Maund, electrical engineer, of 9, St. James's-street, Southport.

The Explosion in Cannon-street.—Referring to the recen explosion in Cannon-street, Alderman Bell, chairman of the City Sewers Committee, at a meeting of the City Corporation yesterday, stated that the accident was caused by the confusion of two high-pressure cables at Bankside, in consequence of which a current was unintentionally put on to a cable which was touching the ground.

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HALF TRUTHS.

The *Evening Standard* of Tuesday last had the following leaderette:

"It has been predicted that the development of electricity must in the end transfer manufactures from the plains where they have always flourished hitherto to mountain districts which at present are occupied by sheep and game. The demonstration appeared to be sound. Machinery driven by steam—that is, by coal—never can compete with machinery driven by electricity, if the latter be generated by water power. The cheapest water power is mountain streams. Therefore in the coming time a bold and enterprising manufacturer will set up works on Snowdon or Ben Nevis, or some such lonely eminence, and undersell his comrades at Manchester or Birmingham. They will be compelled to do likewise, and the great seats of industry at present must become a heap of ruins singularly unpicturesque. It was pointed out that the revolution has already began in Switzerland. This uncomfortable forecast seems to be disconcerted by the announcement that they are using artesian wells in Dakota to generate electricity with great success. Artesian wells can be sunk anywhere almost in the lowlands of this country. The expense may be considerable, but compared with the sum needed for transferring a large business to any mountain district it is a trifle. But then, again, if you sink a number of wells in a narrow space they are apt to drain one another. Let us hope all will come right somehow."

There is in this leaderette about as much misinformation as could well be compressed into the space, and yet there is underlying the whole a substratum of truth which makes the publication the more dangerous. Never has the political Press done more damage to an industry than it has to electricity Not because of the desire to do damage; far from it, the desire is just the opposite: but those who write are absolutely ignorant of the subject upon which they write. Anxious to please, the writers in these papers make famous, men who have few or no pretensions to originality, but are possessed of much push and cheek, while the real workers are left without a word of encouragement. What a pity it is that papers of the standing and the circulation of the *Standard* do not promote a specialist to advise on these matters.

Unless memory is wrong, the *Standard* has more than once or twice, or twenty times, called attention to the handicapping of various English industries because of "cost of carriage." Did it not strike the writer of the above leaderette that something besides the generation of power cheaply had an influence upon the question of profitable manufacture. There is a well-known axiom that threatened men live long, and applying this to the threats towards Manchester and Birmingham, it is just possible that the time of the heap of ruins is further off than the *Standard* writer imagines. Just fancy the cost of getting raw cotton to the top of Snowdon, and the cost of distribution of the manufactured article subsequently, and then ask the question whether it conduces to economy to put a

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factory on Snowdon because of a natural waterfall to supply power. Balance gains against losses, and you will find Manchester and coal winning easily. No, wise writer, the substratum of truth underlying your incorrect statement is the question whether it would pay to generate energy at the natural waterfall and transmit it to such distances as it could be economically used in factories. Norway, Sweden, and Switzerland are not going to become very keen competitors of Manchester unless other factors besides natural waterfalls are favourable.

Similar reasoning may be applied to artesian wells. It may in some cases, generally depending upon geological questions, be possible to utilise the flow of water in artesian wells, but because the geological formation conduces to this in Dakota it does not follow that similar conditions exist in "the lowlands of this country."

The difference between Mark Twain's jumping frog and the *Standard* writer is that the former has too much ballast while the latter is without any. Again we observe what a pity that influential papers should promulgate such utter nonsense.

CONSISTENCY.

Here are samples of the bantam's crow:

Lightning on Folkestone Electric Lighting in the Past:

August 10, 1893.—"A Mr. Mark Parker has been called in to give a report on the electric lighting of Folkestone, and he reckons that £70,000 or £80,000 will have to be expended. I should fancy that Folkestone could make a very good start with £15,000 or £20,000."

August 17, 1893.—"Since I wrote last week I have had the advantage of the perusal of Mr. Mark Parker's report—a very voluminous document. I am glad to see that he freely quotes from these pages, though I feel he would be treating his employers with greater courtesy if he had acknowledged the source of his information. In some parts of the report whole pages are copied from *Lightning* without a single word of acknowledgment. . . . Altogether, I pity the poor unfortunate member of the Electric Lighting Committee who is forced to wade through this Folkestone document. As might be expected from such an inexperienced hand, the latest system of alternating-current distribution is not mentioned."

August 24, 1893.—"The Electric Lighting Committee met on Tuesday to consider Mr. Parker's report; but it is really such a ponderous tome that no one cared to tackle it, and the meeting was adjourned in order that the committee might go into a month's training. . . . I do not know who this Mr. Mark Parker may be that has come out of the *ewigkeit* to compile a treatise on electric lighting for the Town Council, but if the names of Mr. W. H. Preece, Prof. Kennedy, Dr. John Hopkinson, and Mr. Robert Hammond are known to that gentleman, he will be interested to hear that in not one of the schemes recommended by them during this year has the initial cost exceeded £25,000. (*Vide* Kingston, York, Stafford, and Newport.) I should advise the Electric Lighting Committee to make an independent tour of inspection."

Lightning on Folkestone Electric Lighting last week (Nov. 9, 1894):

"Mr. Medhurst is evidently unaware of the fact that when he was at school Mr. Mark Parker was a hard-working electrical engineer, and though when business did not look bright he took up photography as a business, he was simply following in the footsteps of that eminent electrical engineer Mr. J. W. Swan."

THEORY OF TWO AND THREE PHASE MOTORS.

This subject was discussed by Lieut. Samuel Reber at a recent meeting of the American Institute of Electrical Engineers. The author, without attempting a complete mathematical solution, gives an approximate solution in which the change of magnetic properties of the iron and magnetic leakage are neglected, the coefficients of self-induction considered constant, while the mutual induction between the armature and field circuits follows a sine law, and the field is supposed to be without projecting pole-pieces.

The conclusions reached by the author are that the two and three phase motors have in general the same properties, and that the most important relation is that of R to f L; where R is the resistance of the armature; $f = 2\pi$ times the complete periods of armature circuit; and L equals the coefficient of self-induction of one armature circuit. The lower the field armature resistance is, the higher the efficiency of the armature, and the nearer to synchronism is the point of maximum torque. Hence high efficiency motors require a starting resistance, and in such motors the torque can be readily regulated by adjustment of the armature resistance, and we are enabled to throw the point of maximum torque at any speed we desire. It is likewise apparent that the smaller the magnetic leakage the more efficient the motor.

If the frequency is supposed to vary, the speed and output are greatly changed. Increasing the frequency n times in a motor without a condenser, the velocity will be increased n times, the maximum torque is not affected, while the hysteresis is increased n times nearly, the output of the motor will be increased nearly n times if the motor is run at a given percentage of the maximum torque. Hence it is an advantage to increase the frequency till the hysteresis heating becomes too great, or the motor runs too fast. If the efficiency is to be kept constant, the work will then vary as n^2 and the field and armature currents will be increased $\sqrt{n}$ times. Hence, increase in speed gives an advantage in output till the machine begins to overheat. With a condenser the same facts hold, but with this advantage—that an increase in the frequency greatly reduces the size of condenser necessary. A high-frequency motor will weigh less than a low-frequency one. When the clearance is large, the advantage of high-frequency motors is not so decided, and if very large the low-frequency motors are better if weight is no consideration. The higher-frequency motor will contain less iron and more copper. If we vary the size of the motor, keeping the magnetisation constant, output and hysteresis vary directly as the weight, and the heating of the field and armature circuits, directly as the increase of size.

THE SURPLUS AND DEFICIT THEORY OF ELECTRICITY.

BY W. PERREN MAYCOCK, M.I.E.E.

(Continued from page 525.)

ERRATA.

Oct. 26, page 487, 1st col., line 7, for *fitted* read *filled*.
" " line 26, for G_4 *to* G_3 read G_3 *to* G_4.
" " line 27, for G_4 read G_3.
" " line 28, for G_3 read G_4.
Nov. 2, page 525, 1st col., line 19, for *unchanged* read *uncharged*.
" 2nd col., line 2, for *left* read *right*.

(*j*) *The Action of an Influence Machine, Battery, Direct Current Dynamo, and Alternator.*—It should be remembered that all so-called generators of electricity do not generate electricity at all, their function being to displace it, thus causing a difference of electrical pressure or potential. They are therefore more correctly described as generators of E.M.F.—*i.e.*, a force disturbing, or tending to disturb the even distribution of electricity. In Fig. 9 is represented an influence machine, T+ and T− being its terminals, and C C′ condensers or Leyden jars connected therewith. The inner coatings of C and C′ may be looked upon as part and parcel of the conductors forming the terminals or poles of the machine, brought specially near an earth-connected conductor—*i.e.*, the outer

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coating of either condenser—thereby greatly increasing the capacity of the terminals. When the machine is worked it may be looked upon as a kind of electric pump, pumping the electricity from the negative terminal, T−, through the machine, and heaping it up on the positive terminal, T+. A difference of potential is consequently gradually created between T+ and T−, and when this becomes sufficiently great, a spark will pass, the surplus on T+ jumping across to fill up the deficit on T−, and equilibrium will be restored. If the condensers be disconnected from the machine, the capacity of the terminals will be greatly decreased, and on working the machine a constant stream of thin sparks will pass from T+ to T−, the fact that there is a very short interval of time between each spark, and the thinness of the same, indicating that very little electricity is required to be displaced in order to give the required potential difference to cause a discharge across the air-gap—*i.e.*, that the capacity of the terminals is very small. When, however, the condensers are connected with the machine, sparks will only pass at intervals, and they will be much thicker

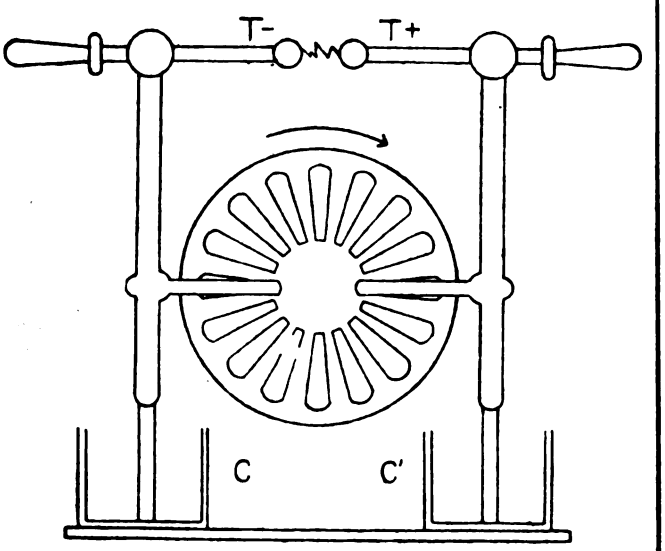

FIG. 9.

sparks, thus indicating that (provided the distance between the terminal knobs be not altered) the potential difference is the same, but the quantity of electricity displaced is much greater, owing to the increased capacity of T+ and T−. The turning of the machine generates an electromotive or "electro-pumping" force, which brings about the displacement of electricity. This electromotive force depends, roughly, on the number and size of the metal sectors, on the quality, thinness, and nearness of the glass discs, and on the rapidity with which they are rotated; and is quite independent of the capacity of the terminals. If the terminal knobs are too far apart, the heaped-up electricity on the + side will overflow, so to speak, and leak back across the plates of the machine, or over the edges of the condensers. The working of the old-fashioned "frictional machines" may be looked upon in the same light, except that their "electro-pumping" action was brought about by the passage of two dissimilar surfaces over each other, and not by influence. In most of these the terminals, or rather terminal (for one, the rubber, was generally connected with earth), was of absurdly small capacity, but this was in some cases slightly increased by adding to the surface of metal connected with the "prime conductor," as it was generally called, thus rendering the machine very cumbersome. In Winter's machine this increase of capacity was effected by placing on the "prime conductor" a metal ring nearly as large in diameter as the glass plate of the machine. This, in virtue of its shape, was supposed to possess superior capacity, whereas any metal body of equal area, such as a sphere, would have answered just as well, and occupied much less room. The capacity of such machines could be greatly increased by attaching the inner coating of a Leyden jar or condenser to the "prime conductor" or terminal, the outer coating, as well as the rubber of the machine, being connected with earth. A primary or secondary cell (or battery) may be looked upon as an electric pump, in which the electromotive or "electro-pumping" force is set up by the chemical action going on within the cell. A dynamo is also an electric pump, whose E.M.F. is due to the movement of conductors and magnetic lines of force across each other. A direct-current dynamo, like a battery, is a pump which works continuously in one direction. An alternator may be likened to a pump exerting its force first in one direction and then in the other, producing a rapid oscillation of electricity in the circuit, instead of a continuous flow in one direction. When a battery or direct-current dynamo is joined up in an incomplete circuit, it may be likened to an air-pump, P−, Fig. 2,* whose inlet and outlet are connected round by a pipe in which is a stopcock, S C; the whole being airtight, and filled with air at the normal pressure. If the stopcock be closed, working the pump will produce a difference of pressure on the two sides of the stopcock, the pressure being greater than the normal on the right-hand side, and less than the normal on the left-hand side; the difference of pressure (indicated in the figure by + and − signs) depending upon the "aeromotive force" of the pump. If the stopcock be opened, there will be a continuous flow of air round the circuit, the rate of flow depending on the "aeromotive force" of the pump, and on the internal diameter and shortness of the pipe circuit. When the battery (or dynamo) is on open circuit, Fig. 10—*i.e.*, when the switch, S (which corresponds with S C in the right-hand figure), is "off" and before the E.M.F. is allowed to act—we may consider that the wires and battery (or dynamo conductors) are imbued with electricity evenly distributed (section *a*). When the E.M.F. acts, the circuits still being open, there is a momentary passage of electricity through the battery (or dynamo), creating a potential difference between the two ends of the circuit; but as the E.M.F. of a battery or ordinary dynamo is only some hundred-thousandths that of an influence machine, there will be practically no spark or other discharge across the air-gap at the switch. When, however, the latter is closed, there will be a continuous flow of electricity round the circuit—the rate of which (in amperes) will be directly proportional to the E.M.F. of the battery or dynamo (in volts), and inversely proportional to the resistance of the circuit (in ohms). Ohm's law, or the law of direct-

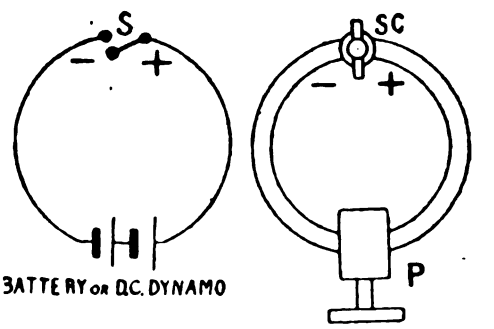

FIG. 10.

current flow in the electric circuit, is comparable with the law of flow of air in the pipe circuit.

(*k*) *The Condenser.*—A condenser may be defined as *a device for increasing the capacity of a conductor by placing it near another conductor connected with earth, or with the other terminal of the circuit containing the source of E.M.F.*

In Fig. 11 I., B is a battery of several cells, G a galvanometer suitable for indicating the passage of transient currents, and K a charge and discharge key. As was explained in the preceding paragraph, when K is depressed, we may suppose that the battery pumps a certain quantity of electricity from left to right until the P.D. between the ends of the circuit + and − is equal to the E.M.F. of the battery. The quantity of electricity that will pass under a given E.M.F. will be proportional to the capacity of the two ends of the circuit, and as this obviously is very small in the present case, the transient flow from left to right, and the return flow (when the key is released) from right to left, will be far too small to affect the galvanometer. The explanation of this return flow is as follows: the E.M.F. of the battery piles up electricity, so to speak, at the right-hand end of the circuit, leaving a deficit at the left-hand end. When the pumping force of the battery is cut out by releasing the key, a transient flow takes place from right to left until equilibrium is restored.

In Fig. 11 II., the two ends of the circuit are bent round so as almost to meet; this will have the effect of slightly increasing their capacity, and with the same E.M.F. there will be a greater transference of electricity before the P.D. between the ends of the circuit becomes equal to the battery E.M.F. The reason of this increased capacity is as follows: let us suppose a slight transference has taken place, there will then be a surplus at + and a deficit at −; the surplus will act influentially across the air-gap, and tend to increase the deficit, and conversely, the − end of the circuit will tend to draw more electricity into the + end. Although the flow to and fro, on depressing and releasing the key, will be greater than in the first case, it will still be far too small to affect the galvanometer.

In Fig. 11 III., the ends of the circuit are laid for some distance side by side. Their capacity will thus be considerably increased, and the transference of electricity greater than in the preceding case; yet even now, unless the galvanometer is

* See remarks on analogies in section (*b*).

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an extremely delicate one, and a great number of cells are used, the former may not be visibly affected. If, however, the two circuit ends be formed of a considerable length of silk-covered wire wound side by side on a bobbin,* a deflection of the galvanometer will possibly be obtained.

In the fourth case (Fig. 11 IV.) we connect the two ends of the circuit to two flat metal plates (shown edgewise in the figure), say, 2ft. square, brought close together with a sheet of paraffin waxed paper interposed to prevent actual contact. On depressing and releasing the key, equal but opposite deflections of the galvanometer will be obtained, showing that the quantity of electricity displaced by the battery is equal to that which returns when the key is released. The return flow may be accounted for thus: when the pumping force of the battery is removed, the piled up electricity at the + end will flow back until equilibrium is restored. The reason for the great increase of capacity is easy to understand: the greater the extent of surface forming the two ends of the circuit, and the nearer together these surfaces are brought, the greater will be the influential action which brings about the increase of capacity. The effect obtained with two opposing plates of ordinary dimensions is not nearly so great, of course, as would be the case were a telegraph condenser used, owing to the much larger extent of the opposed surfaces in the latter.

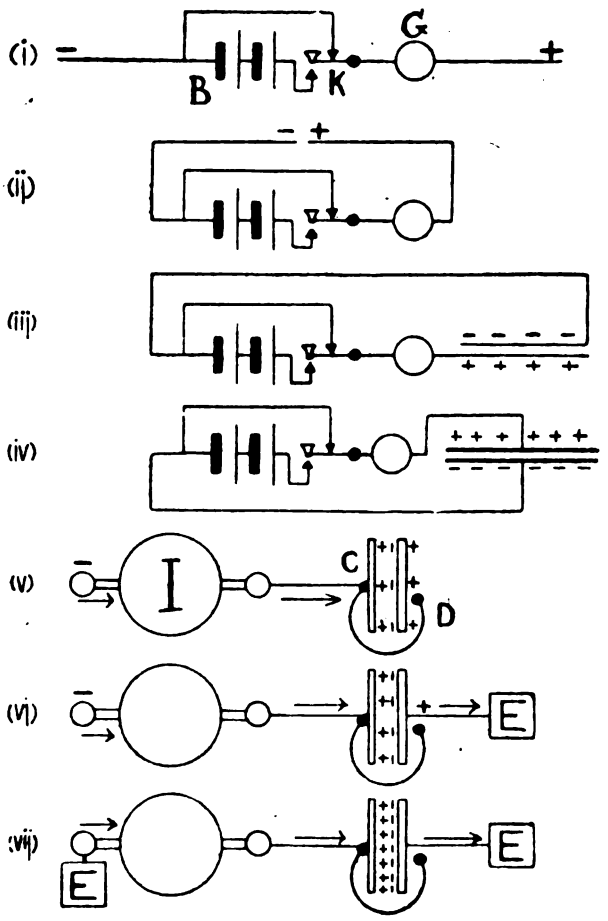

FIG. 11.

Referring to the definition of a condenser at the head of this article, we will now proceed to show that a condenser does not act as such if one coating (or set of coatings) be insulated; also that if the opposite coating be earth connected, and the other end of the circuit containing the source of E.M.F. be insulated, there is only a slight "condensing action." If, however, the other end of the E.M.F. circuit is connected with the opposite coating, either directly or through the earth, the action of the condenser will then be at its best. As a battery and galvanometer would not give any noticeable discharge to illustrate the first two of these cases, we shall employ (Figs. 11 V., 11 VI., and 11 VII.) an influence machine, I, a simple condenser, C, formed of tinfoil sheets on opposite sides of a thin sheet of glass, and discharging tongs, D.

In Fig. 11 V., I is the influence machine "pumping" from left to right: a deficit will consequently be created on the left-hand terminal, and a surplus on the left-hand coating of the condenser. This charge, acting across the dielectric, will influence a deficit on the inner side, and a surplus on the outer side of the right-hand coating. Now, to begin with, the two ends of the E.M.F. circuit are clearly the left-hand terminal of the machine, and the left-hand coating of the condenser: between these, therefore, will be the greatest P.D.

(To be continued.)

* The principle of Langdon-Davies's *phonopore*.

LIGHTING INSTALLATIONS *

BY H A. HENDERSON.

For the purpose of this paper installations may be divided into two classes, good and bad, but I shall divide the latter into two sub-classes—namely: (*a*) installations, which, although they may not be of the best, are still good enough to pass the usual examination nd test of the supply company's inspector; and (*b*) those which do not fulfil this condition. I have not much to say about Class I., except that this quality of installation depends upon three essentials—namely, good supervision, good labour, and good material.

To my mind, the most interesting objects for discussion are included in Class II., so I will at once pass on to these. As we saw that good installations depend upon three essentials, so we may say that any one of these being absent produces a result contained in either sub-class *a* or *b*. First, then, let us briefly touch upon supervision. This is a point upon which I cannot lay too much stress, and I fear it is only too often neglected by just the very class of contractors amongst whom one would expect to find it. The reason of this is not difficult to surmise. It is that the busy contractor cannot spare the time to devote to it that he ought, as he has many enquiries, and special technical work to attend to, which he is unable to trust to his juniors. The immediate effect is that the work being left perhaps under the control of incompetent men—and most of us know what the average wireman does under these circumstances—the installation falls into Class II., and this notwithstanding the fact that the best material may have been supplied. It is, perhaps, unnecessary for me to mention that under these conditions the weak point is, as a rule, bad joints. Bad joints in an installation are, perhaps, the most difficult faults to find out, as one cannot possibly in the course of an inspection pretend to critically examine every one. Generally, the outside appearance is good, and unless the joint be absolutely cut open its weak points are not discovered. There is an example before you of a joint which upon a superficial examination is very good, but it is in reality about as dangerous a combination of unskilled workmanship as one would wish to meet with.

First, we find only one point of contact between the conductors, and this probably rendered bad by the presence of rubber; thus we should be certain to get a heating effect owing to the high resistance. Then instead of stripping the braiding, or outer covering of the wire, back, and leaving the vulcanised rubber to form an insulator, the braiding is carefully bound in on to the conductor, and in case of general dampness would make a fairly easy path for the passage of the current to earth. I may mention that the examples of joints on the table are reproductions of actual ones that I have myself taken out of installations. I am bound, however, to state that these sort of specimens are not often met with now. Out of over 500 installations which I have inspected and tested within the last 18 months, only a small percentage were absolutely bad. I have found that the two most dangerous types of contractor to deal with are the plumbing-electric bell-fitter and the "freshman" at the technical school. Two instances of installations carried out respectively by a plumber and a student will suffice to show what I mean. In the first, one of some 18 or 20 lights, a superficial examination seemed satisfactory. That is, the mains and all easily accessible wires were apparently of good quality. The insulation resistance, however, was below 10 ohms, and a further investigation revealed the fact that ordinary bell-wire of a quality similar to the sample on the table had been used and bedded in new plaster without any casing, tubes, or protection whatever. It was necessary for me to actually dig out the wires before I could discover this. Needless to say, being a very low tender, the contractor lost his money and the confidence of his client.

The second example was a case where the best material had been used and everything done upon the most approved scientific lines, but upon turning on the current the lamps only came up dull red. The reason of this was that the number of lamps being even and on two-light electroliers, they were wired in pairs of two in series, "because," as the contractor informed me, "he could not get four wires down the tube of the fitting"!

Such cases as these are, however, I am happy to state, growing fewer day by day. Before I dismiss this portion of my subject I must just add a word or two upon the various systems of wiring premises. In Manchester we are perhaps more favourably situated than in any other town in England, as we have the alternative of wiring either on the three or five wire systems. The latter plan has been adopted with great success

* Paper read before the Northern Society of Electrical Engineers, November 12, 1894.

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in several installations here, notably the Town Hall, Royal Exchange, Free Trade Hall, and Reference Library, and the advantage both to the contractor and the consumer is considerable. In the case of the contractor it saves labour, and in the case of the consumer current. There are also many installations wired either on the three-wire system or on a modification of it, which are very satisfactory and show a considerable saving in copper. I am inclined to think, however, that in the majority of provincial towns the most improved system of wiring is not recognised. As an instance, I may state from statistics that over 50 per cent. of the installations in Manchester are wired upon the now almost obsolete "Tree system." That is, a pair of mains are run throughout the building and lights tapped on indiscriminately as they are required, without regard either to the carrying capacity of the leads or the proper protection of the branches by cut-outs. I have come across cases, for instance, where a branch of 18-gauge wire, to carry three lights, was tapped directly on to a pair of 20's. No doubt the second wireman who was instructed to put on the extra lights was conscientious to a certain extent, but not sufficiently so to pull out the existing tapping and run his 18's direct to the main.

Such proceedings as this do not conduce to the satisfactory adoption of the electric light by the general public, who—and this is a fact we should never lose sight of—are to a great extent ignorant of technical details, and are in the majority of cases entirely in the hands of their contractors. In my opinion the most satisfactory way of wiring is that which now commonly obtains in London, and has also been adopted by a few provincial contractors—namely, the distribution system—confining oneself as far as possible to five-ampere sub-circuits, each controlled by a double-pole fuse. The advantage of this to the consumer is considerable, as it allows extra lights to be attached without much extra cost, providing, of course, that the contractor has allowed for this in his mains. Unfortunately, however, it is hard to explain to the prospective consumer that the small additional cost at the outset will probably be of advantage to him later, for a large proportion of the British public are inclined to accept the lowest tender, their object being to put in the light for the present without regard to the future. As to prices at which work is obtained, it would, of course, be invidious on my part to mention any figures, but when one sees, as I have done, variations of as much as 300 per cent. in tenders to specification, one cannot help feeling that there is something wrong somewhere. Of course it may be argued that certain contractors can buy material in a cheaper market than others, but I fear that this is not altogether a satisfactory explanation. One is rather led to the opinion that perhaps low quotations are a bait to catch work by contractors who are not already sufficiently established. There is at present going on in our papers a discussion as to whether certain manufacturers should be contractors. I think with regard to cable manufacturers, that perhaps it is somewhat unfair for them to compete with their clients, as friction is sure to be caused by such a proceeding. The manufacturers of fittings perhaps come under a different aspect, as a contractor is frequently asked for a special design or form of fitting, which, if he is himself a manufacturer, he can supply at short notice and comparatively moderate cost, whereas if he has to go to an outside firm, unless he is in a position to order a quantity, such firm will naturally charge him a high price, and the delay in delivery may be considerable. As far as regards cables and wire, the quality is fixed, and one is obliged to employ the particular form and size which is required.

The employment of efficient labour is of very great importance, and this brings me to the second essential. I may say that I have had a large and varied experience of the so-called wireman, and a very interesting and curious study I have found him. I suppose there are black sheep in every fold, but I am sure that the wireman's fold is particularly well supplied with the article. One finds among them individuals who seem to be given up to almost every form of vice from which they should be free. It is evident that the employment of these specimens of humanity is sure to result in trouble, yet sometimes the unfortunate contractor has no alternative. In the busy season one is often only too glad to get hold of a man who knows the difference between a double pole cut-out and a main switch, and your average wireman lets you know that he recognises this by demanding high wages or assuming an independent attitude. Perhaps I may be pardoned for suggesting that a paper on the subject of improving the condition of the electrical labour market would be of great interest, at any rate to a majority of our members.

I will now pass on to the third essential, the use of good material, and I fear that in these days of cheap continental rubbish this important point is often neglected. There are at the present time continental firms who may be said to run English contractors—that is to say, they get hold of a contractor who is short of capital and finance him by supplying him with inferior material, mainly fittings, at a low price. It is a matter for regret that such practices obtain, but I suppose they cannot be improved except by strict supervision on the part of the supply companies' installation inspector, and even then only to a limited extent, as there are loopholes in clients who instal their own plant, and who are thus independent of this source of criticism. Fittings are a very important factor in keeping up the quality of an installation and one which I fear many supply inspectors neglect. Often the inspector places too much confidence in his insulation test, or in the quality of the insulating material of wires and cables without stopping to see if lamp-holders or switches are defective, or proper cut-outs put in where they should be. Either of these points if neglected is a source of great annoyance, or may be danger, to the consumer, and allow inferior contractors to obtain jobs at low prices.

Then again, as I have before mentioned, prospective consumers often make a great mistake in accepting a very low tender on the supposition that it is economical to save a few pounds at first. The remedy for this lies in the employment of a consulting engineer. But I fear that even consulting engineers are not altogether free from partiality. When one sees in a specification, for instance, a certain make of switch mentioned one cannot get away from the feeling that perhaps there is more in it than the mere fact that the particular make of switch is efficient. However, consulting engineers have a great power in controlling the abuses of the trade, and one which I am sure we should all be glad to see more universally used. I fear that perhaps I have dwelt at too great length on some points which may seem trivial, while only briefly touching upon others which have an important significance, but if it should be thought that any portion of my paper is worthy of discussion I feel sure that many of our members would take a lively interest in it, and probably do more justice to this very interesting subject than I have done.

NOTES ON ELECTRIC TRAMWAYS IN THE UNITED STATES AND CANADA.*

BY H. D. WILKINSON, MEMBER.

In the paper communicated to this Institution, I have endeavoured to lay before you some notes on the working of electric tramways on the continent of America. I have not gone so much into descriptions of material and plant as into those questions which I heard constantly being discussed with reference to the return circuit of electric tramway systems, and the marked electrolytic action in some cities on underground pipes and cables. While the single-trolley system is almost entirely universal, I took pains to find out such details of the double-trolley system in Cincinnati, and the underground conduit in Chicago and Washington, as I judged would interest the members of this Institution, not only on account of their using an insulated return, but also on account of possible practical utility in their mode of working. For the details of these systems I must refer you to the original paper; but in order that the points put forward on the various systems may be made clear, I have had some diagrams prepared which show the general scheme of each. Considering first the predominating single-trolley overhead system—the mileage of which to-day in the United States and Canada exceeds that of all the steam, cable, and horse traction systems put together by 50 per cent., and to which, owing to its exceedingly adaptable and flexible character, the enormous development of electric traction in those countries has been due—we have the current supplied to the cars through the medium of a bare copper wire stretched centrally over the rails of the track at a height of about 19ft. from the ground. The current is collected from this wire by means of a thin steel tube and trolley wheel mounted on the roof of the car, the wheel running on the under side of the wire, and being kept up to the same by springs on the tube. The current is conveyed by an insulated wire to the controlling and reversing switches and fuse to the motors, a lightning arrester also being in circuit. The overhead trolley wire is divided into sections of one-quarter or half a mile in length, insulated from each other, and supplied with current from the power station by separate insulated feeders. As each section is independently supplied, it follows that the size of the trolley wire does not depend on the length of line, but simply on the length and average load per section, and is therefore uniform in size throughout, and generally about ⅓in. in diameter. On this system the current passes from the electric motors to the iron frame of the car, and thence by the wheels to the rails and earth. As the earth presents an almost infinite mass compared with the rails, it was assumed in the first instance that a return of least resistance would be secured by well earthing the negative poles of the dynamos. The coal bill, however, stimulated enquiry into the losses in transmission of electric energy. On many lines of five to ten miles the voltage at the most distant section between trolley wire and rails was only 50 per cent. of that generated at the station.

* Supplementary paper read before the Institution of Electrical Engineers, November 8, 1894.

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Some improvement was made by sinking deeper earths into moist soil and connecting the same to more points on the rails. But at the best this was unreliable and variable, and it was noticed that improvement was more marked when attention was turned to the rails themselves as the best return conductor. High-resistance fishplate joints were bridged over by iron and then by copper wires, and the rails at their nearest point of approach to the power station were connected by overhead return cables to the dynamos, thus affording a reliable metallic return, while at the same time the earth formed part of the circuit. The first stage—namely, that described—is bonded rails and return cables.

In the second stage we have the rails connected at intervals to water and gas pipes; this step creating, from the traction companies' point of view, a most satisfactory rise of potential on the line, and improvement in speed of cars at the distant points on their system, but also raising the potential of the pipes above that of the earth, and bringing into existence electrolytic pitting and corrosion, followed by leakage and danger, and producing, as the secretary of the gas company in Washington described to me, a feeling akin to sitting on the top of a volcano. The electrolytic consequences ensuing on this method of "helping out" the return circuit led to a reconsideration of the matter. It was found impracticable to root out all such connections, or to provide such inspection as should prevent its recurrence, but the action was mitigated by clamping copper bands round the pipes at affected points, the same being connected to cables leading directly to the negative collecting bars in the power station. All this pointed to the advantage of a metallic return, and led to the use of a supplementary wire. This consisted of a bare copper rod, wire, or cable laid on the sleepers between the rails throughout their entire length, connected by twisted and soldered wires to the rails on each side of the fishplates, and cross-connected to a similar wire in the adjoining track every 30 yards. But on all lines which I have seen being laid in this manner the wires have been uniform in section throughout (about $\frac{3}{8}$in. diameter for the central wire, with smaller wires to bridge the rail joints), instead of increasing in section as they approach the power station in proportion to the increased volume of current. Unless proportioned to admit of constant density of current, I fail to see that this attains the desired end. The appreciation of this fact led to the adoption in Cleveland by Mr. Charles W. Wason of return feeders connected to the rails every 500ft. The feeders were increased in section and number as the lines neared the generating station, and added to from time to time to meet increased traffic. Other engineers whom I met were considering the adoption of such return feeders on their lines as a means of improving their efficiency of transmission.

Through all the stages thus far the idea has been retained that the negative poles of the dynamos must be connected directly to earth at the power station. Doubtless, if there are no return feeders and poor rail bonds, or if the return feeders are of insufficient section to carry the current ousted from rails so bonded, a portion of the current will take to the earth and metallic bodies within it on its way back to the generators; but, although it will cost a little more, I think we can afford to dispense entirely with the alternative earth path, and should do without it. The safety of buried pipes and cables would thus be assured, and the efficiency of transmission increased. It may be urged that the rails are perforce in contact with earth, and therefore the alternative earth path is always present. The answer to that is, let the negative poles of the dynamos be connected to the rails direct by insulated cables, but not to earth at the station, and the current will then be kept within the rails and return feeders. The only chance for current to pass to earth would be as a shunt round bond joints of high resistance or insufficient conductivity; and should this occur, it will only cause electrolytic corrosion at such joints, and not on underground pipes and cables.

Having arrived at this point, I now divide the exclusively metallic return so obtained under two heads—viz., feeders and rails. If we put return feeders to every half mile of rails, as we put them to every half-mile section of trolley wire, the bonds become of lesser importance—that is, firstly, they need only be of section sufficient to take the maximum current per section; and, secondly, they will be of uniform sectional area throughout. All the return current is then collected by the feeders and returned to the generators direct. Each feeder collects or drains off the return current for a certain distance on each side of its point of attachment to the rails, and when current is collected in this manner at several centres along the route, it cannot all rush to one spot, near the power station, where the density is not only seriously increased, but voltage and power are wasted. But if we do without return feeders altogether, then the current is returned entirely by the rails, and the bonds are of great importance. Since the original paper was communicated, rail bonding has been much improved, and I believe we can thoroughly rely upon these joints as permanent connections. Adequate area of contact with the rail, and that of a permanent character, are the main points. I have taken exception to the supplementary wire; but if increased in section, say, every quarter of a mile, as it approaches the power station, it would do nearly as well as insulated feeders, provided the connections from the rails to the generators were made at the nearest point to the power station by insulated cables. On lines where the route rounded curves or loops it would not do as well, because the current might find a short cut across corners if the earth favoured. By this method, also, current would be "bunched" at one point, instead of being collected and returned at intervals by feeders.

I now come to the double-trolley overhead system. In the original paper I have given an account of my visit to Cincinnati, Ohio, where this system is in operation. I went there to look into the system with an open mind and ascertain whether there were any adequate advantages to be gained for the use on one track of two overhead wires and two trolleys instead of one. The idea and the principle were, of course, complete insulation from earth. I need not repeat here what I have already reported as having seen in Cincinnati, but I may summarise by saying that I found one of the trolley wires in connection with earth, although not in direct connection. I could light the lamps in a single-trolley car by changing the trolley wheel on to one of the double-trolley wires which ran over the same track. However, no direct path for the return current through the earth would be offered by one wire being earthed, because there was (as there must be with this system) a complete return circuit of insulated feeders from the sections of negative trolley wire to the generators in a similar manner to that on the positive side. In other words, the return circuit was a complete duplication of the outgoing circuit, and the dynamos delivered their current outwards by insulated feeders, and received it back by insulated feeders of equal capacity. Any connection of either trolley wire to earth, therefore, could not cause a flow of current directly from the rails to the generators, since the latter were not in connection with earth at the power station. That this fact was an advantage, in view of electrolytic troubles resulting from return currents through earth, I could not doubt; but, notwithstanding the mechanical and commercial success of the double trolley in this city, I could not but reflect that, if we are to have overhead wires at all, one is better than two, and there might be other ways of effecting the same object. This led me to look at the single-trolley system again, and to ask myself the question, "Would not the same immunity from return earth currents be secured if, instead of earthing the generators and favouring an earth path, the return current should be collected direct from the rails by insulated feeders in communication with the negative side of the generators?" I am convinced that it would, and that the gaining of such immunity by insulated return feeders, connected at half-mile intervals to the rails on a single-trolley system, quite compensates for the extra cost. Thus I am led back to the same conditions as in the fifth stage, and this conclusion strengthens the position of the single trolley, while, so far as any superior advantage is to be gained, it disposes of the double trolley. At the same time, I am bound to admit that notwithstanding the increased amount of overhead work, and the extra insulation required at points and crossings, no serious mechanical difficulty presents itself in the double trolley, and the Board of Affairs of that city have acknowledged its practicability and success in authorising considerable extensions. To the gentlemen connected with both systems in Cincinnati, who courteously gave me opportunities of making observations on any part of their systems, and whose names I have mentioned in the original paper, I expressed at the time, after visiting the power stations and travelling over 10 miles in double and single trolley cars in the city and suburbs, my gratification in finding the double trolley work so well; but a somewhat over-zealous though well-meaning reporter put as one of the head lines of an article on my enquiry into that system, that "London will copy." I should be very sorry to disappoint that gentleman or his readers in their good wishes for our metropolis, but I have advanced points whick I think show that simpler systems can be made equally advantageous.

In the three-wire system two 500-volt generators are connected in series, the middle wire being to earth and the free positive and negative terminals connected to the feeders radiating from the station. The single overhead trolley wire is used, divided, as usual, into sections insulated from one another, so that the outside line work is precisely the same as in the two-wire system. Instead, however, of these sections being all of positive potential, they are connected alternately to the positive and negative feeders. Thus only a small part of the total current used in propelling the cars returns by the rails or earth to the station, and that only when the load is not balanced on the different sections of opposite potential. For this reason, I heard that the system was to be tried in districts affected by pipe corrosion on some of the great lines in Massachusetts, but with what result I have not heard. There is, however, a line in successful operation at Portland, Oregon, which I have not seen; but am pleased to say that the authors of the next paper, Mr. R. W. Blackwell and Mr. Philip Dawson, can give us details of the practical working of this system, gathered on the spot. I have also laid before

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you some notes on the conduit or slotted-rail system, which has been working successfully for some time in Chicago and Washington, D.C., as I judged that the members of this Institution should be put in possession of such information as could be obtained on the spot. To avoid repetition, I must refer you to the original paper for details of this system. In the conduit there are two rigid copper rods supported from above at intervals on insulating blocks and gunmetal clips. The rods were in the first instance stretched continuously, but were afterwards divided into sections, with sleeves and springs to take up for expansion. I went up and down the line on the cars, which worked smoothly and perfectly; and by entering a manhole got my head in the conduit, so that I could watch the running of the trolley wheels as the cars went by. The sparking was inappreciable, and the system worked perfectly. The mechanical details at points and curves were well worked out. I have seen other conduit systems on paper, and there are probably several that would work equally well if given so fair a trial as that in Washington; but I have not thought it worth while to bring any system before a body of practical men, capable of designing as good systems as any others at present on paper, without having seen it myself in actual successful work; and the system described has certainly gained public and administrative confidence, and I believe has sound commercial prospects of further expansion. I was very pleased to see Messrs. Siemens's defence of the Budapest conduit line, which is both exhaustive and timely. Somehow or other, an impression has prevailed that a 1¼in. slot is inseparable from an electric system; whereas the case at Budapest was that advantage was taken of the wheel flange slot already existing, and this was necessarily somewhat wide. There is no difficulty in making the slot ⅝in., and bedding the insulated wires of the collector in an ½in. steel carrier. The conduit and slot in the centre of the track, however, is the most satisfactory, as it is not subjected to any continuous wear from the travel of the cars. Of the two systems of electric street tramways, the single trolley is most suitable for outlying districts and the conduit for towns. Although necessarily moving slower in town streets on account of the traffic, and therefore not showing all their good points, it must not be overlooked that electric cars have tractive power to tackle ascents of 1 in 10; and the running expenses per car mile are cheaper than by horses. The approximate total cost of buildings, machinery, and rolling-stock is the same in both the trolley and conduit systems, and amounts to from £1,200 to £1,500 per motor car. The overhead work and poles with single trolley costs about £2,300 per mile of double track, including permanent way, and the conduit system about £4,000 per mile of single track. Cost of rolling-stock and permanent way would, of course, be materially reduced for smaller gauges than 4ft. 8½in. The feeders, both main and return, should be underground, at any rate within town limits, after which there is not much objection to their being carried on the same poles as the trolley wire.

With the extensive experience gained in this country in underground conductors, a good drawing-in system, with spare ducts for adding to the feeders as traffic increased, could be laid in a thoroughly reliable manner, and not cost very much more than special overhead poles. We should then have the overhead trolley system without the great mass of heavy insulated feeder cables on tall poles so disfiguring in American cities. Let us bury our feeder cables and put up no span wires, and then all that is left is a set of light ornamental poles spaced 100ft. apart, with brackets supporting one single-trolley wire per track. Make them of lattice or ornamental scroll work, or make them of more massive ornamental cast iron, to receive, in addition, arc lamps for the lighting of the streets. But let us be assured that the overhead trolley is not so unsightly as many would have us imagine, and that it can be put up in an ornamental and unobtrusive manner. In Philadelphia the insulated feeders are in underground conduits, together with bare copper strips as returns, but I am not aware whether the dynamos are insulated at the power station, or insulated return cables led to the nearest point on the line in the manner I have described. The third-rail system is not generally applicable to any lines, except where built in an exclusive route of its own. The use of storage batteries I have not touched upon. There have been trials in America, but less experience gained than in England and the Continent. If the cost of depreciation and renewal, which is out of all proportion to that of the transmission systems, could be materially reduced, the self-contained battery system would claim attention for town and city traffic. Data on recently worked lines on this system would be welcomed from members who have had experience of such lines. American cars have no top seats, although the double-decked cars, as they are termed, are coming into use in a few places. We are lovers of fresh air, and except in the coldest weather in America, I have taken, in common with others of similar mind, the standing room on the driver's or conductor's platforms on American cars in preference to the inside. But we in England have somehow a strong inclination to get up higher, and we like to see around us from a position of vantage and freedom; and we cannot give up our top seats, no matter what other advantages are offered. Protection must therefore be afforded such passengers against any breakage of the trolley wire. Mr. Alfred Dickinson has met this in a very neat way, together with more important structural advantages, by putting his trolley wire on one side of the road. The matter could also be met by putting an awning over the top seats, as on the steam tramcars in Birmingham and elsewhere. With the conduit system, of course, top seats would need no such provision.

With regard to electric traction in the centre and outskirts of our own metropolis, while impossible in our already too crowded main thoroughfares, I am still of opinion that lines could be laid advantageously in our wider and less frequented thoroughfares, which would relieve the congestion of the narrower streets, and at the same time afford wide and attractive views, which would draw people by such a route by preference. For instance, let us say that one of our Westminster lights has been seeing a client in the City and is returning to Westminster—or perhaps it would be more dignified to say that a City client has an appointment with a Westminster luminary. He is, of course, pressed for time, and sooner than go by 'bus up crowded Fleet-street and the Strand, with an exasperating wait or change at Charing Cross, he will take a ticket at the Mansion House or Blackfriars and get himself put down at Westminster Bridge by the District Railway. But if someone informed him that electric cars ran every two minutes from Blackfriars to Westminster Bridge *vid* the Victoria Embankment, and would land him there in 10 minutes, I am very much mistaken if he would not take that route. At any rate, if nothing short of a cab would suit our City man on such a visit, I suspect that the route named would be much sought after and appreciated by the ordinary travelling public, and this noble thoroughfare would be made a scene of life and energy, and be an attraction to many who cannot spare the time to walk along it. I respectfully commend this to the notice of the London County Council as a scheme that might well be combined with that of the river frontage electric lighting, and be a work of great public utility. I only mention this in passing as an instance, but we have only to look around our outlying districts and see plenty of paying routes to our breathing spaces, open commons, parks, etc., where neither horses nor the railroad are practicable, where the ascents with heavy loads cannot be tackled by horseflesh, and railroads would mean cuttings and tunnels on the level; but the electric car can easily climb hills and take heavy loads of people to where they can get Nature's best tonics—long stretches of view and pure air. The termini of such lines could be situated with the greatest advantage at or near the suburban railway stations.

The points I have hitherto brought forward have been almost entirely confined to experience in the States, where, in fact, most experience has been gained; but in so far, at least, as administrative, industrial, and public opinion in this country may be influenced by what has been done on the New Continent, there is much to be said on the progress made by our compatriots in the Dominion of Canada. As in the States, the life is vigorous and expansive, but none the less in true accord with British instincts. The cities of Montreal and Toronto are well provided with electric tramways, and the citizens avail themselves of this means of transport in living out some distance in the suburbs. The streets of the city of Toronto are as well laid out and kept as those in our own metropolis, the roadways being asphalted, and the footways well flagged. The overhead trolley is everywhere in use and æsthetically does not intrude upon the general appearance of the city. In Montreal, I went over the new power station of the Montreal Street Railway Company, then being fitted up with engines and boilers of 3,600 h.p. The engines and dynamos were of Canadian manufacture, and the boilers were from England. This station was designed to meet the needs of the entire tramway system of the city after converting all the remaining horse cars into electric. The change meant an electric supply to something like 150 motor cars, with nearly as many trailers. The rails in these two cities are of the grooved girder type, imported from Great Britain, 72lb. to the yard, and laid, as in this country, directly on the concrete foundation of the roadway with tie-rods, but not sleepers. While scarcely coming under the head of ordinary road tramways, the electric line from Queenstown to Chippewa, Ontario, is of special interest. The line follows the western side of the Niagara Strait, near enough to the edge of the cliff to obtain magnificent views of the Falls and rapids, and was built by the Niagara Falls Park and River Railway Company on Government ground, rented at £2,000 per annum, with the object of developing tourist and excursion traffic. It was only opened in May, 1893, and in that summer 10,000 to 15,000 people travelled on the line per day, at fares ranging from 2½d. to 3s. The latter is the return fare covering 23 miles. The takings during July and August were £500 per day. Land in the vicinity fetched £40 an acre when the line was first constructed. After six months' working it fetched £100 per acre, and no doubt will continue to rise, as the company intend laying out a few good hotels, and the facility of locomotion promises the starting of good residential property on the heights, which have hitherto been unapproachable, except at rates particularly

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gratifying to cabmen. The line is of the most substantial character, laid as a steam railroad, with 56lb. rails, on sleepers, and ballasted. There were last year 24 motor cars, 10 of which were "observation cars," and 18 trailers. The observation cars weigh 20 tons loaded, and carry over 100 people easily. They are specially constructed with two rows of seats, fitted lengthways in the car, one above the other, and facing one way, so that everyone can get the view. The usual thing is to run one motor car and one trailer with over 150 people aboard. It was anticipated that there would be a fair amount of traffic in winter as soon as the ice bridge was formed below the Falls, as this is a great attraction. There was a foot of snow on the ground when I went over the line, but the travelling was most agreeable, as the cars were kept up to a comfortable temperature by electric heaters under the seats, supplied with current tapped off the circuit. Six of these heaters in a car, three on each side in multiple series, consumed two amperes at 500 volts, and would therefore cost less than 3d. an hour. The cars were well lighted by incandescent lamps, and the route was lighted by clusters of these lamps placed at the top of every alternate pole. I am much indebted to Mr. W. T. Jennings, C.E., of Toronto, who designed the line and power plant, for his courtesy in showing me over the line and affording me information for this paper. The power is derived mainly from the Falls, a head of 57ft. clear fall being utilised, which now supplies three wheels of 1,000 h.p. each, one being in reserve. To meet the heavy loads when climbing the Queenstown heights, up a grade of 1 in 20, it was found more economical to put a small additional power-house down at that terminus, with dynamos driven by steam power, than run two 37/15 or one 37/12 insulated feeders from the water-power station, a distance of nine miles, which would have cost at least £2,600. This fact is significant of economies to be effected in transmission, and seems, as far as long lines and heavy traffic are concerned, to point to a practical conclusion as regards the maximum power per station in street tramway power plant similar to that enunciated by Mr. Crompton with reference to electric lighting stations—namely, that there is a limit to the amount of power it is economical to supply from one point only. The cost of insulated feeders comes in as a considerable item in first cost on lengths above five miles, and the loss of voltage and energy in transmission of the current is a continuous one. I think it worth while to consider high-tension transmission by underground feeders and the use of motor transformers, or the direct use on ordinary lines of what the Americans call "boosters," or motor generators; or, again, the three-wire system, or the establishment of power stations situated, not as they are now—namely, in the centre, from which lines radiate outwards—but at the most distant points, and feeding towards a centre. The stations are situated in this manner in the city of Cleveland, Ohio, and through the courtesy of Mr. Wason I am pleased to be able to show you a day-load curve. The largest curve, which reaches 3,400 amperes at seven o'clock in the morning, is from the original station, and the curves below are of two new stations feeding into the same network, and which together add another 2,400 amperes at the same hour. The curve was that for the day previous to my visit, when the ground was covered with frozen snow and the temperature was 9deg. of frost. Of the total current, about 600 amperes is used to drive motors in shops and factories.

I have specially made mention of the Canadian line at the Falls on account of four points which are deserving of notice and reflection. The first I have already touched upon—namely, the cultivation of tourist and excursion traffic along a route where attractive views and fresh air can be obtained. The second point is that the termini are in close proximity to two main lines of railway—namely, the Michigan Central and the Grand Trunk—which not only increases the tourist traffic, but creates a traffic of its own independent of scenery, but with the scenery thrown in. The third point is that the line passes near an agricultural and fruit-growing district, and special freight cars have been added for conveyance of these crops to the railways at rates lower than could formerly be obtained, and at the same time profitable to the tramway company. And, fourthly, the line forms part of a through connection between the two large cities of Toronto, on the north, and Buffalo, on the south, by steamboat connection at the termini of the line. The line has already been described to you by Mr. W. H. Preece, C.B., in his paper at the beginning of last session, in a more fascinating way than I can hope to bring it before you. When Mr. Preece first enlivened us by his presence at the Chicago Exposition, everyone who was bound to admit to him that he had not seen that line at the Falls felt somehow at once to have lost half his stature. Mr. Preece, like all Englishmen, when he takes his seat in a tramcar or railway carriage, likes to go ahead, and I do not think anyone could have put a more worrying enquiry to Mr. Preece than to ask him if he was going back to his hotel in Twenty-second-street by the elevated, or so-called rapid-transit, line. I suppose our suburban railways in the Metropolis, which I hold are second to none in the world for speed and safety, somewhat spoil an Englishman for any more tardy lines. While it is evident that the combination of fortuitous conditions in the Canadian Falls line is very exceptional, yet I am of opinion that, by keeping these and other favourable conditions in view, there are many districts in our own country where electric tram lines could be put down at once with advantage. I have drawn attention in my paper to some points in power-station plant, more particularly with reference to flywheel strains under the exceptionally sudden changes of load in street tramway work, which are sometimes the cause of serious mishaps. The ordinary fluctuations in load are caused by the starting or stopping by chance of a number of cars at the same instant, the variations being at times from over full load to quarter load; and the more excessive fluctuations are due to short-circuits, or the sudden release of load by automatic circuit-breakers. In one large station of 4,000 h.p., I was informed that the average was 20 short-circuits per day. Most of these were temporary, and caused either by high winds shifting some of the overhead gear, or falling telegraph or telephone wires, but in exceptional cases caused by the trolley wire itself breaking and falling on to the rails or ground. An overload or short-circuit, when driving by belt, puts a sudden brake on the periphery of the flywheel and a shearing strain on the spokes. The belt, of course, slips, but at times it parts or is thrown off, and in the course of its career sometimes damages the governor and leaves the engine uncontrolled, under which circumstances it is rare if there is time to shut down before something goes; and, as they tersely put it on the other side, it is best to get behind a pillar and await developments. The bending strains set up in the rim by centrifugal force in a racing engine appear to have been the cause of more fractures of the wheel than the shearing strains. The reason for wheels with one to two thousand foot-tons of stored energy is, presumably, to secure regulation of speed in engines having a small number of steam admissions per unit of time; but I think it will be admitted that the governor has more chance of producing an immediate effect upon the speed when there are a large number of admissions per unit of time, and there is the additional advantage in the use of much smaller and solid flywheels of approximately one-tenth the stored energy, and therefore well able to "stand the racket" with safety.

Regarding the use of belts, I think engineers in the States are coming to see that it is worth while to put a little more material in the generators, and do without these weak links in the chain of transmission. At any rate, I noticed many of the newer plants were direct driven, with marine-type engines. I admit that there is something very stately and imposing in a long row of trip-gear engines with large flywheels and belts. I enter very keenly into the enjoyment of such a sight, and am also much impressed by the number of yards super in stone and brick outside the building, and feet super of floor inside; but when we have to consider capital cost of works, and adaptability of plant to get down in good shape to its work under trying conditions with safety, we may wisely let such considerations take a secondary place.

Our corporations would do well to study the needs of the people in and around their townships; and I am confident that the good sense and judgment they, as business men, always display in schemes for the benefit of their townspeople, would lead them to select paying routes for light railways not paralleling the ordinary railways, and which would not only meet the needs of the daily transference of the population, but take in and out light market freights, and, by affording healthy travel, tend to foster the energies of their townspeople. The success of the Isle of Man electric tramway is an indication that such needs of the population do exist, and when catered for and fostered result in benefit to themselves, the promoters, and indirectly to the country at large. As I have before pointed out, such lines create traffic of themselves, and raise the value of land and property in the vicinity. I venture to predict that if facilities for reasonably quick and cheap travel between the suburban districts of our large towns and outlying villages were afforded the masses, they would gladly avail themselves of them. Such facilities would afford them enjoyment of open space, pure air, and opportunities of observing life in different grooves to their own, on the one hand, and cheap carriage for market produce, on the other, which could only have a beneficial effect, and would most probably bring about an alleviation of agricultural discontent, and a mitigation of the crises resulting from the labour problems of the day. Speeds can be accelerated somewhat in the open country.

The recent proposal made by the Board of Trade to the Chambers of Commerce and other bodies interested to discuss the question of light railways, is an action of much importance to the country at large, apart from the consideration of systems of travel, and one that I am sure is fully appreciated by this Institution. The questions of land, permanent way, signals, staff, level crossings, and fencing in where it is not practicable for such lines to take the high road are to be brought forward. The Board of Trade has ever shown the most ready spirit to favour electrical enterprises in the best interests of the public, with due regard to the protection of property, as exemplified in

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electric lighting orders and in the drawing up of the present practical code of regulations for electric railways; and I have no doubt that the question of operating light railways in suburban, interurban, and country districts by electricity will be thoroughly brought forward by the Engineering and Electrical Trades Section of the London Chamber of Commerce, in response to the esteemed invitation issued by Sir Courtenay Boyle. We can count on our fingers the number of electrically-worked roads in the United Kingdom, and they can only claim a short mileage; but I beg to assure our American cousins that this is not because we are afraid of running into the sea. There are more people to the square mile in our large towns and cities than in more roomy America, and our streets are not mapped out on squared paper before a town is built. Hence the special character that must necessarily pervade our designs in electric roads. After all, mileage is not the only gauge of advancement. What will do for one American city, generally speaking, does for a second, a third, and a thousand. It is refreshing to notice the individual character in institutions, public works, and speech that obtains in the different townships of our country in contrast to the sameness of cities in the States. At the same time, this means more investigation into the needs of the people and design of road, calling for greater achievements, although not on so large a scale. Taking the cities of Liverpool and London, for instance, we have our elevated electric road, our subterranean electric road, and a second now building, which are engineering works of the highest order, and exceedingly well adapted to the necessities of our traffic. I call these achievements to be proud of.

In conclusion, I may be permitted to say that, while judging such information as I could bring to bear upon the question as it affects us in this country to be of interest to our engineers, as it certainly has been given me with infinite open-handedness and cordiality by my American friends, I do not cease to recognise the great labours and genius of our great engineers and electricians who have frequently addressed you in this room, and from the presidential chair in both this Institution and the Institution of Civil Engineers, and whose indomitable perseverance and energy have led the van in laying the earliest electric rails in the United Kingdom.

WORTHING AND THE ELECTRIC LIGHT.

A report has been submitted by Prof. A. B. W. Kennedy to the Worthing Town Council with respect to the proposed electric lighting of the town. He points out that it is necessary to give four schedules: the first setting forth the area within which the order is to apply; the second giving the list of streets through which the Council undertake to lay distributing mains within a period of two years after date of the order; the third giving a list of streets not repairable by the local authority, etc.; and the fourth dealing with the maximum price to be charged for electric energy under the order. The report proceeds: "As to the first schedule, you will no doubt take the whole area of the borough as the area over which you are to have the power of supply. As to the second schedule, I should advise, after full discussion with your Electric Lighting Committee, and after careful personal examination of your town, that it consist of the following streets and places: Marine-parade (from Warwick-buildings to Heene-road), South-street, Warwick-street, Chapel-road (up to the railway station), Shelley-road, Montague-street, Steyne." Explaining the schedules, the professor says the Corporation will undertake to lay distributing mains in the second schedule within two years. He thinks the Schedule II. area will increase rapidly. The professor advises the following maximum charges per quarter: for any amount up to 20 units, 15s.; for each unit over 20, 9d. The total length of roadwork in the compulsory area is 4·8 miles, to which has to be added about half a mile more in order to carry the mains into the station. In addition to this work about one mile of special pipes would have to be laid on the south side of the Marine-parade, to carry current for the arc lamps there, as these lamps ought no doubt to be rather placed beside the sea-walk than on the pavement nearer the houses. The 2,700 yards of frontage for shops included in the compulsory area covers all the principal shops in Worthing. Outside the compulsory area, therefore, nearly the whole of the extensions will be in residential streets. Altogether, the professor thinks that there are about 14 miles of frontage in which it may reasonably be expected that within a few years it would be advisable for the Council to lay down electric mains. All the shops in the compulsory area, if lighted by electricity in only a very modest manner, without allowing for arc or any other lights specially used in shops for advertising purposes, would probably take the equivalent of 7,500 lamps of 8 c.p. Of these he thinks it would be advisable to provide, in the first instance, for, say, two-fifths, or 3,000 lights. This is an estimate which does not make any allowance for the Pier Company as a possible consumer. The private houses in the compulsory area, again, on the assumption of each taking only a modest amount of electric light, would require the equivalent of 9,600 lamps of 8 c.p. In the first instance, the Council ought to provide for one-fourth of these, or 2,400 lamps. Altogether, they should not provide for less than the equivalent of 5,400 lamps installed, of which, in this particular case, about 3,000 might be alight at once as a maximum. For supplying the 3,000 lamps at one time—as well as the arc lamps with which he had to deal further on—Prof. Kennedy states that about 225 h.p. would be required, and in order that there may be proper reserve at the station, about 100 h.p. more than this must actually be put down. The report proceeds: "On the Marine-parade, where you of course wish to make a special show of light, it is advisable that arc lamps should not be placed further than 60 yards apart. This would require about 24 arc lamps. If lamps were placed at the same distance apart up South-street, and as far as the railway station, an additional 24 would be required, making 48 lamps in all. Very probably, however, from the sea-front to the station the lamps might be placed further apart, and so a smaller number might serve, but in the estimates which follow I have allowed for a total of 48 lamps. I have been informed that you are able to spare a part of the ground now occupied by the old waterworks as a site for an electric lighting station. I have carefully examined this site, and am glad to be able to say that it appears to be in every respect a most suitable one. It has ample area, it is fairly centrally situated, and it has the very great advantage that the steam-engines could be made to work with condensation, with a very small additional cost in plant, and with practically no additional cost for water. There is also a chimney stack about 70ft. high upon the ground, and this could be utilised quite well, at least for some time to come, for the purposes of the electric lighting station. I have no doubt also, from the appearance of the chimney and from what your borough surveyor has informed me, that it is strong enough to carry a considerable addition to its height when required. The old engines which are in the waterworks are, of course, of a type quite unsuitable for electric lighting. The boilers also are made for far too low a pressure to be economical. The highest pressure at which any of them can work is 60lb. per square inch, and it would not be economical for you to use a less pressure than 120lb. per square inch. In general, indeed, I find it advantageous to use a pressure considerably higher than this. I think, therefore, that you must consider that the waterworks site gives you simply the land, the chimney, and the possibility of condensation, but nothing in the way of plant. As to buildings, it would be very difficult to make the existing buildings—which have been specially schemed to suit the machinery which is in them—suitable for the purposes of an electric lighting station, and there would be no economy in attempting to do this. It would, no doubt, be advisable that special buildings should be erected on a part of the site at present unoccupied, where there is very ample area for this purpose."

Prof. Kennedy estimates the cost of the plant (for 3,000 8-c.p. lamps) at about £27,500. This includes the roadwork, plant, lamps, and meters. The sum of £3,500 is included for buildings. Should the scheme he recommends be carried out, an additional expenditure of £7,500 would increase the maximum output by more than 150 per cent. He proceeds: "With a view to estimating your probable income from the scheme, I have examined the figures for Bournemouth, Eastbourne, Brighton, and Hastings, as to the current sold per lamp wired. I find this varies from 13·5 units per lamp per annum in Bournemouth to 22 units per annum in Brighton. Taking the lowest figure—namely, that of Bournemouth—5,400 lamps would give you a consumption of 72,900 units per annum, or a total of £2,430 at 8d. per Board of Trade unit. I have already advised that you should ask permission from the Board of Trade to charge a maximum of 9d. per unit if necessary, but I have not thought it wise, in this estimate, to assume that you are actually charging more than 8d. . . . If you adopt the plan of having half the arc lights extinguished at 11 p.m, leaving the others to burn through the night, and charge for the lamps at the rate of £25 per annum for each lamp burning the whole of the night, and £12 for each lamp burning till 11 p.m., the total sum received for the lamps will very closely balance the total extra expenditure at the station on account of supplying them with current, including the cost of carbons, and including also the additional charges on the capital outlay. At the rates which I have just quoted the total expenditure in lighting the 48 arc lamps would be £888 per annum. I understand from the town clerk that the expenditure on gas and lamp cleaning along the same lines is at present about £340. The total cost will therefore be about two and a half times as great as at present, while the amount of light will be something like 40 times as great as at present. Adding the income from arc lighting at this rate to the income from incandescent lighting already estimated, it will be seen that the total amounts to £3,318 per annum, to which is to be further added, say, £150, for the rental of meters and transformers, making in all £3,468. I have given very careful attention to the question of the best system of supply to be used in your case. I find that Worthing differs from ordinary English commercial towns of about the same size, or larger, in that it has a very much smaller proportion of its streets taken up by shops, and a much larger proportion as private houses. In fact, out of the 14 miles of roadwork which you may very probably have to carry out within the next few years, practically only about 1½ miles—namely, the shop district comprised in your compulsory arer—is occupied by shops; all the rest is residential. Moreover, the larger number of the private houses are separate houses standing in their own gardens, and at a very considerable distance apart. These circumstances combine to make the length of mains which have to be laid unusually great in proportion to the number of lamps supplied. This makes the capital cost of a low-tension system of distribution, whether with low-tenson or high-tension feeders, proportionately great. For the sake, therefore, of the reduction of capital costs, I think that your system ought to be a high-tension one, with current supplied at

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an electric pressure of 2,000 volts, transformed down to a pressure of 100 volts, as usual, before use in the premises of consumers. This system, as commonly carried out, has the very great drawback, especially for a town such as yours, that steam machinery has to be kept continuously running all night and throughout the daylight hours, although the actual paying load between each midnight and the following sunset is practically nil, and, as a consequence, the cost of coal per unit in such cases has been frequently most unreasonably large. The disadvantage can, however, be very greatly reduced by the use of a battery, and I consider that a battery of accumulators ought to be put down in your station with a motor alternator. In this way the battery would be charged in the evening, when the station was running at any rate, and would then discharge during the hours of light load through the motor, and thus drive a small alternator sufficiently large to supply current for all demands. In this way boilers and engines would be actually used only for seven or eight hours a day, as in a continuous-current (low-tension) station, and the running expenses both in coal and wages would be very much reduced as compared with a station in which steam has to be kept up all the 24 hours, and engines have also to be continuously at work. I have allowed for this in my estimate of costs both as to capital and revenue. For the arc lights the current would be supplied by the alternators in the station which supply the incandescent lamps, but I think that the current for the arcs ought to be passed through 'rectifiers' in the station, as is being done in Portsmouth, and as I am also arranging in Edinburgh. Lamps burning in this way appear in every respect more satisfactory than ordinary alternating-current lamps; indeed, in some respects they even have advantages over continuous-current lamps. I have allowed for this plant also in my estimate of costs."

LEGAL INTELLIGENCE.

CASSEL GOLD EXTRACTING COMPANY, LIMITED, v. THE ELECTRO-CYANIDE GOLD RECOVERY SYNDICATE.

The plaintiffs were registered owners of letters patent granted to several persons for improvements in obtaining gold and silver from ores and other compounds. The action was brought to restrain the defendant syndicate and two other defendants from infringing the patents. The counsel engaged for the plaintiffs were Sir Richard Webster, Q.C., Mr. Moulton, Q.C., Mr. Bousfield, Q.C., and Mr. A. J. Walter; and for the defendants Sir Edward Clarke, Q.C., Mr. Neville, Q.C., and Mr. T. M. Goodeve. **Mr. Justice Romer**, in giving judgment, said he was of opinion that the patent could not be sustained. The invention claimed was a very simple one, and the claim was very comprehensive, but no special apparatus, machinery, or device, or scheme of any kind was required to carry the patent into effect. Having regard to what was published and known at the date of the plaintiffs' patent, he came to the conclusion there was no real invention in the plaintiffs' alleged discovery. There was also another ground on which the patent was bad, because even if the invention was one which could be a good subject for a patent he thought it had been anticipated. The action would be dismissed, the plaintiffs paying the general costs. Execution would, however, be stayed pending an appeal.

WISE v. THE METROPOLITAN ELECTRIC SUPPLY COMPANY.

In this case the plaintiffs had in April last obtained an injunction against the company restraining them from carrying on their works at Manchester-street, W., so as to cause a nuisance to the plaintiffs by vibration. The operation of that injunction was, however, suspended until September 5. It will be remembered, says the *Times*, that the defendant company have established a large electric lighting station in the neighbourhood of Manchester-street, and the plaintiffs, who are householders and lodging-house keepers in the vicinity, complain of a nuisance caused by the vibration of the machinery. At the hearing of the action for an injunction it was proved that such vibration did exist to a serious extent. Owing to the peculiar nature of the soil upon which the works are erected, the task of preventing the vibration of the machinery from being communicated to the surrounding houses presents an engineering problem of great difficulty. At the time of the granting of the injunction the company were, under the advice of eminent engineers, endeavouring to overcome the difficulty by works intended to increase the rigidity of the bed or platform upon which the engines are rested, and although their operations in that direction were partially successful, they do not seem to have been entirely so, for the company have, since the injunction, come to the determination to substitute for the reciprocating engines hitherto in use steam-turbines, which, it appears, can be used without causing any vibration. The company have accordingly removed some of their old engines to another of their stations, and have already erected one turbine and ordered two others, which, when in position, will, it is hoped, enable them to supply all the necessary electric energy without using any of the old class of engines. In the meanwhile, the plaintiffs alleged that, in spite of the injunction, the company have allowed the nuisance to continue, and they now moved for leave to issue a writ of sequestration against the company. A great mass of evidence was read on either side, that of the plaintiffs tending to show that there had been very little, if any, abatement of the nuisance, and that of the company being to the effect that, since the granting of the injunction, there had been no such vibration caused by the engines as amounted to a breach of the order, and that they had almost, if not altogether, succeeded in overcoming the engineering difficulties. At the conclusion of the evidence his **Lordship** asked if the company were willing to undertake not to use more than one reciprocating engine, besides the turbines, for a period of three weeks, and, upon counsel for the company consenting to that, his Lordship said that it appeared to him, upon the evidence now presented to the Court, that if the company worked three engines of the reciprocating class a nuisance would be caused, but if they only used one there would be no such vibration as to amount to a breach of the injunction. He was anxious to be satisfied by a further experiment that that was so, and under these circumstances he should direct the motion to stand over for three weeks upon the above undertaking by the company.

The counsel appearing in the case were Mr. Hastings, Q.C., and Mr. Beaumont for the plaintiffs; Mr. Vernon Smith and Mr. Waggett for the company.

COMPANIES' MEETINGS.

WESTMINSTER ELECTRIC SUPPLY CORPORATION, LIMITED.

Lord Sheffield presided on Wednesday at an extraordinary meeting of the above Company, held at the offices, Eccleston-square, which was held for the purpose of confirming a resolution passed at a meeting on October 24 authorising an increase in the capital from £300,000 to £400,000. In formally moving the resolution, he said the Board had not yet arrived at a conclusion as to the price of issue and the date.

Mr. J. B. Martin seconded the motion.

Mr. D. Hutton considered that it would have been better if the shares were issued at par, and not at a premium, as was suggested, though he would not have objected so much if the Company had paid better dividends.

The **Chairman** stated that the course which the directors advised had been taken with the approval of their largest shareholders and financial advisers. He did not agree that the Company had not been successful, considering the great difficulties with which they had to contend.

The resolution was then carried.

WEST INDIA AND PANAMA TELEGRAPH COMPANY, LIMITED.

The ordinary general meeting of the shareholders of the above Company was held at Winchester House on Wednesday, Mr. C. W. Earle (chairman of the Company) presiding.

The **Chairman**, in moving the adoption of the report, said that during the past half-year, if they eliminated the results of a piece of luck they had met with about this part of last year, owing to an interruption in the working of the French cable, the normal traffic of the Company showed a decrease of about £2,400. One of the causes of these recurring decreases was that experience had enabled merchants by codification of messages to reduce the average number of words per message one-half since the Company had been at work in the West Indies. The other cause was the decline which had taken place in the price of sugar. The Company's earnings in messages to and from Dominica were so small that they sometimes amounted to £7 in a fortnight, while on one occasion no message was sent from the island and only one received. Still, the Company was compelled to maintain an establishment on that island, the result being that, as far as it was concerned, the Company, instead of being a commercial body, carrying on commercial business for itself, was in reality a company carrying on Imperial work for the defence and protection of the colony, without subsidy or assistance from the Imperial Government. With regard to the accounts submitted by the directors, there was an apparent—but more apparent than real—decrease in the expenditure to the amount of £300. This had arisen from the advantage given by an interruption to the work of the French cable. There was an increase in the cost of repairs and renewals attributable to the difficulty experienced in repairing the duplicated cable between Jamaica and Cuba, which had failed—the directors could not say from what precise cause—at 2,000 fathoms. The Danish colonies of St. Thomas and St. Croix had renewed their subsidies for five years.

Mr. W. Andrews seconded the motion, which was agreed to.

COMPANIES' REPORTS.

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING COMPANY, LIMITED.

Directors: Right Hon. D. R. Plunket, Q.C., M.P., chairman; J. B. Braithwaite, jun., deputy chairman; W. C. Braithwaite; Anthony N. Denny; Frederick W. Reynolds; Aymor H. Sanderson; Francis E. Savory; R. Percy Sellon; B. H. Van Tromp. Engineer and manager: A. J. Lawson, M.I.E.E.

Report of the directors and balance-sheet to be presented to the

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shareholders at the general meeting to be held at the City Terminus Hotel, Cannon-street, E.C., on November 19, 1894, at 2 p.m.

County of London.—The work necessary for giving effect to the provisional orders held by the Company for the districts within the county of London, is in active progress under the contracts mentioned in the prospectus of March 28, 1894, and by which it is provided that generating plant capable of supplying 90,000 8-c.p. incandescent lamps shall be erected by September 30, 1895. Contracts for the laying of pipes for street mains have been entered into, and are now being executed. It is intended to at once lay sufficient conductors to meet immediate requirements, together with a number of spare pipes into which, without further disturbance of the roadway, additional cables may be drawn when required. The directors have acquired at a moderate rental, under a 99 years' lease, a suitable site at the Regent's Canal Basin, upon which the generating station for the St. Luke's and Clerkenwell districts will be erected, and they have made arrangements with the owners for obtaining additional land, should it become necessary at any time to enlarge the buildings. The freehold has also been secured of riverside premises in the Wandsworth district, upon which the generating station for that area will be built. At both these stations coal can be delivered out of barges alongside the buildings, and there is an abundant supply of water available for boiler feeding and condensing purposes.

Provinces.—The Company has purchased a controlling interest in the Bournemouth and District Electric Supply Company, the extension of whose business during the past year has been very encouraging, and it is expected that the accounts for 1894 will show a substantial profit. The connections to the mains of the Bournemouth Company are now equivalent to about 18,000 8-c.p. lamps. The Company is also largely interested in the Dover Electricity Supply Company. Work upon the station buildings and mains of that company is approaching completion, and it is expected that it will be in a position to supply current to consumers by the end of the present year. The prospects of the Dover company are very hopeful in view of the arrangements already entered into with the Corporation for street-lighting and with the military authorities. Other important lighting contracts at Dover are also in course of negotiation, with every probability of a satisfactory conclusion. At Windermere the water power of the River Leven, at the outlet of Lake Windermere, has been secured, and the Windermere and District Electricity Supply Company has been formed for the purpose of utilising this power in supplying current at a moderate price to such towns in the neighbourhood as may desire to avail themselves of it.

Future Annual Accounts and General Meetings.—It is intended to close the financial year in future on December 31, and to present the accounts to that date at the annual general meeting to be held in March or April following. Under this arrangement the next general meeting will be held early in 1895, when the provisions contained in the articles of association with regard to the retirement and election of directors and auditors will take effect.

Balance-sheet to June 30, 1894.	£	s.	d.
Authorised capital	800,000	0	0
Capital issued	200,000	0	0
Less calls not due	119,600	0	0
	80,400	0	0
Plus calls paid in advance	1,604	0	0
	82,004	0	0
Less calls falling due June 30	33,602	0	0
	48,402	0	0
Sundry creditors	2,739	14	10
	£51,141	14	10

Note.—The contingent liability upon the shares in associated electricity supply companies is £6,000.

	£	s.	d.
Preliminary and other capital expenses—viz., formation of Company, increase of capital, purchase of orders, and outlay in respect of applications for same	17,942	18	0
Lands and building account—payment for release of premises	100	0	0
Shares in associated electricity supply companies, at cost	21,850	0	0
Advances to associated electricity supply companies against bills of exchange and collateral security £8,645 2 9			
Less rebate for interest not accrued 233 18 11			
	8,411	3	10
Preliminary expenditure on account of proposed undertakings	812	0	2
Office furniture, books, etc.	172	5	7
Sundry debtors	533	11	2
Directors' remuneration, salaries, rent, and current expenses from June, 1891, to June, 1894	1,164	14	7
Cash at bank and in hand	155	1	6
	£51,141	14	10

Maschinenfabrik Oerlikon.—This Company inform us that at the International Exhibitions of Lyons and Antwerp this year they have obtained the highest award, the *grand prix*, for electrical machinery.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

York.—Tenders are invited by the directors of the North-Eastern Railway Company for telegraph apparatus and for telegraph wire and line stores. Forms of tender may be obtained on application to Mr. Graves, Telegraph Department, York, and tenders must be sent in to the secretary at York by Tuesday, 27th inst.

St. Pancras.—The St. Pancras Vestry invite tenders for works under the following two contracts: (*a*) supplying and laying armoured cable mains; (*b*) extension of underground sub-station building. The drawings can be inspected, and specifications, schedules of quantities, and general conditions can be obtained, at the offices of Prof. Henry Robinson, C.E., 13, Victoria-street, Westminster, on payment of 5s. for each contract. Tenders to be sent to Mr. Albert E. Pycraft, chief clerk, Electricity and Public Lighting Department, Vestry Hall, Pancras-road, London, N.W., on or before 22nd inst.

Derby.—Among stores for which the Midland Railway Company ask for tenders by the 20th inst. are (10) telegraph instruments, stay-rods, bolts, etc.; and (10a) telegraph and signal wires. Contractors cannot be allowed to submit or tender to supply goods to their own patterns, nor can the company's patterns be sent away for inspection, all being sealed, and exhibited at Derby only. The patterns are ready for inspection at the General Stores Department, Derby, and forms of tender may be had on application to Mr. G. Morrall, Derby, care being taken to give reference to the particular contract (by the above numbers) for which it is proposed to tender. Tenders to be addressed to the secretary.

Hampstead.—The Vestry of St. John, Hampstead, invite tenders for wiring the buildings in the stoneyard, Lithos-road, Finchley-road, N.W., for the electric light, including the supply and fixing of all cables, casings, and electrical fittings; but not lamps. A form of tender, with copy of specification and a description of the general routes to be followed, may be obtained at the office of the vestry clerk, Vestry Hall, Haverstock Hill, N.W., upon the deposit of £1. 1s., which will be returned on receipt of a *bonâ fide* tender. The various buildings at the stoneyard may be inspected on presentation of an order to do so, signed by the vestry clerk. Tenders must be delivered by Thursday 29th inst.

RESULTS OF TENDERS.

London, N.—The Vestry of St. Mary, Islington, have received the following tenders for the erection of the structural part of the new electric lighting station at Eden-grove, Holloway, N. Mr. A. Hessell Tiltman, 6, John-street, Bedford-row, W.C., is the architect, and the quantities have been got out by Messrs. Young and Brown, 7, Southampton-street, Bloomsbury, W.C.:

		A.
Rider and Son	£24,996	£1,800
Leslie and Co.	24,731	1,670
Higgs and Hill	24,484	1,704
Hall, Beddall, and Co.	24,440	1,710
L. H. and R. Roberts	23,493	1,896
Bush and Sons	23,360	1,718
Perry and Co.	23,229	1,680
Holloway Bros.	23,210	1,938
J. T. Messom	22,750	1,700
W. Shepherd	22,500	—
G. S. Williams and Sons	22,264	1,917
Mattock Bros.	21,901	1,885
Macfarlane Bros.	21,685	2,100

A. Extra for glazed-brick facings.

BUSINESS NOTES.

Chester.—In taking office as mayor, Mr. W. H. Churton stated that he hoped to see the electric light question settled during his term of office.

Staverton.—The mills and stores of Mr. E. J. Bowden's Staverton Bridge Roller Mills have been lighted throughout by electricity.

Blackburn.—Mr. E. M. Lacey, C.E., Westminster, has been chosen by the Gas Committee of the Town Council as consulting electrical engineer to the Corporation.

Burton.—The new Town Hall, which has been presented to the town by Lord Burton, is lighted electrically, the work having been carried out by Messrs. B. Verity and Sons.

Walthamstow.—The Local Board have made application for a provisional order to enable them to produce and supply electric light for public and private purposes within the district.

Southampton.—Mr. Button, the newly-elected mayor, in his opening address has pointed out the advisability of the Town Council acquiring the works of the electric light company.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 11th inst. amounted to £892, as compared with £577 in the corresponding week of last year.

Carlisle.—The Town Council have approved of the minutes of the Gas Committee describing the preliminary steps which have been taken with reference to getting a provisional order to supply electric light.

Blackpool.—The Electric Lighting and Tramways Committee of the Corporation is now constituted as follows: Aldermen Bicker-

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staffe and Buckley, Councillors Blundell, Heap, Hampson, Pearson, Smith, and Sergenson.

Hove.—Mr. F. G. Clark, auditor of the Hove Electric Lighting Company's accounts, has presented his report to the Town Commissioners on the statement of accounts to December 31 last.

Bath.—The Surveying Committee of the Town Council have decided that the electric light company should be paid £10 a month from the present time till February for an additional half hour's lighting in the morning.

Fareham.—The Local Government Board have informed the Local Board that with reference to the borrowing of £7 000 for the purchase of the electric lighting plant a public enquiry would be held as soon as business permitted.

Whitechapel.—The Board of Guardians have decided to fill in the forms sent round by the District Board in respect to electric lighting, but it was understood that this did not bind the Board to take the electric light for the workhouse and infirmary.

Worcester.—The Town Council have decided to arrange with the Brush Company to work the electric light installation for three months from October 11. The city engineer has been instructed to report on the work which has yet to be completed.

Wolverhampton.—The Lighting Committee of the Town Council have received 37 applications for a supply of electrical energy. These applications, including the lighting of the municipal buildings, represent a total of nearly 5,000 8-c.p. lamps.

Newport.—The Newport Town Council have discussed the question as to the probable cost (£600) of fitting the electric light at the Town Hall. It was decided to go on with the fitting of the Town Hall. Applications for the electric light are coming in rapidly.

Canterbury.—The members of the Electric Lighting Committee are the Mayor (Mr. George Collard), Aldermen Cross and Mount, and Councillors Mills, Mourilyan, and Warren (re-elected), with Councillor Lukey in place of Councillor Wiltshire, and Councillor Dean added.

Motherwell.—The Motherwell Police Commissioners have unanimously agreed to procure a provisional order empowering the Commissioners to introduce electric light, the subsequent action of the Commissioners in the matter being subject to review after the order is obtained. It is estimated that the total cost would be £12,500.

City and South London Railway.—The receipts of the Company for the week ended November 11 were £969, against £911 for the corresponding week of 1893, or an increase of £58. The total receipts for the current period of the present half-year amount to £16,719, as against £15,591 in the corresponding period of 1893, an increase of £1,128.

Dover.—It has been reported to the Town Council that a new contract with the gas company for lighting the borough would shortly have to be entered into, and it was decided to obtain prices for lighting the usual lamps, and a price for keeping up and clearing columns which would not be used owing to the proximity to the electric lamps.

Bristol.—The following have been appointed members of the Electric Lighting Committee of the Town Council: The Mayor (Mr. R. H. Symes), Aldermen Pethick and Proctor Baker; Councillors Tryon, Hughes, Lloyd, Board, Bastow, Hill, Wills, Pearson, and Pembery. The Docks Committee will light the new Dean's Marsh shed electrically.

Michael Corbitt and Sons, Limited.—This Company has been registered with a capital of £50,000 to acquire the business and assets of T. W. Spencer and Co., Limited, of Hebburn and elsewhere, and to carry on the business of hemp and wire rope manufacturers, telegraph, telephone, and electric light cable manufacturers, lightning conductor and electrical appliance manufacturers, etc.

Brighton.—The Lighting Committee of the Town Council have in a report recorded their high appreciation of the unremitting attention and zeal which Alderman Moon has devoted to the business of the committee, and the opinion that the success which has attended the electric light undertaking of the Corporation is in a great measure to be attributed to his earnest advocacy and great administrative ability.

Bournemouth.—The Town Council have accepted the offer of the Electric Supply Company to light the Winter Gardens for three or 5½ years, charging on the basis of their current price for the time being, less a discount of 25 per cent. The town clerk was instructed to prepare an agreement for 5½ years, to be determinable at the expiration of three years, at the option of the Council, on giving six months' previous notice.

Ormskirk.—Preparations are being made on a site in Southport-road, near to the parish church, for electric lighting works in accordance with plans submitted by a private firm of electrical engineers, and recently passed by the Local Board. It is intended to commence fixing the engine and dynamo in a temporary erection on the site of the building, and to proceed with the permanent structure at the same time, which, when completed, will be 190ft. long and 60ft. wide.

Poole.—The Town Clerk stated that he had received a letter from the Board of Trade with reference to the application of the promoters of the Poole and Bournemouth tramways asking for a further extension of time for the commencement and completion of the tramways, and under the circumstances the Board of Trade gave their sanction to the proposed extension till August, 1895. The town clerk added that the promoters had given the guarantee which the Council had asked for.

Bradford.—The new Gas and Electricity Supply Committee of the Town Council consists of the following gentlemen: Aldermen Edhouse, Feather, Lobley, Morley, Moulson, Watmough, and Whitley; and Messrs. Armitage, W. E. Aykroyd, Barker, G. A. Booth, Crossland, Dixon, Dobby, Dobson, Freeman, C. Greenwood, J. Greenwood, Hayhurst, Jennings, Kay, Land, North, Pilling, Popplewell, Ratcliffe, Speight, Toothill, Townend, and Walker.

Lynton.—The Local Board have received a letter from the electric lighting company stating that they would be glad to know whether the Board wished to have the lighting extended to the outer district. The Clerk to the Board (Mr. Roberts) said, at a recent meeting, he had written in reply that before a fresh agreement was entered upon it would be necessary that a test should be applied to ascertain whether the light already provided was in accordance with the present arrangement.

Telegraph and Telephone Appliances.—Messrs. F. Butzke and Co., Limited, manufacturers of telegraph, telephone apparatus, and accessories, of Berlin, inform us that they have appointed Mr. G. Straus, of 130, Queen Victoria-street, London, E.C., as their representative for Great Britain. The showrooms of Mr. Straus contain a complete set of samples of Messrs. Butzke's telephones, bells, speaking-tubes, fire and burglar alarms, and accessories, and an English catalogue will shortly be ready.

Swindon.—The Swindon Local Board recently discussed the subject of lighting the town by electricity. The General Purposes Committee recommended that Mr. J. G. W. Aldridge, of Victoria-street, Westminster, should be the electrical engineer for the purposes of the provisional order. It was further resolved that the notice applying for a provisional order should include every street within the district and all the public buildings belonging to the Board. The committee's recommendations were adopted.

Eccles.—The following members of the new Town Council have been chosen to constitute the Town Hall, Tramway, and Electric Lighting Committee: Aldermen Kendall and Mellor, Councillors Farrar, Hamilton, M.D., Heath, Oldfield, W. Smith, M D., and Whitehead. Alderman J. F. Wilkinson, on his appointment as mayor, stated that by a provisional order the Council had power to adopt a system of electric lighting, but the ratepayers might have every confidence that, whether that order was carried out or not, it would be proceeded with on careful lines.

Extension of Premises.—Mr. Robt. W. Paul, of 44, Hatton-garden, E.C., informs us that he has again been obliged to obtain more factory accommodation, and that he has taken the lease of Nos. 114 and 115, Great Saffron-hill, E C., a few doors from Farringdon-street Station. These premises have been equipped with new machinery and engine, and Mr. Paul has increased his staff with a view to manufacturing his high-class electrical and physical instruments in an expeditious and economical manner. He has also retained his premises in Hatton-garden for office purposes.

Keswick.—The Street Committee of the Local Board have received a letter from the Keswick Electric Lighting Company, Limited, giving notice of the company's intention to apply for a provisional order under the Electric Lighting Act, and asking if the Board would have objection to the company being released from supplying current continuously during the 24 hours, as required by the Board of Trade. The committee recommended the Board to acknowledge receipt, but to give no pledge as to the course of action they may adopt upon the letter. The report has been adopted.

Bacup.—The Liberal Club has been lighted by electricity. The installation has been put in by Messrs. Matthew and Yates, of Manchester, under the supervision of Mr. Thomas G Slater, the electrical engineer to the firm. Power is supplied by a "National" gas-engine of 8 h.p. nominal, running at 180 revolutions per minute, and driving a Matthew and Yates compound dynamo which, running at 1,200 revolutions, has an output of 80 amperes at 100 volts. The incandescent lamps amount to a total of 1,510 c.p. Five electric air-propellers are used for ventilating the card, committee, billiard, and lecture rooms.

Swan United Electric Light Company, Limited.—Shareholders of this Company are requested by the liquidator to send in their certificates in exchange for the new securities. Each holder of five fully-paid shares will receive in exchange as follows: 3¼ fully-paid £5 shares in the Edison and Swan United Electric Light Company, Limited, £6. 0s. 7d. debenture stock, £1. 0s. 8d. cash, being dividend and interest to June 30, 1894. Each holder of five partly-paid shares will receive as follows: 3¼ partly-paid £3 shares in the Edison and Swan United Electric Light Company, Limited, £4. 16s. 6d. debenture stock, and 14s. 2d. cash, being dividend and interest to June 30, 1894.

Extension Ladders and Fire Appliances.—An illustrated price-list of their specialities has reached us from Messrs. J. H. Heathman and Co., of 2 and 37, Endell-street, London, W.C. Attention is first directed to the fire appliances made by the company, and then to their variety of extension ladders, of which a large number is already in use. Other manufactures include bank trolleys, cask trucks, luggage bogies, barrows, hand-carts, etc. We note from the list that the company's fire appliances have been supplied, among others, to the Royal stables at Buckingham Palace, to Earl Malmesbury, and the Duke of Norfolk, to various theatres and music halls, public buildings, local boards, schools, etc.

West Bromwich.—The Corporation have been agitating for the South Staffordshire Tramway Company to adopt a better system of traction upon their lines running from Darlaston to Handsworth and from Dudley to Handsworth. The license for the use of steam expired on the 1st inst., and the Corporation thought

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it time that the company should make some definite arrangement as to when a better system would be introduced. They have, however, consented to the license being extended until January, 1895, the company in the meantime to make some definite arrangement. The Corporation is said to favour cable traction. The company, however, favour the electric system, and point to its successful working on their other lines.

Hampstead.—The Metropolitan Asylums Board met on Saturday last, when they approved of the action of the North-Western Hospital Committee in having engaged Prof. Ayrton to prepare a report on the question of lighting the North-Western Hospital by electricity at a fee of 30 guineas, to prepare a specification for wiring the hospital at a fee of 20 guineas, and to supervise the work for 75 guineas, with an additional charge of three guineas for each attendance on the committee, and to accept the offer of the Hampstead Vestry to supply electrical energy to the North-Western Hospital at 4d. per Board of Trade unit, the agreement in the matter to last for three years certain. The committee will shortly advertise for tenders for wiring the hospital.

Heising's "Acid-Proof" Enamel."—We have received from Messrs. E. Wallace and Co., Limited, 30, Newgate-street, E.C., who represent Messrs. Heising and Co., of Berlin, particulars of Heising's "acid-proof" enamel, specially prepared for the electrical trade. It is stated that this enamel has been tested, and is recommended by Messrs. Siemens and Halske and the Accumulator Works at Hagen among others, and that it is the only absolutely reliable protection for accumulators and accumulator-rooms against the destruction of walls, ceilings, and woodwork by acid sprays, fumes, or gases. It serves for the protection of battery jars and all other electrical apparatus which are used in connection with acid. We are informed that it is also an excellent insulator for dynamos, cables, and wires.

Chiswick.—The Works Committee of the Local Board have reported with regard to the progress of the works at the electric lighting stations, and recommended that a letter be written to Messrs. Bourne and Grant expressing the Board's dissatisfaction at the slow progress of the work. The surveyor said that the work had been stopped because Messrs. Bourne and Grant wanted to excavate a larger area of land for the work than was stated in the agreement. They intimated that they were not aware there was any limit fixed to the area of land to be utilised, and the works could not be proceeded with in the area mentioned in the agreement. Captain Alleyne said the best method to adopt was to ask Messrs. Bourne and Grant to submit plans of the work showing the area of land required. This was agreed to.

Hertford.—After a long and heated discussion the Town Council on Friday last agreed to the following resolutions proposed by Alderman Willson: "That the following resolutions, passed at the meeting of the Council held on September 7, 1894, be and are hereby rescinded: 'That the electric lighting scheme prepared by the engineer, extended so as to supply the Hertford General Infirmary, be carried out as speedily as possible.' 'That the engineer be instructed, with the assistance of the borough surveyor, to prepare detailed plans for carrying out the scheme, and the requisite forms of tender for the several sections of the same.' 'That application be made to the Local Government Board for their sanction to the loan of £6,000 for the purpose of carrying out the scheme'"; and "That all orders and instructions given to give effect to these resolutions be forthwith cancelled."

Halifax.—Alderman Michael Booth, who has been elected mayor, on the occasion of his opening speech, stated that the time was fast approaching when many of the shops in the town would be lighted with electricity supplied by the Corporation. He did not know whether the Gas Committee had considered the feasibility of producing this light by other means than coal and coke, but he understood that at Ealing the electric light had been produced by the burning of the town refuse, and at Worcester by the utilisation of compensation and other waters by means of turbines, in each case effecting a great saving by dispensing with the use of coal. In the face of the rapid development of electricity for producing light, heat, and power, as well as for cooking and other purposes, any extension of the gasworks beyond what was absolutely necessary for immediate purposes would, he believed, be wisely suspended.

Llandudno.—A public meeting was held on Wednesday for the purpose of considering a scheme for the lighting of the town by electricity. The meeting was promoted by the Llandudno Electric Supply Company, Limited, and the chair was taken by Mr. R. Conway, C.C., and a number of the Town Commissioners was present. Dr. Nicol, J.P., chairman of the company, who was unable to be present, sent a letter to the chairman, in which he said that the light was desirable on the ground of health and cleanliness. It was desirable that local authorities should have control over the lighting of their districts, but in Llandudno that was not expedient, as the town was already burdened with a heavy debt, and there were in the future large schemes to be carried out which involved heavy outlay. A resolution put to the meeting expressing the opinion that the work of supplying the electric light should be undertaken by the company was lost.

Kingston (Surrey).—By the erection of electric arc lamps in the streets, the Town Council have reduced the gas lamps by 99 compared with last year. Councillor Collings has given the Council a few figures as to the development of the electric lighting business. In the first quarter—up to December 31, 1893—there were 2,050 lamps installed, the current used was 5,596 units, and the revenue received was £139. 18s. The next quarter up to March 31 showed an increase of 450 lamps, by the end of June there was a further increase of 550 lamps, by the end of September another 250 lamps had been installed, and up to that day (less than half a quarter) 264 extra lamps had been fixed. The total number of lamps now installed was 3,564, and up to September 30 the current supplied had reached 25,219 units, for which the money received was £630. 19s. 6d., with an additional £29. 3s. 6d. for meters. They would see that the business was rapidly increasing, and he hoped and believed it would go on until it was made a financial success.

Milngavie.—On Friday last, the electric light was introduced here. On the site of the old calico print works ex-Provost Woodburn has erected several tenements. The shops and houses along Station-road have been fitted up for this light. The power is obtained from a turbine, which is driven by water from the River Allander 100 yards away, and led to the turbine by a "trow" 4ft. by 3ft., partly concreted and partly of wood. Provost Drew turned on the light in the new hall, where Mr. Woodburn was surrounded by his brother commissioners and the chief residents of the place. The turbine was provided by Mr. MacDonald, of Pollokshaws, along with the main shafting. The electrical plant was supplied by Messrs R. D. Smillie and Co., and erected by them. The dynamo is capable of supplying 150 incandescent lamps of 16 c.p. Mr. Smillie, the engineer, stated that this was the first occasion in Scotland in which water power had been used to produce electric light for shops and dwelling-houses, and that it would be copied by others.

Paisley.—The Town Council have received a letter from Mr. Thomas Henderson, secretary of the Caledonian Electric Supply Company, Limited, intimating the intention of that company to make application for a provisional order authorising them to supply electricity within the burgh, and proposing to make offer for a transfer of the provisional order obtained by the Council. The minutes showed that Mr. Bryson, electrical engineer, Glasgow, had made a statement as to the prospects of electric lighting. He gave it as his opinion that it was not desirable for the Corporation to undertake the work, and that it would be preferable for them to transfer their provisional order if suitable terms could be arranged. After consideration, it had been agreed that the clerk should write to Mr. Henderson asking that his directors should make an offer for a transfer of the order, and Mr. Bryson also undertook to obtain an offer from the Scottish House-to House Supply Company, Limited. The minutes were adopted.

"Snowflake" Composition for Coating Lamp Bulbs.—Being in the neighbourhood of Regent's Park, one of our representatives called upon Mr. V. Fabris, electric light contractor, of 171, Drummond-street, Hampstead-road, N.W. The attention of our representative was particularly called to the "Snowflake" composition, prepared by Mr. Fabris, for coating the bulbs of incandescent lamps. This composition, which is porous, allows some of the direct rays from the filament to pass, which, in combination with the reflected light, has a very pleasing effect, and produces, it is claimed, a light of more equal intensity over a larger area than can be obtained by using ordinary incandescent lamps. Among other advantages claimed for this composition may be mentioned (1) that it can be permanently fixed on any portion of the globe, throwing the reflected rays in any direction; (2) that the light is of a pure white quality, thus reducing the yellowish tint produced in ordinary incandescent lamps; (3) that lamps coated with this composition dispense with the use of all other kinds of shades shells, or additional reflectors; and (4) that by using this composition the fixing of the bulb to the brass rim of the lamp is strengthened.

Acton.—A communication has been received by the Local Board from Messrs. New and Mayne, who stated that they had gone into the question of taking up the electric lighting of the district, and the result of their enquiries and investigations was that they were fully satisfied that the district was one that could be economically lighted by electricity. They offered to take over the Board's provisional order in the matter, and to put down the necessary plant. They understood that the principal object of the Board was the lighting of the public streets by electricity, and they had no doubt that they would be able to carry out that work at a lower cost than was incurred by gas-lighting. In further letters the company suggested that in connection with the proposed electric lighting works they might arrange to erect and run a dust destructor, and they asked the Board to transfer to them the monopoly of electric lighting for 42 years, instead of 21, as was proposed by the Board. A letter has also been received from Mr. Smith, making a proposal for the purchase of the electric lighting order. Both these letters have been considered by the Works Committee, and the committee reported that they considered that Messrs. New and Mayne's stipulation for a lease of 42 years was reasonable, but that they could not recommend the Board to sell their order for less than £500. The committee decided to take no action for the present regarding Mr. Smith's letter. They had ordered the clerk to prepare a draft agreement for the transfer of the order to Messrs. New and Mayne.

Western and Brazilian Telegraph Company.—The total earnings for the half-year amount to £77,603. 3s. 6d., as against £79 373. 10s. 4d., a decrease of £1,770. 6s. 10d. compared with the half-year to June 30, 1893. The working expenses amount to £39 739. 11s. 5d., as against £43,424. 1s. 3d, a decrease of £3 684 9s. 10d. Including the amount brought forward from 1893 (£1,045. 6s. 6d.), the balance to the credit of the revenue account is £38 908 18s 7d., from which has to be deducted £11 672. 10s. for debenture interest, £5,000 for the debenture redemption fund, and £2.000 placed to reserve fund This leaves £20,236 8s. 7d. The directors recommend the payment of a dividend, free of income tax, for the half-year at the rate of 2 per cent per annum, carrying forward £5,630. 6s. 7d. This

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dividend will be payable as follows—viz., 3s. per share to the ordinary shares and 3s. per share to the preferred ordinary shares The conversion of ordinary shares into preferred ordinary and deferred ordinary shares will be suspended on and after January 1, 1895, until further notice. The Company have received from its representative in Rio de Janeiro the following communication: "Urgent.—Bill presented yesterday in Congress, and published to-day, November 8, in *Diario Official*, authorising the Government to purchase at once the Western and Brazilian Telegraph Company under conditions of Clause 14 Decree 5,270 of April 26, 1873, of the Western Company's concession, and to emit special telegraph bonds, value £100 sterling, bearing interest at 5 per cent. per annum, for this purpose." For the past week the receipts were £3,132.

Glasgow.—The arrangements for lighting the Corporation cars by electricity are now completed, and a few weeks probably will see the old oil lamps displaced by the new illuminant. The Froggart Electric Lighting Company, Limited, whose system is at present used in London, are the contractors, and Mr. Thomas Froggart, the patentee, is already at Coplawhill depôt carrying through the preparations for the change. In each car there are to be four lamps—two inside and two outside—and each is to be of 8 c.p. On the outside the lights are to be elevated on iron standards from 3ft. to 4ft. above the level of the roof, and each, in an elliptic glass globe with copper frame, will be in the centre of a disc of about a foot in diameter. On the one side bullseyes of particular colours will unmistakably indicate the routes, and on the other a white light will illuminate the top of the car sufficiently to enable passengers to scan their evening newspapers on their way home. The lamps in the inside are to be placed in the roof. In order to avoid vibration, the accumulators on all the Glasgow cars will be suspended on powerful indiarubber straps. Each lamp is also fed from a separate accumulator on the platform, so that in the remote contingency of one failing the car will not be left without a light. At Coplawhill and Kinning Park buildings are being erected for dynamos, charging gear, and so forth, and here the accumulators, which are to contain sufficient current for 10 hours, will be recharged, being conveyed afterwards to the different depôts in specially-constructed vans. The intention is, it may be pointed out, to utilise part of the disc for advertising purposes, with the object probably of as far as possible reducing the cost of the light. With the exception of a circle in the centre of from 4in. to 5in. in diameter, the disc will be devoted to an artistically coloured advertisement.

Leeds Tramways.—The City Council on Wednesday met to consider the question of making application for a provisional order for the extension of the tramways, and an adjourned meeting was also held to dispose of the business left over from Friday last. Alderman Firth moved a resolution that application be made by the Council, as the local authority under the Tramways Act, 1870, for a provisional order authorising the construction of various lines of tramways. Mr. Graham, who had on the agenda an amendment, stated that it was that no extensions of the tramway lines be proceeded with until the system of haulage in the different districts was decided upon. Ultimately the resolution and amendment were withdrawn, and the special meeting was concluded. The adjourned meeting to dispose of the remainder of Friday's business was then held. The question of the tramways was then further considered, Alderman Firth, for that purpose, moving the suspension of the standing orders. Alderman Firth moved: "That the Council apply to Parliament in the ensuing session for a Bill empowering the Corporation to construct additional tramways in Leeds and at Roundhay Park, and that the requisite notice of such application be prepared and published in the manner required by the standing orders of Parliament." Alderman Boothroyd seconded the resolution. After some discussion, Mr. Battle moved the following addition to the resolution: "That in the application to the next session of Parliament for an extension of the city tramways, clauses be inserted giving power to the Corporation to place or run carriages upon the city tramways, including such extensions, and to demand and take tolls and charges in respect of the use of such carriages." Eventually the addition and resolution were adopted.

Richmond.—The Town Council have adopted the recommendation of the Finance Committee that the sum of £1,000, with accrued interest thereon, should be paid to the Richmond Electric Light Company in return of their deposit under a clause of their contract with the Corporation, the same having been duly performed as far as was material to this purpose. The following report was also agreed to: "The question of the recovery from the electric light company of three several sums outstanding for work done for them by the Corporation has also been before the committee. Under Clause 6 (*h*) the Corporation has power to deduct these sums from the amount of £400 deposited under the same clause, as security for certain work to be done by the Corporation on account of the company. This course has already been adopted on two previous occasions, and in view of the delay experienced in recovering these payments from the company, the committee recommend that the sum of £22. 12s. 1d., due to the Corporation from the Richmond Electric Light, etc., Company, for work done up to Michaelmas, 1894, be deducted from the balance of the £400 deposited by the predecessors in title of the company, under their contract with the Corporation. On deduction of the sum in the last preceding paragraph mentioned, the balance of the £400 deposit will be reduced to £62. 12s. 6d. By Clause 6 (*h*) of the contract, the Corporation are not bound to perform any work for the company when the deposit is reduced below £400, or payments due from the company to the Corporation have been outstanding for more than seven days. Under these circumstances the committee recommend that the Council call the attention of the Richmond Electric Light, etc., Company to Clause 6 (*h*) of their contract, and request them to make up the deposit therein required to the specified sum of £400."

Taunton.—Mr. Harold W. Couzens, the borough electrician, in his quarterly report to the Town Council stated: "I have the honour to report that the demand for light has been steadily increasing until, at the present time, we have no more small transformers in stock to supply new consumers until No. 2 sub-centre is in operation. At the present time we are using about 25 per cent. less coal than during the corresponding period of last year, whilst our output is much greater. We have now the equivalent of 2,000 16-c p. lamps connected to our mains, exclusive of arc lamps, of which 224 have been added during the past quarter." The Electric Light Committee presented the following report, which has been approved of by the Town Council: "Your committee recommend the Council to enter into an agreement for two years with the Syndicate of Electrical Engineers (?) for receiving from their institution students for the electric lighting works. The committee herewith present the form of agreement, and recommend that the common seal of the borough be affixed thereto. Your committee report that Mr. R. W. Phillips, assistant electrician, has left the works, having obtained another appointment. The committee recommend that Mr. E. B. Thornhill be promoted to Mr. Phillips's place, at a salary of £67 a year, and that Mr. E. R. Shand (a former pupil) take Mr. Thornhill's place, at a salary of £55 a year. The committee also recommend that Mr. A. E. P. Witham be raised from £20 to £30. The foregoing arrangement will make an increase of £2 a year An application has been received from Mr. Bessemer to have the electric light installed at his house at Highlands. The committee recommend that the necessary wire be laid in order to give such supply." Notices have been received from the Local Government Board that Colonel John Ord Hasted, R.E, one of the Board's inspectors, was to hold an enquiry on Tuesday last, the 13th inst., as to the application from the Council for sanction to borrow £5,000 for purposes of electric lighting.

Cheltenham.—The minutes of the Electric Lighting Committee of the Town Council stated that the Mayoress wrote expressing her thanks for the handsome silver trowel presented to her on the occasion of her laying the memorial stone of the electric lighting station. The electrician, Mr Kilgour, reported that the wiring orders had been placed in tradesmen's hands for 450 16-c.p. lamps, and that orders for another 300 would be given in the course of a few days. Mr. T. Whittard, hon. sec. to the officers of Salem Baptist Church, wrote stating that it was intended to introduce the electric light into the chapel, lecture-room, etc., and making certain suggestions on public and economic grounds for churches, chapels, and other large public buildings. It was decided to refer Mr. Whittard's letter to the borough surveyor to report thereon. It was resolved to request the Public Library Committee to consider the question of introducing the electric light into the library. The surveyor reported that the transformers having been ordered, and the sub-stations commenced, it was necessary that the order for switchboards should be placed. The quotations were: the Brush Company, £210. 4s. 6d.; Messrs. Siemens Bros., £376; and he advised the acceptance of the Brush Company's offer, their apparatus being simple and effective. For testing the alternators, transformers, and meters, an artificial load consisting of 100 incandescent lamps would be required, costing between £90 and £100. They should also require from Messrs. Callender, who were supplying the cables, 20 sub-station joint-boxes at a cost of £76. As there were already 14 certain customers, he recommended that an order for 20 meters be placed at once. Three hundred and fifty pounds was due to the Corruganza Manufacturing Company on account of contract for paper tubes. It was resolved to accept the tender of the Brush Company for switchboards, and to purchase the other apparatus mentioned in the surveyor's report. The following members of the new Town Council have been appointed as the Electric Lighting Committee: the Mayor, Aldermen Thoyts and Norman, Councillors Dimmer, Lawrence, Parsonage, H. Waghorne, and Wheeler.

Derby.—The Electric Lighting Committee report that the whole of the arc lamps for street-lighting (76) are now in position. The total candle-power of street gas lamps displaced by these is 9,072. The effective light produced by the arc lamps amounts to at least eight times that of the gas lamps displaced. The price of electric current for purposes other than lighting has been reduced to 3d. per Board of Trade unit. Mr. F. L. Lister has been appointed assistant engineer, and Mr. Reginald S. Downe second assistant. Messrs. Siemens Bros. and Co., Limited, handed over the working of the station to the committee's staff on August 25 last, since which time it has been entirely worked by such staff. The mains and public lamps are still in the hands of the contractors. The engineer (Mr. Stewart) has been allowed to take two pupils instead of one. Contracts for coal have been let to Messrs. Eckersley Bros., Messrs. Steer and Smith, and Mr. Pepper. Thirty additional meters have been ordered. It has been found necessary that the staff sanctioned by the Council on February 7, 1894, should be rearranged and added to, and there are now employed in addition to the staff authorised by the Council the following officers: a second assistant engineer, a driver, and a greaser. Continuous running is now carried out in accordance with the provisions of the lighting order, and the work is done in three shifts. The private lighting, the committee consider, promises to be a good business success. It is, of course, premature to positively make any statement, but when it is remembered that the present installation, so far as private lighting is concerned, is designed for 7,500

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lights, and that 7,450 lights are already attached, and there are signed applications for 3,000 lights more, the conclusion that the public show a distinct inclination to take the light is inevitable. The committee regret that they cannot at present settle their accounts with the contractors, so that the exact amount of capital and annual expenditure can be ascertained, but they need hardly tell the Council that this will be done at as early a moment as possible. The expenditure of the committee is still within the amount granted by the Council (£35,000), but further expenditure will undoubtedly be necessary. The 250-h.p. engine and dynamo combined is now nearly completed, but the demand for current for domestic and business lighting purposes is already sufficient to absorb all that it will produce in addition to the plant already at work. The machinery cannot well be increased to be of much service during the present winter, but early in spring the matter must have attention.

PROVISIONAL PATENTS, 1894.

NOVEMBER 5.

21185. **Improvements in oil, gas, electric, and other light pendants.** Charles Thomas Powell, 12, Cherry-street, Birmingham.

21202. **An electrical typewriter.** George Cockroft Walker and Thomas Smith Paynter, 73, Wroughton-road, Balham, London.

21218. **Improvements in electrical switches.** Charles Philipp Ehmann, 106, Meadow-street, Moss Side, Manchester.

21244. **Apparatus for electrically signalling from the locomotive to the carriages of a railway train.** Max Zvee Levy, 89, Chancery-lane, London.

21250. **Improvements in or relating to multiple telegraphic apparatus.** Alfred Piedfort, 323, High Holborn, London. (Complete specification.)

NOVEMBER 6.

21323. **Improvements in apparatus for welding electrically.** William Phillips Thompson, 6, Lord-street, Liverpool. (Charles Lewis Coffin, United States.) (Complete specification.)

21330. **Improvements in galvanic batteries.** Georg Hübner, 115, Cannon-street, London. (Complete specification.)

21347. **Improvements in systems of telegraphic or telephonic exchanges.** Wallace Childs, 70, Chancery-lane, London. (Complete specification.)

21353. **Improvements in electric motors for railway vehicles.** Harvey Slaughter Park, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

21366. **Improvements in connection with electrically-propelled vehicles for running on ordinary roads.** Frank King, 47, Lincoln's-inn-fields, London.

21367. **Improvements relating to the connections of battery receptacles employed in electrically-propelled vehicles.** Frank King, 47, Lincoln's-inn-fields, London.

NOVEMBER 7.

21410. **Improvements in and connected with electrical apparatus for signalling on railways.** William John Rawson, 78, Fleet-street, London.

21439. **Electrical sewer ventilator.** Ernest Matthew Lacey, 19, Old Queen-street, Westminster.

21446. **Improvements in electric meters.** Clement Johnson Barley, 45, Southampton-buildings, Chancery-lane, London.

21452. **Improvements in automatic electric fire alarms and signals.** Percy Richard Julius Willis, 55, Chancery-lane, London. (Louis Aloysius Werner and Clement Julius Werner, United States.)

21461. **Electric motors.** Charles Riordon, 4, South-street, Finsbury, London. (Complete specification.)

NOVEMBER 8.

21482. **Improvements in recording apparatus for ships' telegraphs.** Ellis Fletcher, 4, Clayton-square, Liverpool.

21489. **An electric track machine for railway system.** Edward Deming, 57, Barton-arcade, Manchester. (Complete specification.)

21531. **Improved electric sash-balance.** William Candler Hodgkins, 55, Chancery-lane, London.

21549. **Improvements in electrically-heated robes, towels, quilts, and other articles of flexible fabric.** Henry G. O'Neill and Edward Jewell, 65, Chancery-lane, London. (Complete specification.)

NOVEMBER 9.

21555. **Improvements in secondary batteries.** Illius Augustus Timmis, 2, Great George-street, Westminster.

21613. **Improvements in telephones.** Edgar Charles Parker, 55, Chancery-lane, London.

21629. **Improvements in and relating to electric railways.** Ludwig Hanisch and the Hoerder Bergwerks and Hütton-Verein, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

21630. **Improvements in electric meters.** Heinrich Leupold, 45, Southampton-buildings, Chancery-lane, London. (Harry Leupold, Italy.)

21640. **Improvements in or connected with electric switches.** George Jacob Gurl, 4, South-street, Finsbury, London.

NOVEMBER 10.

21684. **Automatic hydro-electric indicator and alarm.** Horace Dando, 9, Sanfoin-road, Upper Tooting, London. (Henry Augustus Dando, New Zealand.)

21707. **Improvements connected with the electric conductors of electric railways.** Alfred Slater, 6, Bream's-buildings, Chancery-lane, London. (John Platt, United States.) (Complete specification.)

21731. **Improvements in arc lamps.** Charles Aubrey Day, 321, High Holborn, London. (George Joseph Schoeffel, United States.) (Complete specification.)

21750. **Improvements in arc lamps.** James William Rogers, 24, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1893.

19427. **Electrical toys.** Myers.

20837. **Electrical measuring instruments.** Ayrton and Mather.

22876. **Electric switches.** Hopkinson.

23211. **Electro-mechanical governors.** Goolden and Lewis.

23605. **Attaching reflectors to electric lampholders.** Ebbutt and Verity.

24001. **Thermo-electric lubricating apparatus.** Coombes. (Coombes.)

24081. **Electrical carbons.** Niewerth.

24217. **Electrical measuring instruments, etc.** Ayrton and Mather.

24276. **Electrolytic apparatus.** Guthrie.

24353. **Electric accumulators.** Mills. (Barbier,)

24389. **Secondary battery plates.** Lehmann.

24442. **Electrical accumulator plate.** Mills. (Barbier.)

13066. **Incandescent gas or electric light mantles.** Boult. (Steur.) (Second edition.)

15669. **Electrolytic treatment of liquids.** Brown. (Vogelsang.) (Second edition.)

1894.

17296. **Dynamo-electric machines.** Lake. (Eickemeyer.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	5	5⅞-6
Bournemouth Electric Company	—	—
Brush Company, Ordinary	3	2⅞-2⅝
—— Nom. Cum., 6 per cent. Pref.	2	2-2⅛
—— 4½ Debenture Stock	100	110-113
Charing Cross and Strand	5	4½-5⅛
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	12-13
—— 6 per cent. Cumulative Pref.	10	14⅜-15½
—— 5 per cent. Debenture Stock	115	131-133
City and South London Railway, Consolidated Ordinary	100	37-39
—— 4 per cent. Debenture Stock	100	120-122
—— 5 per cent. Pref. Shares	10	13½-14
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2⅝-3
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	95-100
Electric Construction, Limited	2	⅜-⅝
—— 6 per cent. Debentures	—	87-92
—— 7 per cent. Cumulative Pref.	2	1⅛-2
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1⅝-1⅝
Elmore's French Company	2	1-1⅛
Elmore's Wire Company	2	1⅝-1⅝
Fowler-Waring Cables	5	¾-1⅛
W. T. Henley's Telegraph Works, Ordinary	10	8-9
House-to-House Company, Ordinary	5	2⅛-2¼
—— 7 per cent. Preference	5	6⅛-6⅝
India Rubber and Gutta Percha Works	10	25-26
—— 4½ per cent. Debentures	100	102-104
International Okonite, Ordinary	—	—
Kensington and Knightsbridge	5	4⅞-5⅛
—— 6 per cent. Pref.	—	6⅛-6⅜
Liverpool Electric Supply, Ordinary	5	6 9/16-6 11/16
—— Pref.	—	—
Liverpool Overhead Railway	10	7 15/16-8 1/16
—— Pref.	10	13-13½
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric	5	⅜-1⅛
Metropolitan Electric Supply	10	9⅛-9⅜
—— 5 per cent. Reg. Debentures, 1-10,000 in Bonds of £10, £20, and £40	—	—
National Telephone, Ordinary	5	4⅞-5⅛
—— 6 per cent. Cum. First Pref.	10	15-16
—— 6 per cent. Cum. Second Pref.	10	14⅛-15⅛
—— 5 per cent. Nom. Cum. Third Pref.	5	5⅛-5⅜
—— 4½ per cent. Deb. Stock	—	110-113
Notting Hill Company	10	6⅞-7⅛
Oriental and Electric Company, £1 shares	1	1-1⅛
—— £5 Shares	—	6⅛-7⅛
—— £4½ shares	—	5⅛-6¼
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7⅛-8
—— 7 per cent. Pref.	5	8⅜-9⅛
Swan United	—	—
Telegraph Construction and Maintenance	12	41-43
—— 5 per cent. Bonds	100	106-109
Westminster Electric Supply, Ordinary	5	7-7⅛
Yorkshire House-to-House	4½	4¼-4⅜

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NOTES.

Mill-Lighting.—It is stated that English weavers are taking great interest in the electric lighting of their mills.

Telephony in Germany.—It appears that telephonic connection between Berlin and the East will be extended to Memel *viâ* Tilsit.

Electric Lighting in Russia.—Proposals have been received by the Municipality of Jalta for the electric lighting of the town.

Electric Traction in Switzerland.—A project is being discussed in Switzerland for an electric mountain railway up the Jungfrau from Guyer-Zeller.

Electric Lighting in Switzerland.—A central electric light station is to be erected at Ruppoldingen. Messrs. Brown, Boveri, and Co. are interested in the scheme.

Northern Society of Electrical Engineers.—A smoking concert of this society will take place at the Palatine Hotel, Hunt's Bank, Manchester, this (Friday) evening, at 8 p.m.

Lord Armstrong.—The Christmas number of *The Tyneside*, published at 75, Pilgrim-street, Newcastle-on-Tyne, will contain as a presentation plate an ink photo of Lord Armstrong.

Electric Lighting in Spain.—The municipal authorities of Guadalajara, a town of 8,500 inhabitants, near Madrid, are open to receive offers for the introduction of the electric light into the town.

Telegraphy in the Straits Settlements.—The telegraph land line, which the Straits Government propose to erect between Singapur and Malacca, through the territory of Johore, will be put in hand at once.

Electric Traction in Austria-Hungary.—Good progress is being made in connection with the underground electric railway, which is being built by Messrs. Siemens and Halske at Budapest, from Stadtwäldchen to the Donauquai.

Presentation.—The representatives of the staff of the submarine cable companies over which Sir John Pender presides have presented him with a silver trophy to mark the twenty-fifth anniversary of cable communication with the Far East.

Hermann von Helmholtz.—A lengthy obituary notice, dealing with the life and work of Hermann von Helmholtz, whose death, as mentioned at the time, took place on the 8th of September last, is published in the *Elektrotechnische Zeitschrift* of November 8.

Civil and Mechanical Engineers' Society.—The members of this society on Friday last visited the works of Messrs. Bullivant and Co., in the Isle of Dogs, where the processes of making steel wire cables and ropes, torpedo-catching nets, and wire netting is carried on.

Obituary.—The death is announced, at the age of 95, of Mr. Robert Davidson, of Aberdeen. The deceased is credited with having constructed, among other electrical apparatus, a storage battery locomotive as long ago as 1839, which was tested on the Edinburgh and Glasgow Railway.

Sunderland Exhibition.—On Monday there was opened at Sunderland a marine, electrical, and engineering exhibition in the Artillery Drill Hall. There are about 300 exhibitors. The buildings are lighted electrical ly by Messrs. Ernest Scott and Mountain. The exhibition will remain open for two months.

Royal Institution.—The Christmas course of lectures, adapted to children, will be delivered by Prof. J. A. Fleming, F.R.S., professor of electrical engineering in University College, London. The subject will be "The Work of an Electric Current," and the first lecture will be delivered on Thursday, December 27, at three o'clock.

Shocks.—An arc lamp trimmer in Blackpool received a shock last week whilst attending to a lamp in the street. From the newspaper account it appears that he had not switched off the current in the base of the lamp before attempting to trim the lamp. At Keswick a broken wire is reported to have been the cause of several persons being slightly shocked.

Light Railways.—In response to the invitation from the Board of Trade, the London Chamber of Commerce have nominated Sir Edward H. Carbutt, Bart. (chairman of the Engineering and Allied Trades' Section), and Mr. Emil Garcke (chairman of the Electrical and Allied Trades' Section) as the delegates of the Chamber to the conference on light railways, which is to meet early next month.

Physical Society.—At the meeting of this society to be held to-morrow afternoon at the rooms of the Chemical Society, Burlington House, the following papers will be read: (1) "The Measurement of Electromagnetic Capacity,' by Mr. Fred. Womack; (2) "Mirrors of Magnetism," by Prof. Silvanus P. Thompson and Miles Walker; and (3) "Students' Simple Apparatus," by Prof. W. E. Ayrton and others.

Trans-African Telegraph.—According to Reuter's agency, Mr. Cecil Rhodes states that the Salisbury-Tete section of the trans-African telegraph has advanced 100 miles, leaving still 100 before the link is completed. He is of opinion that the wet season now coming may prevent its completion till after the rains. The material for the line is at Salisbury. It is officially announced at Cape Town that Blantyre and Tete are now connected by telegraph, thus bringing London within a week of Blantyre.

Utilisation of Water Power.—We have received a copy of a pamphlet by Mr. John Ritchie, hydraulic engineer, Edinburgh, on "The Utilisation of Water for Power and the Transmission of Same," and on "Improved Turbines for the Utilisation of Water for Power," these treatises being reprints of papers read last year before the Royal Scottish Society of Arts, and which were awarded the Keith medal and prize of £5. The author advocates a more extended application of water power in Scotland for electric lighting purposes.

Moving Sidewalks. — A sub commission of the universal exhibition to be held in Paris in 1900 met last week at the Ministry of Commerce to consider various proposals brought forward in connection with the exhibition. One of the schemes suggested is by M. Blot, of Paris, for a moving sidewalk, similar to that at the Chicago Exhibition, to be worked by electric power within the grounds. Another project—this by MM. Casalonga and Faure, of Paris—is for the construction of a metropolitan railway operated on the same principle.

Telephony in Germany.—Application has been made from Frankfort-on-the-Maine to the Imperial postal authorities that when telephonic communication is shortly established between Frankfort and Berlin, the two lines between Frankfort and Berlin, and between Frankfort, Cassel, Nordhausen, and Berlin should be reserved from 12 noon till 3 p.m. for the use of members of the exchanges. This has not been agreed to, the authorities considering that such a course would be unfair to telephone subscribers who are not members of the exchange. A new telephone exchange has been established at Moabit, Berlin.

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Electric Motors on War Vessels.—Whilst the English Admiralty have almost, if not entirely, refrained from installing electric motors on British men-of-war for the operation of heavy guns, the French Naval Administration have recognised the important part which this type of motor may be expected to play in the ready manœuvring of such weapons. As an instance of this fact, it may be mentioned that four of the latest French armoured cruisers are not only equipped with electric motors for the working of the guns, but also for the operation of the turrets.

New Mains in London.—The London County Council have approved of the City of London Electric Lighting Company laying additional mains on the west side of Southwark Bridge-road; of the House-to-House Company laying high-tension mains across Warwick-road into Longridge-road; of the Westminster Company to lay mains in Carrington-mews and across and along Little Stanhope-street; and of the Woolwich District Company to lay mains across Powis-street and in Eleanor-road. The Council have declined to allow the City Company to lay mains and construct street boxes in a part of Tower-hill, on the ground that the works would be outside the company's area of supply.

Royal Meteorological Society.—The opening meeting of the session was held on Wednesday at the Institution of Civil Engineers, Westminster, Mr. R. Inwards, F.R.A.S., president, in the chair. Dr. H. B. Guppy read a paper on "Suggestions as to the Methods of Determining the Influence of Springs on the Temperature of a River as Illustrated by the Thames and its Tributaries." Mr. Eric S. Bruce, F.R.Met.Soc., exhibited and described some lantern slides showing the disastrous effects of the great gale of November 17 and 18, 1893, upon trees in Perthshire, Scotland. Mr. Alfred B. Wollaston gave an account of the formation of some waterspouts which he had observed in the Bay of Bengal.

The Electric Light in Ceylon.—It has been definitely decided to light the new post office at Colombo with the electric light. In the illumination of the building 28 arc lamps will be used, and about 100 incandescent lamps. Twelve arc lamps will be used outside the building. Round the pavement in front of the post office there will be eight fancy lamp-posts bearing lights, while four others will be placed at the corners of the building outside. Then there will be four arc lamps in the main hall and eight in the sorting department. There are two sets of residential apartments within the building, and these will also be lighted by incandescent lamps, while all the other parts of the building will be illuminated in the same way.

Electrocution in America.—We referred to this subject last week. Another Dalziel's message now says: "There is great public indignation at the decision of Governor Flower to allow the body of the murderer Wilson, who is shortly to be electrocuted at New York, to be experimented upon immediately after the execution with the idea that life may be restored. Governor Flower has promised Wilson's attorney that in the event of resuscitation the man's life shall be spared, and Wilson himself clings to the only hope left him, and has expressed his gratitude to the governor for the remote chance of life given to him. A petition, which is being extensively signed, will be presented to the governor praying him not to allow the experiment to be made. Public feeling in the matter runs high."

Electric Traction in Germany.—A new project for an electric tramway to open up the Grunewald, Berlin, has been prepared by Messrs. Havestadt and Contag. It is proposed to start from the Nollenplatz.—The Allgemeine Deutsche Kleinbahngesellschaft, of Berlin, who own the Spandau tramways, have come to an agreement with the local authorities whereby electric traction will be adopted on the line. The work will be carried out by the Allgemeine Electricitäts-Gesellschaft, and the overhead trolley system will be employed.—An extensive system of electric tramways is to be established at Aix-la-Chapelle, where not only are the existing horse tramways to be changed into electric lines, but several new lines are to be built for electric traction.

Another Competition of Self-Contained Vehicles. A French contemporary states that it is proposed to organise a new competition of self-contained carriages, and that the comfort of passengers will not be studied as in the case of the *Petit Journal* contest, but that awards will be made to those competitors whose vehicles attain the highest speed on a long route. The minimum distance to be traversed is 620 miles; the start will be made from Paris, to which city the carriages will return; and the vehicles admissible to the competition must be operated either by an electric motor, a steam-engine, or a petroleum or similar motor. An organising committee has already been formed, and it is intended to arrange for the competition taking place next year.

Curious Octroi Process.—The town of Roubaix, according to *L'Energie Electrique*, levies tolls, or octroi duty, on coal for the gasworks and on petroleum, but industrial coal for the spinning mills is exempt. As the majority of the works provide their own light by running dynamos, the town claimed the right to tax the coal used for this particular purpose. Three of the manufacturers, acting for all those whose premises are electrically lighted, thereupon commenced an action against the town for the return of the money paid as octroi duty. The case was decided in favour of the manufacturers, and this decision has been confirmed by the Tribunal Civil de Lille. The town, however, now intends to carry the case to the Court of Appeal.

Sliding Roofs for Theatres.—A new theatre and concert-hall have been erected on the site of the former concert-hall known as "La Cigale" in the Boulevard Rochchouart, Paris. The buildings are lighted by 500 incandescent lamps, the current being obtained from the Edison Company's station in the Avenue Trudaine. Not only this, but on the suggestion of Mr. E. Pacoret the proprietors have had two electric motors installed for the operation of the sliding roof. The roof is divided into two parts, which form travelling bridges, each of which is equipped with an electric motor of 1 h.p. running at 1,000 revolutions. By means of gearing the travel of each half of the roof is effected, and alarm bells are automatically caused to ring on each half reaching its proper position.

Electromotive Force of Alloys in a Voltaic Cell.—Before a recent meeting of the Chemical Society Mr. A. P. Laurie, M.A., read a paper on this subject. The paper contains the results of determinations of the E.M.F. of 16 of the 19 alloys alluded to in Matthiessen's paper on the conductivity of alloys (*Phil. Trans.*). The results obtained confirm Matthiessen's conclusions, that only one compound, the tin-gold alloy, exists among the 16, which are: bismuth-tin, bismuth-lead, bismuth-gold, bismuth-silver, gold-silver, antimony-lead, cadmium-zinc, antimony-tin, lead-gold, lead-silver, lead-tin, lead-zinc, lead-cadmium, and cadmium-tin. In some cases the addition of a metal to the alloy results in displacement. Thus mercury decomposes the gold-tin compound, and zinc, added to copper-tin alloy, appears to replace the tin.

Telephony between England and Holland.—An application has been made to the London Chamber of Commerce by the Netherland Chamber of Commerce in

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London for information as to whether a trade requirement would be met by, and, commercial support given to, a telephone line between London and Holland, if such were established. The Netherland Chamber state that it would be possible to carry out the project by laying a line *vid* Dover to Sangatte, Dunkirk, Antwerp, Roosendaal, and Dordrecht to Rotterdam and Amsterdam. In order that the council of the London Chamber of Commerce may comply with the request of the Netherland Chamber, the secretary has sent out forms to members asking whether they think the establishment of telephonic communication with the Netherlands would be appreciated, and whether if such a means of communication were available, they would have occasion to use it.

Submarine Electric Boat.—Judging from the long interval that has elapsed since we last heard of the French and Italian submarine electric boats, the conclusion was naturally arrived at that they had gone to Davy Jones's locker. It appears, however, that this conclusion was too hasty, at least in regard to one of the French boats, which was tested again last week. This is, according to a *Times* correspondent, the "Gustave Zédé." She is a cigar-shaped vessel, 131ft. long, and displacing, when submerged, about 266 tons. On Wednesday of last week she moved about the roadstead at Toulon for three hours, never, however, as far as could be seen by those who were watching her from the shore, going beneath the surface. She attained a speed first of about five knots, and subsequently of about eight knots, with the 300 new accumulators with which she has been recently fitted. Her turning circle was found to be 700ft. or thereabouts. It appears that, although the boat was probably not submerged for a single moment, those on board experienced some discomfort from the acid vapours disengaged, and that submersion for more than a few minutes, the correspondent concludes, will be impossible unless measures can be devised for correcting this inconvenience.

Electric Lighting in Germany.—The central electric light station at Weissenfels is to be opened next month.—The Municipality of Plauen have under consideration the question of establishing an electric light station.—The local authorities of Kastel have arranged with Messrs. M. Schorch and Co., of Rheidt, to light the streets electrically.—It is expected that the central station at Goldberg, Silesia, will be ready about February.—The electric light mains at Munich are to be extended.—Application has been made by a local syndicate to the Municipality of Traunstein for a concession to use the water power of the Traun for electrical purposes. It is stated that from 200 h.p. to 250 h.p. could be obtained at small expense.—The local authorities of Königstein have determined to erect a central electric light station.—Messrs. Scheidt and Witzsche, who light their works at Grosblittersdorf electrically, have made an offer to the local authorities for the electric lighting of the streets.—It is proposed to light the streets of Alberschweiler, in Lorraine, electrically.—The Municipality of Strasburg, West Prussia, have adopted the proposal of the Helios Company for the erection of a central station.—The Lebus sugar factory at Frankfort-on Oder has been lighted electrically.

Paris Central Electrical Laboratory.—A few weeks ago we described the scope of the Laboratoire Central d'Electricité, which has been established for some time at 12 and 14, Rue de Stael, Paris. We now learn that to the laboratory has been added an Ecole d'Application, the object of which is to afford practical information to engineers in the extended employment of electricity in industrial operations. Students of any nationality and of any age will be admitted. Those candidates who are provided with diplomas which are not recognised as sufficient, will have to undergo an examination in electricity, and in a knowledge of mathematics, mechanics, and physics. The fees, which are payable in advance, amount to 200f. (£8), of which one half is to be paid on entrance and the other half on the 1st of March. The instruction will comprise (1) a course of from 30 to 35 lessons in industrial electricity; (2) a course of from 20 to 25 lessons on electrical instruments; (3) a series of lectures on special questions; (4) practical electrical work; (5) workshop work; (6) the establishment of industrial installations; and (7) visits to works. The lessons and lectures will take place between 9 a.m. and noon; laboratory and workshop work will either be in the morning or afternoon. An examination of the students by the professors will be held in the middle of the year, and a second examination will also take place. The session will open on December 3 next.

Society of Arts.—The one hundred and forty-first session of the Society of Arts was opened on Wednesday evening, when Major-General Sir John Donnelly, chairman of the council, delivered an address, in the course of which, having mentioned the society's efforts in establishing drawing and modelling schools for artisans, and in promoting in 1852 the union of institutions to aid and develop the work of the literary and scientific institutions and mechanics' institutes, he referred to the establishment in 1872 by the society of examinations in technology, which had since been developed by the City and Guilds of London Technical Institute. The examinations of the Society of Arts and those of the City and Guilds Institute did not now overlap, but were complementary one of the other. Their own examinations were literary and commercial, while those of the institute were in the technology of trade and manufactures. In conclusion, the chairman suggested that the Society of Arts should undertake the initiative in bringing together the various bodies concerning themselves with the question of technical education, so that they might form some kind of joint Board, or at least co-operate in the general interests of the movement. The chairman afterwards distributed the society's silver medals awarded for papers presented during the past session. The paper at next Wednesday's ordinary meeting will be on "Experiments in Aeronautics," by Mr. Hiram Maxim."

Electrical Apparatus.—A glance through the new illustrated catalogue just issued by Messrs. Dorman and Smith, of Ordsal Electrical Works, Salford, and of 11, Grocers' Hall-court, London, E.C., shows the large variety of electrical appliances made by the firm. Commencing with an assortmsnt of holders for different kinds of lamps, the list passes on to guarded and shaded iron reflectors, and to the "D. & S." (new series) porcelain switches. These switches are made entirely of porcelain and metal, no fibre or other semi-insulator, liable to be affected by damp, being used. In addition to these, carbon break switches, switches for house service, single and double pole main switches, and main switchboards occupy a prominent position. These are followed by porcelain cut-outs, distributing fuse-boxes, resistances and regulators, and wall sockets and socket connections for heavy currents. Dealing with fittings, some neat and handy balanced suspension pendants are shown, together with a variety of plain brackets, cast-iron mill fittings, universal fittings. A new series of strong brass fittings for ships is illustrated. In this case a flanged well glass is used, and being held up against an indiarubber ring a watertight joint is made. The guards of these fittings are made of wrought-brass tape, and are exceedingly strong and graceful in appearance. They are stocked finished in steel

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bronze, but can be made of polished and lacquered brass when required. The Raworth and the "D. & S." bobbin detectors bring this catalogue to a close.

Length of Electric Tramways in Europe.—It has for many months past been extremely difficult to follow the complications attending the different schemes for the construction both in Berlin and Vienna of underground and surface electric railways. Nevertheless, the question has recently been taken up prominently by the Vienna Elektrotechnische Verein, who have made some excellent suggestions for improving the facilities of transport in that city by the introduction of electricity as the motive power. Not only this, but the Verein has now been supported by the Verein für die Förderung des Local und Strassenbahnwesens. One of the members of the latter, Mr. Ziffer, referred particularly a few days ago to the report presented by Mr. Paul van Vloten at the meeting in August last of the Permanent International Tramway Union. It appears that Mr. van Vloten investigated on behalf of that union all the important electric tramways in Germany, France, Italy, and Switzerland, subsequently drawing up an exhaustive report on the subject. The following table, extracted from that report, shows the position of electric traction in different European countries at the close of 1893:

	In operation.	In construction.	Total.
Belgium	3·2	18·5	21·7
Germany	102·0	66·1	168·1
England	71·4	21·4	92·8
France	41·4	29·0	70·4
Italy	13·0	—	13·0
Holland	4·9	—	4·9
Austria-Hungary	33·4	—	33·4
Roumania	—	5·5	5·5
Russia	3·0	7·0	10·0
Sweden and Norway	—	6·5	6·5
Switzerland	23·6	10·6	34·2
Servia	—	10·0	10·0
Spain	14·0	—	14·0
Total	309·9	174·6	484·5

Lamps Supplied v. Lamps Installed.—Some interesting statistics were recently brought under the notice of the German Gas and Water Union by Messrs. Bunte and Rasch in regard to the development of electric lighting in Germany. The authors calculated and grouped the number of incandescent lamps installed in the cases of private installations and central stations per 1,000 inhabitants, the towns concerned having populations exceeding 100,000 persons. Arc lamps are each reckoned as equivalent to 10 incandescent lamps. The following few instances will illustrate the number of lamps installed per thousand inhabitants: Aix-la-Chapelle, 77; Berlin, 80; Hamburg, 108; Hanover, 126; Magdeburg, 148; Munich, 192; and Frankfort-on-the-Maine, 193. Very interesting are the following figures, which show the percentage of lamps supplied as compared with the total number of lamps installed: Aix-la-Chapelle, 43 per cent.; Berlin, 60 per cent.; Dusseldorf, 62 per cent.; Elberfeld, 88 per cent.; Hamburg, 19 per cent.; Hanover, 39 per cent.; and Stettin, 71 per cent. An average of 12 towns gives a percentage of 52 per cent. In order to draw a proper conclusion from these statistics it is necessary to ascertain (1) how long the central station has been in operation; (2) if the mains extend throughout the town or only in a part of it; and (3) if there are many industrial establishments where private generating plant is in use. The authors state that out of the total number of lamps installed in Germany, only one quarter is supplied from central stations, and they conclude that with the extension of similar investigations it will be found that this proportion will prove to be less favourable to central stations because a number of works in the same locality will put down their own plant.

Railway Rates.—The council of the London Chamber of Commerce have decided to support, and to financially assist, the executive committee of the Mansion House Association on Railway and Canal Traffic, in bringing test cases for the purpose of determining, as far as may be practicable, the reasonableness of the general increase in railway rates, and with the object of clearing up several other points of great interest to traders arising out of the Railway and Canal Traffic Act passed last session. To prosecute this course of action successfully, it will be necessary to obtain the assistance of leading members of the legal profession. Neither the Chamber nor the association have at their disposal ordinary funds which can be diverted to this object. The council point out that there can be little doubt, however, that the "test cases" will be the means of saving, not only immediate but future heavy expenses to traders, and they therefore appeal to members to subscribe to a guarantee fund, in accordance with a form issued to members. At the same time these test cases cannot be held to obviate, as a matter of course, the necessity for the submission of complaints to the Board of Trade on the part of those who desire to establish their title to deductions which they have made from the railway companies' accounts, or to recover increases which they have paid. Members who desire to avail themselves of the Act of 1894 are therefore recommended to complain to the Board of Trade without delay as the best means of avoiding legal proceedings at the instance of the railway companies, and upon this point it must be borne in mind that, if it is desired to obtain from the railway companies damages in satisfaction of over-charges made prior to the passing of the Act, complaint must be made to the Board of Trade not later than February 25, 1895.

Double-Voltage Dynamo.—A new machine called the Fuller double-voltage, automatic, constant-potential dynamo, has been brought out by the Fontaine Crossing and Electrical Company, Detroit, Mich., for which a number of advantages is claimed. Among these, according to the *Electrical World*, are that the dynamo can be connected to any three-wire system without alteration in wiring throughout the building, and used equally as well with a two-wire system and for either of two voltages. For example, in a 100-h.p. generator the current can be taken at 110 volts or at 220, while any intermediate number of horse-power from zero to full load can be taken at either voltage or both at the same time. The dynamo is, in fact, practically two machines in one. The company guarantees all machines to regulate within two volts from zero to full load with brushes practically at a fixed point of commutation. Particular attention has been given to the mechanical construction of this machine, ensuring long life, as the bearings are long and large in diameter. The field windings are of high resistance, while the armature windings are of low resistance, ensuring long life, from the fact that heating is almost entirely avoided. The bearings are self-oiling and self-aligning, ensuring perfect lubrication. The advantage of this machine is particularly apparent where 220-volt motors are in use, and it is desired to put in a lighting plant, as in this case the motors can be supplied with a 220-volt current, and the lighting circuits yet run at 110 volts. In large cities, where floor space is valuable, it is obvious that where one machine is put in to do the work of two the expense is greatly decreased. There is one foundation dispensed with, one belt and one clutch pulley, as well as the actual floor space saved. In the ordinary system of lighting and power service,

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where two voltages are desired, it has always been necessary to couple two machines in series, thus making the first cost of the plant extremely high. While the cost of a dynamo of this description is slightly higher than a single-voltage dynamo, it is low when compared with the cost of two machines.

Electric Traction in Egypt.—A telegram from Cairo states that the Council of Ministers have granted a concession for the construction of an electric tramway in the city to a Belgian syndicate. It will be remembered that tenders for this line were invited some time ago. It appears, however, that a dispute has arisen in connection with the undertaking, as is shown by a further dispatch from Cairo. The telegram states that the concession, which was granted to the Société Belge des Chemins de Fer Economiques, will probably be rescinded or suspended by order of the British Government, until the appeal of Mr. John Fell, of Leamington, the late concessionaire, has been heard by the Mixed Tribunal, or till the Egyptian Government agree to pay him sufficient compensation to induce him to withdraw his case from the Court of Appeal. It is submitted that by the terms of the new concession the Belgian company was to refund the £2,000 deposit which Mr. Fell had originally lodged with the Egyptian Government, but a new face having been put upon Mr. Fell's case by a correspondence between Lord Kimberley and the British Agency, it is considered likely (the telegram continues) that the Administration will consent to refund several thousand more of the claim for expenses which were incurred under the first concession rather than throw over the Belgian company, who hold an advantageous tender. From the information in possession of the British Agency, the authorities there were enabled to supply Lord Kimberley with particulars as to Mr. Fell's claims, and the matter is now in Mr. Fell's hands. It is thought that the Egyptian Government misrepresented the facts in their endeavour to convince the Foreign Office that the claim of that firm was groundless. In this information, it is alleged, an official copy of the letter from Sir Colin Scott Moncrief to Mr. Fell, dated 1891, appears with the words "Under Secretary of State" suppressed, and without a registered number, and a telegram from the Alexandria Customs authorities is produced denying the existence in the Customs at the time of a cargo of rails to Mr. Fell's address. From this apparently crooked dealing it is thought that the British Government will interfere, and insist upon a fair compensation being granted by the Egyptian Government to Mr. Fell.

Decimal System of Weights and Measures.—The New Decimal Association, which has been established to promote the adoption of a decimal system of weights, measures, and coinage in the United Kingdom, met on Tuesday at the offices of the London Chamber of Commerce. Sir Samuel Montagu, M.P., presided, and amongst those present were the Right Hon. Sir J. W. Mellor, M P. (representing the Halifax Chamber of Commerce), Mr. H. O. Arnold Foster, M.P. (Belfast Chamber of Commerce), Mr. E. H. Bayley, M.P., Mr. Alex. Siemens, Sir Philip Magnus, Mr. Thomas Kyle (Incorporated Society of Inspectors of Weights and Measures), Mr. A. J. Hamilton Smythe, M.I.C.E., Mr. Frank Debenham, Mr. Martin Wood, etc. The Chairman mentioned that the association proposed to confine the present movement to weights and measures, and not deal with the subject of decimals in money. Sir Albert K. Rollit, M.P., proposed the following resolution: "That this association learns with satisfaction that the Government consents to the appointment of a Select Committee to enquire whether any and what changes in the present system of weights and measures should be adopted, and the executive committee is hereby authorised to take such steps as it may consider best for promoting the adoption of the metric weights and measures." He remarked that we occupied an isolated position with weights and measures in reference to international trade. The metric system was used by 400,000,000 of people, with some 60 or 70 per cent. of whom we did business, and our system of weights and measures, which really belonged to bygone ages, was a great impediment to our operations. He was sure the change proposed would have a beneficial effect on the growth of our industries. The change was inevitable, and should be carried out without delay, while as to the difficulties, Germany, split up as she was, had been able to overcome them in four years. The motion was seconded by Mr. J. Emerson Dowson, C.E., and after it had been supported by half-a-dozen speakers, was carried. A further resolution was passed to the effect that the Hon. William L. Wilson should be informed of the present position of the movement in this country for adopting the metric weights and measures, and that he be invited to use his influence to secure such legislation as may provide for the adoption of this system of weights and measures in the United States.

Central Electric Light Stations in Paris.—In *L'Industrie Electrique*, Mr. J. Laffargue gives some particulars respecting the central electric light stations in Paris. The Compagnie Continentale Edison has now three central stations—the Drout, Trudaine, and Palais Royal, as well as a St.-Georges sub-station. When the output is at its maximum the stations are coupled in parallel. The company has made every endeavour to improve the condition of the mains, which at first were very defective. Artificial ventilation is employed, and other improvements have been introduced. The Société Anonyme d'Eclairage et de Force par l'Electricité have continued their work without any important changes on the original installations, showing that the original scheme had been well considered and satisfactorily carried out. The Société Anonyme d'Eclairage du Secteur de la Place Clichy possess a central station which has been established under excellent conditions. Since 1892 there has been added to the plant two vertical steam-engines of 500 h.p. Great care is exercised in the supervision of the machinery. Minute precautions are taken in connection with the testing of the mains, and a portable laboratory is taken to all parts of the district so that the whole of the network is visited once a year. Visits are also made from time to time to inspect the installations of customers. The Compagnie Parisienne de l'Air Comprimé has ever since it started been undergoing a process of transformation. The district is now to be arranged for two central stations and three sub stations, the five-wire system being employed. The Société Anonyme du Secteur Champs-Elysées have the concession of a very wide district, mainly consisting of private houses and hotels, and the distribution has been more difficult than in central Paris. The company appear to have some difficulties in connection with the coupling of alternators in parallel. The Société Anonyme du Secteur de la Rive Gauche are one of the least advanced. Their central station at Ivry is still only a project, though the subject has long been under discussion. The Usine Municipale d'Electricité des Halles Centrales shows little alteration from its original arrangements, but four Desrozier dynamos and two batteries of accumulators have been added. On the whole, the central stations of Paris are in a satisfactory condition, and have got over their initial difficulties. The most delicate part of the work has been in connection with the laying of the mains, owing to the conditions imposed by the municipal authorities.

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THE INSTITUTION DINNER.

The sixth annual dinner of the Institution of Electrical Engineers took place at the Freemasons' Tavern on Wednesday evening, under the presidency of Mr. Alexander Siemens. It was a large gathering, there being, as will be seen from the following list, some 200 gentlemen present.

Adams, Prof.
Addenbrooke, Mr.
Albright, Mr.
Allen, Mr. W. H.
Allen, Mr. R. W.
Armstrong, Dr.
Atherton, Mr.
Auerbach, Mr.
Bagnold, Major.
Bailey, Mr. B.
Bailey, Mr. F.
Barr, Mr.
Beevor, Mr.
Benedict, Mr.
Bergtheil, Mr. A.
Bergtheil, Mr. E.
Binswanger, Mr. G.
Binswanger, Mr. M.
Blackwell, Mr.
Blomefield, Sir T.
Bristow, Mr. A. W.
Bristow, Mr. G. L.
Broekman, Mr.
Brown, Mr.
Browne, Sir J. C.
Bryce, Right Hon. J.
Buckney, Mr.
Burstall, Mr.
Caffin, Mr.
Cardew, Major.
Carpmael, Mr.
Chamen, Mr.
Chauvin, Mr.
Christie, Mr.
Clarke, Gen. Sir A.
Cooke, Mr. H.
Cooke, Mr. H. C.
Creak, Captain.
Cree, Mr.
Crompton, Mr.
Crookes, Prof.
Crowe, Mr.
Curra, Mr.
Cushing, Mr.
Dale, Mr.
D'Alton, Mr.
Davis, Mr.
Dawson, Mr.
Dieselhorst, Mr.
Donkin, Mr.
Donovan, Mr.
Dowsing, Mr.
Dowson, Mr.
Eden, Mr.
Edmunds, Mr.
Edwards, Mr.
Ehrhardt, Mr.
Ellis, Mr.
Elphinstone, Mr.
Epstein, Mr.
Erskine, Mr.
Esson, Mr.
Estler, Mr.
Evans, Mr.
Fairfax, Mr.
Fellows, the Hon. J.
Fernie, Mr.
Ferranti, Mr.
Fleetwood, Mr.
Forde, Mr. H. B.
Forde, Mr. H. C.
Foster, Mr.
Fowler, Mr.
Fraser, Sir M.
French, Mr.
Galindey, Mr. de
Gray, Mr.
Grindle, Mr.
Grove, Mr.
Hager, Mr.
Hall, Mr.
Hammond, Mr. C. P.
Hammond, Mr. R.
Handcock, Mr.
Harrison, Mr.
Hart, Mr.
Hawkins, Mr.
Hayman, Mr.
Heaphy, Mr.
Heaviside, Mr.
Hedges, Mr.
Heilmann, Mons.
Herbert, Sir R.
Hesse, Mr.
Hirst, Mr.
Holden, Mr.
Holden, Major
Hook, Mr.
Hookey, Mr.
Hopkinson, Dr.
Horton, Captain
Howard, Mr. J.
Howard, Mr. A. H.
Hughes, Prof.
Hughes, Mr. H.
Hughes, Mr. S.
Hume, Mr.
Ince, Mr.
Jack, Mr.
Jackson, Mr.
Jacobs, Mr.
Jenkin, Mr.
Keith, Mr.
Kempe, Mr.
Kempster, Mr.
Kennedy, Prof.
King, Mr.
Kolle, Mr.
Lambe, Mr.
Lane, Mr.
Lattre, Mr. de
Leese, Mr.
Levesley, Mr.
Lloyd, Mr.
McDougall, Mr.
Madden, Mr.
Magden, Mr.
Mance, Sir H.
Marsh, Mr.
Martineau, Mr.
Mavor, Mr. A.
Mazan, Mons.
Merriman, Mr.
Minty, Mr.
Mitchell, Mr.
Moir, Mr.
Mordey, Mr.
Morgan, Mr.
Munro, Mr.
Parshall, Mr.
Partridge, Mr.
Peace, Mr.
Pearson, Mr.
Pender, Sir J.
Pender, Mr. J.
Perkins, Dr.
Perry, Prof.
Phillips, Mr.
Pole, Dr.
Popham, Mr.
Preece, Mr. W. H.
Preece, Mr. W. L.
Price, Mr.
Rawlings, Mr. J. L.
Rawlings, Mr. W. R.
Rawlins, Mr. T.
Rawlins, Mr. W.
Rawlinson, Sir R.
Raworth, Mr.
Reeves, Mr. E. H.
Reeves, Mr. F.
Reid, Mr.
Rentell, Mr. S.
Reynolds, Mr.
Robins, Mr.
Robinson, Mr.
Rorke, Mr. T. J.
Rorke, Mr. A.
Russell, Earl
Salomons, Sir D.
Samuel, Sir S.
Sandon, Mr.
Sankey, Captain
Sedgwick, Mr.
Seymour, Mr.
Shaw, Sir E. M.
Scholey, Mr. H.
Shoolbred, Mr.
Siemens, Mr. (chairman)
Sinclair, Mr.
Smith, Mr. M. H.
Smith, Mr. W. O.
Smith, Mr. W. S.
Snell, Mr.
Spagnoletti, Mr. C. E.
Spagnoletti, Mr. J.
Sparks, Mr.
Sprenger, Mr.
Stanley, Mr.
Stiffe, Captain
Stothert, Mr.
Stroh, Mr.
Stuart, Captain
Swan, Mr.
Swinburne, Mr.
Swinton, Mr.
Taylor, Mr.
Thompson, Prof.
Tralen, Mr.
Tree, Mr.
Tresize, Mr.
Troughton, Mr.
Trotter, Mr.
Tucker, Mr.
Tunzelmann, Mr.
Verity, Mr. H. S.
Verity, Mr. J. B.
Voysey, Mr.
Wallis-Jones, Mr.
Weaver, Mr.
Webb, Mr.
Webber, Major-General
Wilkinson, Mr.
Willett, Lieut.
Williamson, Mr.
Wright, Mr.

It was about half-past nine when, on looking towards the chair, the fingers of the toastmaster in the rear were observed to twitch nervously round a small mallet. Someone was heard to remark that an auction was about to take place, but by dint of expostulation the toastmaster was quietened down, and no bargains were made. Then, with a gentle tap, way was given to

The PRESIDENT, who in a few touching words proposed the toast of "Her Most Gracious Majesty the Queen." This having been duly honoured, the President put that of "Their Royal Highnesses the Prince and Princess of Wales, and other Members of the Royal Family," adding some appropriate words in reference to the cordial sentiments existing between those absent at the Russian Court and the Russian Royal family.

"Our Colonial Empire," coupled with the names of Sir Saul Samuel, K.C.M.G., C.B., agent-general for New South Wales, and Sir Malcolm Fraser, K.C.M.G., agent-general for Western Australia, was also proposed by the PRESIDENT.

Sir SAUL SAMUEL, in the course of his reply, caused some amusement by stating that by the aid of submarine telegraphs to the colonies we could send telegrams there to-day, a distance of 12 or 13 miles, and get a reply next morning. But the astonishment depicted on the surrounding countenances caused him to extend the distance to between 12,000 and 13,000 miles. As an instance of land work in the colonies, he mentioned that in the early days fencing wire was used for telegraphic purposes, wooden insulators covered with shellac being employed.

Sir MALCOLM FRASER, in acknowledging the debt Australia owed to the Institution of Electrical Engineers, went so far as to state that electricity was only in its embryonic stage. It was fortunate for him on that occasion that steam interests were subservient to those of electricity, or his observation that steam had had its day, and that the century would hardly last out before it was overcome by its rival—applied science of electricity—would hardly have been permitted to pass unchallenged.

A few seconds vanished before the ironical laughter passed away on the announcement by the toastmaster that Mr. Pearce would give the toast of "The Learned and Engineering Societies," coupled with the names of Dr. H. E. Armstrong, F.R.S. (president of the Chemical Society), and Sir Robert Rawlinson, K.C.B. (president of the Institution of Civil Engineers).

Mr. W. H. PREECE, F.R.S., who, whilst fully appreciating the joke, assumed a solemn countenance, said, lest there were any doubt as to the identity of the individual, that "I am the man." After an amusing story of the Irishman and the egg—the difficulty being either the killing of the man or the hatching inside him of a Cochin China chicken—the speaker said that the engineer was the man. The practical man of to-day, he continued, had not only alleviated, but removed disease; he at the same time utilised energy; he extended life, and, after all, he succeeded in answering in the most practically satisfactory way the question, "Is life worth living." The finger of the philosopher had pointed the way in which the practical man had to go.

Sir ROBERT RAWLINSON, who met with a similar misfortune to that attending Mr. Preece, he being at first announced as Dr. Armstrong, made some suitable remarks on behalf of civil engineering.

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Dr. H. E. ARMSTRONG excited some interest by propounding the problem whether orange-peel or electricity was the greater danger to public safety. He did, however, not attempt a solution. A little shot was fired at the expense of electrical engineers, who were told that they were moving in too narrow a sphere, and that they were "slaves of the lamp"—no, of the dynamo. Whilst attention was largely being devoted to the dynamo and its uses in producing light and as a source of power, there were other uses for the electric current which were likely to be of enormous importance. For instance, on the chemical side there was its application in connection with bleaching operations, and in other directions, and there was no doubt that ere long all copper would be made by the aid of the electric current. The speaker suggested the widening of the sphere of operations on the part of electrical engineers in the great development that would take place, and in this they would be assisted by chemists. Unfortunately, they were greatly behind in those matters as compared with the Continent.

Dr. J. HOPKINSON, F.R.S., in proposing "Our Guests," united with the toast the names of the Right Hon. James Bryce, M.P. (President of the Board of Trade), and Lieutenant-General Sir Andrew Clarke, G.C.M.G., C.B. The speaker observed that part of the duties of the Board of Trade was to curb the aspirations of the electrical engineer. He suggested that the Mr. Bryce who wrote about the American commonwealth should confer with the Mr. Bryce who presided over the Board of Trade, and bring to his notice the fact that in America, where electrical engineers were far less trammelled than in this country, there were thousands of miles of electric tramways. Supposing that once in a way this greater freedom did result in the loss of a life or two, surely the Mr. Bryce who climbed Mount Ararat might think the loss compensated for by the increased facilities afforded to the public.

The Right Hon. JAMES BRYCE, M.P., amused his hearers by mentioning that there were three poets at the Board of Trade. As if to dispel any idea that this was detrimental to the Department, he stated that those three gentlemen were the most efficient on the staff. In paying a high tribute to the Institution of Electrical Engineers, he stated that the Board of Trade looked on the Institution as a reservoir of knowledge to go to whenever they were in any difficulty. Valuable service had been rendered in that way in connection with electric lighting. The Board of Trade had been able to do much to facilitate the progress of electrical engineering, especially by fixing those electrical standards which were adopted by the Chicago Conference, and which they hoped in a short time to see adopted by the leading Powers of Europe. He agreed with the proposer of the toast that the United States were ahead of us in electric lighting of cities, but he doubted whether they were so far advanced in the lighting of private houses, and the Department would soon have matters under consideration with regard to electric tramways and light railways which would, he hoped, bear fruit in no distant period. They were more tender of human life than their American kinsmen, and he thought they would agree with him that progress in electrical engineering would proceed more rapidly and meet with more popular favour if accompanied with safety, as at present, than if it were accompanied with such accidents as often occur in America. No pains were spared by the Board of Trade to facilitate the creation of new undertakings calculated to give employment, to add to the comfort of the public, and to develop commerce. Their work progressed faster than the politicians, for they were anxious to help one another and find out the truth, while the politician was engaged in efforts of an exactly opposite character. Any attempt to make progress in politics led to an immediate evolution of heat, while they provided light with as little heat as possible. He thought theirs was the more enviable lot, seeking the unseen and hidden truths of nature. They were engaged in bringing mankind into one chamber, and in trying to draw force from the wind and water, hoping thereby to turn the banks of mountain streams into homes of industry. It was impossible not to admire what they had done, and to look forward with pleasurable anticipation to what they hoped to do.

The concluding toast, proposed by Sir JOHN PENDER, M.P., was "The Institution of Electrical Engineers," which was suitably acknowledged by the PRESIDENT.

ON THE EFFECT OF MAGNETISATION UPON THE DIMENSIONS OF WIRES AND RINGS OF ANNEALED IRON.*

BY SHELFORD BIDWELL, M.A., LL.B., F.R.S.

In the year 1885 I submitted to the Royal Society the first of a series of papers † upon the changes produced by magnetisation in the dimensions of rods, etc., of iron and other magnetic metals. The chief, and perhaps the most interesting subject of the paper, was the observation that if the magnetising force were sufficiently increased, the extension which a magnetised iron rod at first underwent (as originally noticed by Joule)‡ was followed by contraction, the rod ultimately becoming shorter than when it was unmagnetised. The elongation was generally found to attain a maximum with a magnetising force of from 80 to 120 C.G.S. units, and to vanish with a force of 300 to 400, retraction occurring when still higher forces were applied.

From that date until quite recently no accounts of similar experiments by others workers have, so far as I know, been published. About the beginning of last year, however, it was stated in the scientific journals that M. Alphonse Berget had investigated the magnetic dilatation of iron in strong fields, and had found that the length of his bar was still increasing when the magnetic field had reached as high a value as 540 units, beyond which point the experiment was not carried.

On reference to the original paper in the *Comptes Rendus*,§ it appeared that the experiment was made with a cylindrical bar measuring 5·2cm. by 1·95cm., its length being less than three times its diameter. The actual magnetising force must therefore have been enormously less than that due to the coil itself, and it is very improbable that it ever reached the value at which the iron or the greater portion of it (for the magnetisation must have been far from uniform) would attain its maximum extension.

The *Philosophical Magazine* of December, 1893, contains an account of some experiments by Mr. Sydney Lochner, made, as he states, with the express object of determining whether M. Berget's results or my own were correct. Using a thin iron rod, he obtained a curve very closely resembling those published by myself; but, as might have been expected, he found that a short thick rod, like that of M. Berget, gave no decided indication of having passed a maximum extension within the limits of the magnetising force that he employed.

A paper of great interest on "Hysteresis Attending the Change of Length by Magnetisation in Nickel and Iron," by Mr. H. Nagaoka, published in the *Philosophical Magazine* for last January, also incidentally confirms my observations.

In subsequent papers I have shown how the elongations and retractions were modified by tension, and by the passage of electric currents through the specimens under examination; and in the present communication I propose to deal with the somewhat unexpected effects which were produced by carefully annealing the iron before using it.

Upon this point, Joule's observations are as follows: "On inspecting the tables, it will be remarked that the elongation is, for the same magnetic intensity, greater in proportion to the softness of the metal. It is greatest of all in the well annealed iron bars, and least in the hardened."‖

The current belief, in which till quite recently I myself shared, is in accord with this statement. It appears, however, as will be shown, that it represents the reverse of the truth. Joule's conclusion with regard to iron seems to have been based entirely upon the results of a single experiment with an unannealed bar, and he may possibly

* From the *Proceedings* of the Royal Society.

† Royal Society's *Proceedings*, vol. 40 (1886), pp. 109, 257; vol. 43 (1888), p. 407; vol. 47(1890), p. 469; vol. 51 (1892), p. 495. Philosophical Society's *Transactions*, vol. 179, A (1888), p. 205.

‡ Joule's Scientific Papers, pp. 48 and 235.

§ *Comptes Rendus*, November 7, 1892, p. 722.

‖ Joule's Works, p. 246.

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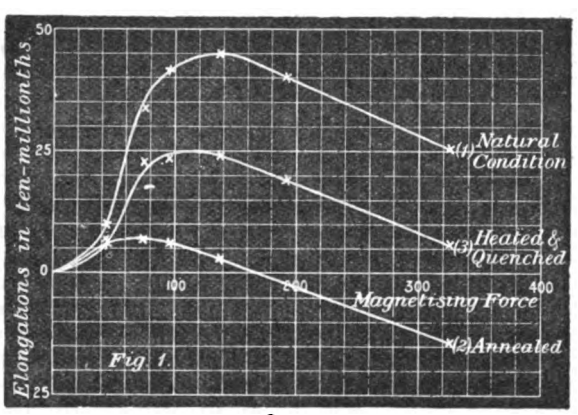
have been mistaken in supposing that it consisted of the same quality of iron as the annealed bars which he had used before.

My own experiments, the results of which are given in Table I. and Fig. 1, were made with a piece of iron wire 10·6cm. in effective length and 0·265cm. in diameter. The curve marked (1) shows the behaviour of the iron in the condition in which it was bought. Its length increased rapidly with the magnetising force, the maximum increment which was obtained in a field (due to the coil) of about 140 units being as much as 45 ten-millionths of the length of the wire. The same wire was then carefully annealed, and the experiment repeated, with the results indicated in curve (2). It will be seen that the maximum increment had fallen from 45 to about eight ten-millionths—less than one-fifth of its former value—and was reached with a force of about 60 units. Finally, the wire was raised to a bright red heat in a blow-pipe flame, and dropped into cold water, its subsequent performance being as indicated in curve (3). This last operation was found to have raised the maximum elongation from eight to 25 ten-millionths, while the corresponding magnetising force had increased from 60 to about 110 units.

TABLE I.

Magnetising force, C.G.S. units.	Elongations in ten-millionths of length. Iron as bought. (1).	Annealed. (2).	Made red hot and quenched (3).
43	10	7·0	6
74	34	7 0	23
96	42	6·0	24
138	45	3·5	24
192	40	− 1·2	19
324	25	−17 0	6



Other experiments gave results of a similar character, and many attempts were made to obtain an annealed wire which would not be lengthened at all by magnetisation, but begin to contract from the first, like nickle and cobalt. But I never succeeded in bringing a wire into such a condition that its maximum elongation was less than seven or eight ten-millionths.

Though I failed with straight wires, however, I was perfectly successful with an iron ring.

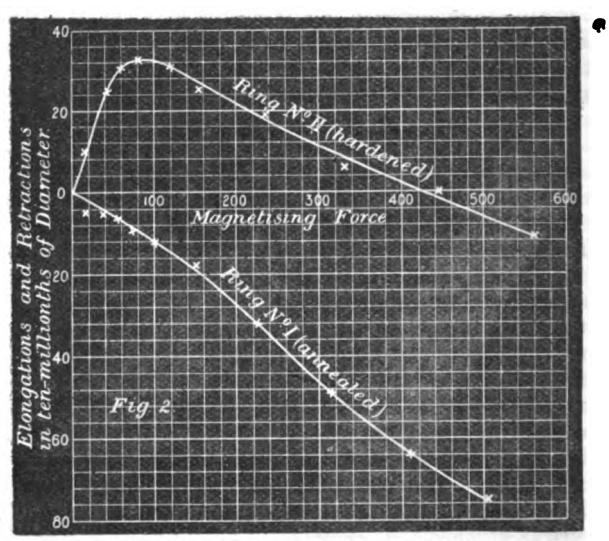
I have in a former paper given an account of some experiments made with rings.* The changes in the diameter of a ring were found to be of just the same character as those observed in straight rods. With a continuously increasing magnetising force, the diameter first increased in length, and after passing a maximum, ultimately became shorter than at starting.

In those experiments three different rings were employed, not one of which had been annealed before being used; I therefore had a new ring made of good soft iron, and very thoroughly annealed. It was afterwards fitted with a boxwood jacket, around which 515 turns of insulated wire were wound in the usual way. With this ring it was found that the smallest currents which caused any effect at all produced contraction. There was no indication of the smallest preliminary extension.

The results of an experiment with the ring (which I shall call Ring I.) are given in Table II, and in the lower curve of Fig. 2. The latter bears a close resemblance to the earlier portion of the curve given by a rod of cobalt. The greatest retraction reached was nearly 75 ten-millionths (exceeding any that has been ever before obtained with iron), and from the appearance of the curve there is reason to believe that this was still far from its limiting value, but the heating effect of the magnetising current made it impossible to carry the experiment further.

TABLE II.

Ring II. (annealed) Magnetising force, C.G.S. units.	Elongations in ten-millionths of length.	Ring I. (hardened) Magnetising force, C.G.S. units.	Elongations in ten-millionths of length.
15	− 4·5	15	10
39	− 5·6	42	25
56	− 6 2	61	31
73	− 9	81	33
101	−12	119	31
152	18	155	25
226	−32	239	19
312	−49	328	6
410	−64	445	0
506	−75	560	- 11



I at first contemplated unwinding the wire, hardening the iron, and repeating the experiment with the same ring; but felt unwilling to run the risk of spoiling so remarkable a specimen which it might turn out to be difficult or impossible to replace. I therefore had another ring made of iron from the same parcel, and believed to have been cut from the same bar as the first. As, however, there was some doubt about this latter point, I thought it better in the first instance to anneal the new ring, and test it with a few turns of wire wound upon it. Its behaviour was found not to differ materially from that of Ring I. A very small elongation—too small to be measurable—was, however, observed with a magnetising force of only three C.G.S. units, contraction beginning when the force was increased beyond this value. The ring was then made red hot, and plunged into cold water, with the object of hardening it, after which operation it was replaced in its boxwood jacket and wound with 473 convolutions of wire.

This ring, called Ring II, was now found to give the same results as the old unannealed rings and straight wires. As appears in Table II. and Fig. 2, it attained its maximum elongation of about 33 ten-millionths in a field of 80, its original length was recovered in a field of about 440, and a retraction of 11 ten-millionths occurred in a field of 560.

It appears, therefore, that as regards magnetic changes of dimensions, an iron rod or ring is affected by annealing in very nearly the same manner as by tensile stress,* a result which would hardly have been anticipated.†

* The Philosophical Society's *Transactions*, 179, A, p. 205. A ring is prepared for the experiment in the following manner: Short brass rods are attached to it at opposite ends of a diameter, forming prolongations, which serve to transmit the effect of changes in the length of the diameter to the measuring instrument. The ring is then covered with a loosely-fitting boxwood jacket, also ring-shaped, and through holes in this the two brass rods protrude. The magnetising coil is wound directly upon the wooden ring, the object of the latter being to protect the iron from the heat generated when a current is passing through the coil.

* Royal Society's *Proceedings*, vol. 7 (1890), p. 469.

† The less so since the length of an iron rod seems to be diminished by annealing. A piece of iron wire 100mm. long, cut from the same hank as that used in the experiments, was heated in

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Notes Regarding Details.

The apparatus and methods of experiment were the same as those fully described in the Philosophical Society's *Transactions*, vol. 179, A, pp. 218, 224, the instrument being arranged so as to have a magnifying power of 43,745.

The height of each little square in Fig. 2 corresponds to a length of about one-millionth of an inch (0·00000088in. for Ring I, and 0·00000103in. for Ring II).

The wires and rings were demagnetised by reversals before every single observation. For a description and diagram of the demagnetising apparatus, see *loc. cit.*, p. 207.

The dimensions of the iron rings and their boxwood jackets were as follows:

	Ring I.	Ring II.
Rings—External diameter	6·9cm.	6·1cm.
Width	2·9 ,,	3·0 ,,
Thickness	0·4 ,,	0·35 ,,
Mean radius	3·25 ,,	2·82 ,,
Boxwood jackets—External diameter	7·7 ,,	6·9 ,,
Width	3·7 ,,	3·8 ,,
Thickness	1·3 ,,	1·15 ,,
Convolutions	515	473
Gauge of wire	0·91mm.	0·91mm.

The rings were formed from rectangular bars with welded joints, and were turned in the lathe to the above dimensions.

The magnetic fields were calculated from the formula $H = 2ni/r$, where n is the number of convolutions, i the C.G.S. current, and r the mean radius.

The current was derived from a battery of 27 storage cells used for lighting the house.

ECONOMICAL WORKING OF ARC LAMPS.

In arc light installations, as is well known, the cost of carbons forms a considerable part of the working expenses, which it is desirable to reduce. With a view to overcome this disadvantage Messrs. Hardtmuth and Co., of Vienna, have devised an apparatus for the purpose of diminishing the consumption of the carbons by surrounding the upper electrode with a protecting mantle. As our readers are aware, there is formed in the upper carbon during the period of lighting, not only a crater, but the end points conically towards the edges of the crater. The cause of this lateral consumption of the carbon is to be found in the circumstance that the current of air produced through the points of the arc spreads to the side surface of the carbon upwards, and thus renders its consumption possible. If one succeeds in preventing the free passage of the air to the upper or positive carbon, the cause of the useless consumption of the outer carbon surface in the production of light is removed, and the duration of the carbons is correspondingly prolonged. This arrangement, according to the *Elektrotechnische Zeitschrift*, constitutes the principle of the apparatus devised by the firm mentioned, who term it a "lasting burner."

The appliance consists, as will be seen from the illustration, of a mantle surrounding the upper carbon carried in a bow and frame as shown. The frame is provided at its lower horizontal part with a leading-in ring, which, by means of three small platinum cramps, is arranged on the conical end of the negative carbon, and in such a manner that as the latter is used it falls with it. The vertical rods of the small frame are provided with male and female screws, and are insulated from the upper horizontal bow. Moreover, the upper part of the metallic protecting mantle is surrounded by a tube of insulating material, through which the carbon can freely pass. The lower and distant part of the protecting mantle is enclosed in a fireproof mantle, and the dimensions are so chosen that a circular air passage remains between this mantle and the outer surface of the carbon rod. By the insertion of the screws, the distance between the protecting mantle and the leading in ring is so regulated that when the lamp is alight the lower end of the positive carbon lies at the same height as the under edge of the protecting mantle. The end of the carbon is therefore almost completely protected from air currents.

Experiments with this apparatus have been made in the Vienna Technological Trade Museum (Versuchsanstalt für Elektrotechnik) to ascertain whether the fact of adopting the "lasting burner" affected the lighting power of the lamp, and what the saving in carbons amounted to. For this purpose the same lamp (having carbons 11mm. and 16mm.) was tried both with the appliance and without it, photometric tests being taken. It was found that the introduction of the apparatus did not essentially affect the lighting power of the arc lamp. As far as the consumption of carbons is concerned, the following figures from the tests mentioned show the use per hour:

Consumption in millimetres.	Upper carbon.	Lower carbon.
Lamp not fitted with "lasting burner"	14·1	15·5
Lamp equipped with "lasting burner"	4·9	10·0

NON-SYNCHRONOUS ALTERNATING-CURRENT MOTOR FOR HIGH PRESSURE.

In installations for the distribution of electrical energy for power purposes at high pressure on a large scale, the use of small motors at low pressure fed from transformers is generally recommended, whilst large motors are directly constructed for the high pressure on the line. Apart from the important reduction in the cost of installation incidental to the latter, the dispensing with the employment of large converters essentially simplifies the installation and renders the working safer, of course assuming that that part of the motor carrying the high-pressure winding is at rest.

In discussing this subject in the *Elektrotechnische Zeitschrift*, Mr. Emil Kolben, of Oerlikon, says that, notwithstanding the inconvenience of a separate exciter, synchronous motors similar to the generators have hitherto been recommended for use as large alternating-current motors. This is due, on the one hand, to the fact that a proper method of constructing large non-synchronous motors was not hitherto known; and on the other, because of the considerable current strength at no load, which was inconveniently made perceptible through the load on the line and the generators.

This disadvantage, the author states, has, however, now been met by such careful design and solid construction as to allow of a reduction to a minimum of the play between the fixed and rotating parts. This has been accomplished by a clever arrangement of the winding, which only admits of slight distribution of induction, but especially by correctly dimensioning the individual parts. By this means we obtain for the working of a motor at high efficiency down to one-tenth load, the capability of overloading, insensibility to changes in pressure and even changes in speed of the primary machine, and the advantage of not having to use a direct-current exciter. It is correct that the factor of performance is not so favourable with a non-synchronous motor as with one of the synchronous type, although this difference almost disappears at full load, which, indeed, is only proportional to the maximum fall of the line and of the generator.

With a view to show the difference between the two kinds of motors, the results of a series of tests with an 80-h.p. synchronous motor and a 100-h.p. non-synchronous

a Bunsen flame and slowly cooled. It was found to have contracted 0·07mm.—*i.e.*, 0·07 per cent. It was then heated in the blow-pipe flame and dropped into cold water. This produced an elongation of about 0·02mm., leaving the wire 0·03mm. shorter than it was originally. These measurements were made with a rough apparatus extemporised for the purpose, and I do not attach much importance to the quantitative results, though there can be little doubt that they are qualitatively correct.

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motor are graphically represented in Figs. 1 and 2. The former is installed in a corn mill and the latter in a spinning mill. The synchronous motor is of the Kapp type, with a flat disc armature, constructed by the Maschinenfabrik Oerlikon, of Oerlikon, near Zurich. It is wound for 2,200 volts, with its shaft direct coupled to its exciter. The E.M.F. curve is almost exactly a sine curve. The non-synchronous motor shown in Fig. 3 is an 18-pole high-pressure three-phase motor built by the same firm for 1,730 volts pressure at 50 periods per second, and arranged for rope-driving at the low speed of 320 revolutions a minute.

It will be seen from the curves that the factor of performance of the synchronous motor is more favourable for all loads than that of the non-synchronous motor, although the difference at full load is small, being 0·94, as compared with 0·86. This difference, for instance, with a loss on the line of 5 per cent. would scarcely bring about ½ per cent. additional drop in the conductor. On the other hand, the efficiency of the non-synchronous motor is higher at all loads; its curve is such as those of a good transformer. It amounts at full load to 91 per cent., as compared with 86 per cent. of the synchronous motor. The total exciting energy, including losses in the exciter, are comprised in this especially at small loads, where it strongly reduces the efficiency.

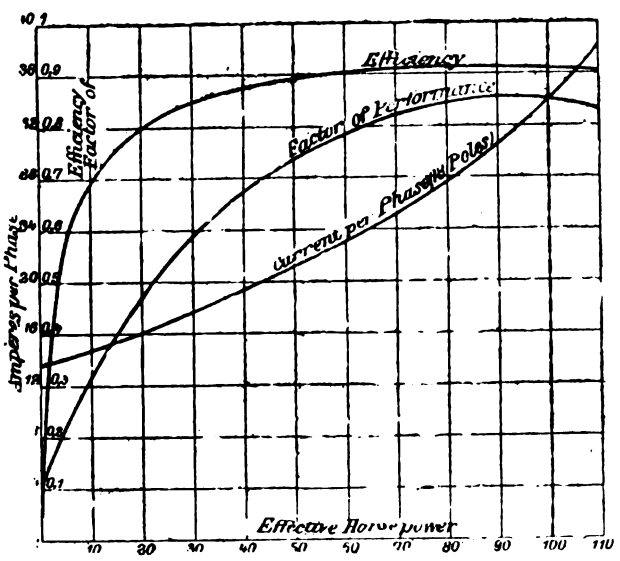

FIG. 1.—80 h.p. Synchronous Single-Phase Motor.

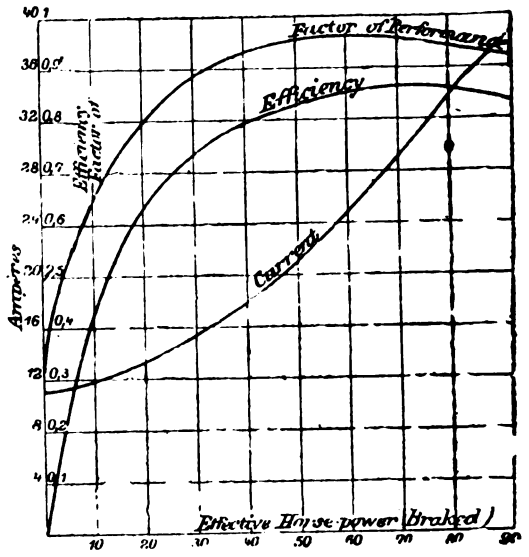

FIG. 2.—100 h.p. Non-Synchronous Three-Phase Motor.

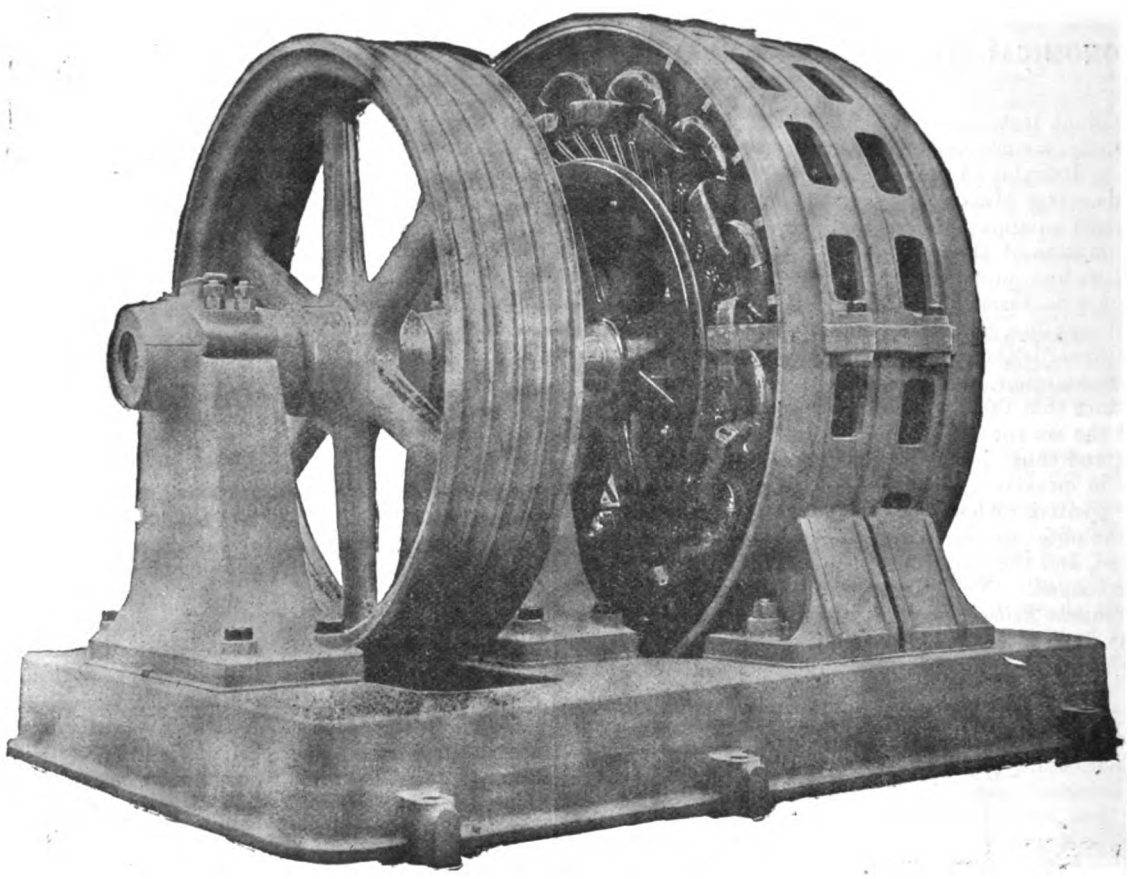

FIG. 3.—18 Pole High-Pressure Three-Phase Motor.

Electric Lighting in France.—Offers are being invited by the Secretary-General, 2, Cours du Trente-Juillet, Bordeaux, for the electric lighting of the Bordeaux Exhibition of next year.—An electricity station is being installed at Chapareillan, where the water power of the Cernon will actuate seven turbines of a total of 1,200 h.p. Current will be distributed from here to Chamberg and in the neighbouring villages.

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ELECTRIC LIGHTING AND TRACTION IN SPAIN.

Some time ago a correspondent in Bilbao sent to *L'Electricien* a communication (which we abstracted at the time) referring to electrical matters in Spain. The same correspondent now writes to that journal that development continues to take place. At present, he states, the Allgemeine Elektricitäts-Gesellschaft, of Berlin, does the major portion of the work; the other firms, including the Oerlikon Maschinenfabrik, Messrs. Schuckert and Co., and Messrs. Siemens and Halske, only dealing generally with small installations. An exception is, however, to be found in the case of Messrs. Schuckert, who have equipped a central station at Baracaldo, near Bilbao, with plant to the extent of 600 h.p. for the supply of alternating current to some twelve villages situated on the left bank of the Nervion. The Allgemeine Company have formed, with the assistance of Seville commercial firms, a company with a capital of £80,000 for the electric lighting of Seville. The central station will comprise three groups of 400 h.p. each, and as the Allgemeine Company are now making 120-volt lamps, it will be possible to arrange the arc lamps three in series for public lighting. The same company have acquired the station erected at Barcelona by the Sociedad Espanola de Electricidad, having 8,000 lamps connected, and it has now been resolved to establish a new station, comprising three groups of 1,000 h.p., at a cost of £240,000. It is intended to start this station in a year, when the old works will be shut down. Apart from lighting operations, the Allgemeine Company are pushing ahead with electric traction. One instance of this is to be found at Bilbao, where the company have entered into a contract for the conversion of the horse-car line from Bilbao to Santurce to an electric tramway. It is anticipated that the work, which is being hurried on, will be completed so that the line may be opened next June. The tramway, which is about nine miles in length, runs parallel with the Portugalette railway, and it is expected that it will prove a formidable competitor to the latter, which annually carries 2,500,000 passengers. The line will be on the overhead trolley system, and will be equipped with 12 cars fitted each with two 25-h.p. motors, and capable of hauling trailers at a speed of 12 miles an hour. The generating station will be erected at Luchana, and will contain plant to the extent of 330 h.p. Other electric traction schemes are under consideration.

THE SURPLUS AND DEFICIT THEORY OF ELECTRICITY.

BY W. PERREN MAYCOCK, M.I.E.E.

(Concluded from page 577.)

There is not much transference of electricity, however, owing to the small capacity of the ends of the E.M.F. circuit. The coating of the condenser will therefore only receive a small charge; the deficit on the right-hand coating will, of course, be equal to the expelled surplus, and both of these will be slightly less than the influencing surplus on the other coating. From what was said in section (*b*), it is clear that both coatings of the condenser are at a + potential; but there will be a slight P.D. between them, due to the preponderance of the influencing charge over the influenced charges. This may be verified by means of the discharging tongs, D, the spark obtained (the length of which is proportional to the P.D. between the coatings) being in this case only just perceptible. The influence machine should be disconnected from the condenser (while it is rotating at its normal speed), before making the above experiment.

In the next case (Fig. 11 VI.), the right-hand coating of the condenser is connected with earth. This allows the surplus thereon to flow to earth and a greater deficit to be influenced on the inner side. This increases the capacity of the left-hand coating, enabling it to receive a larger charge. As before, the greatest P.D. exists between the left-hand terminal of the machine and the left-hand coating of the condenser. Now, though the right-hand end of the E.M.F. circuit has been increased in capacity, the capacity of the left-hand end—*i.e.*, of the terminal—is, as in the first case, very small; and when we consider it is from this that electricity is being "pumped," it is easy to understand that the ultimate P.D. between the ends of the circuit is reached without the transference of much electricity, the potential at the − end falling more rapidly than it increases at the + end. The quantity of electricity displaced will, however, be greater than in the first case, owing to the increased capacity of the right-hand end of the circuit. Now with regard to the condenser; as we have already seen, the + charge on the left-hand coating is greater than before; there is a nearly corresponding deficit on the opposite coating, and the repelled surface has gone to earth. Disconnect the machine while running, and then the earth wire. The right-hand coating is now clearly at earth's potential, since it has just been disconnected therefrom; while the left-hand coating is at a slight + potential, nearly all its charge being bound by the opposite deficit. There is, however, a considerable difference of potentials between the coatings, and the spark obtained with the discharging tongs will be much longer than in the previous case.

In the last example (Fig. 11 VII.) the − terminal of the influence machine is connected with earth, through which it is in connection with the condenser's right-hand coating, or it may be connected directly thereto. The machine on being rotated "pumps" electricity from one coating into the other. The capacity of the −end of the circuit being very great, the influencing charge will be large to start with; the deficit on the opposite side (partly due to influence, but principally due to the fact that electricity is being "pumped" away from there) will react on and increase this; the capacity of both coatings will be very much increased, and a considerable quantity of electricity will be displaced before the P.D. between the coatings reaches its maximum, which will be when it is about equal to the E.M.F. of the machine. On disconnecting the condenser and discharging it, a long and thick spark will be obtained, showing that the P.D. and the quantity of electricity displaced is greater than in either of the two previous cases. The discharging of the condenser should be done directly after disconnecting it from the machine, as there is always a certain amount of leakage taking place over the surface and edges of the glass dielectric.

(*l*) *The Action of Points.*—If a charged body has a projecting point upon it, the charge will be slowly dissipated into the air at the point. If, facing the point, there is another conductor, the discharge will be more rapid, and will be still more rapid if the conductor facing the point is earth connected. A conductor may also be discharged by presenting an earth-connected point to it.

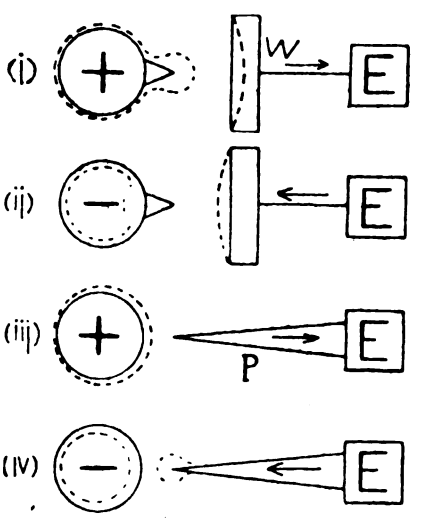

FIG. 12.

In Fig. 12 I., + is a +ly charged body, and W an earth-connected conductor, such as the wall of a room. We will first consider the case in which there is no conductor opposite the point. The density on the charged body is approximately indicated by the dotted line; at the point it is very great, so great, in fact, that the air and dust particles immediately around the point become +ly charged also; these then fly off from the point, and others take their place, become charged in a similar manner, and are repelled. As these electrified particles have no neighbouring body to impart their charge to, the discharge at the point is not very energetic. Now, let us suppose the earth-connected conductor, W, to be opposite the point. The presence of the charged body will influence a deficit on the side of W facing it. To this region the +ly electrified particles will be attracted, they will give up their charges to W, and will then move to one side to make room for other charged particles. There is thus a continual "wind" coming off from the point, which may be felt by the hand if the point is on a highly-charged conductor, such as the terminal of an influence machine.

In Fig. 12 II., the case of a −ly charged body is considered, first of all without an opposing conducting surface. The − density round the point is so great that the neighbouring particles of air, dust, etc., which, like every other body (conductor or insulator), may be supposed to have a certain

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quantity of electricity upon them, have part of this abstracted to help fill up the deficit on the charged body, and being then themselves in a state of deficit, are repelled from the former, their place being taken by others which are likewise acted upon. The deficit in the charged conductor is thus gradually filled up with electricity abstracted from neighbouring air particles. When there is a conducting surface facing the point, a + density is influenced thereon. To this part the −ly charged particles are attracted, and having had their deficits filled up, move on one side to make way for others.

Next we have the case of a +ly charged body with an earth-connected point presented to it. A − density will be influenced at the point, and the particles around, in the same manner as was explained just now, will have electricity abstracted from them, and being −ly charged will be attracted to the charge-ball +, and have their deficits filled up from it. In other words, a stream of −ly charged air particles will be projected at the ball, and gradually rob it of its charge.

Lastly, in Fig. 12 IV. we have a body with a deficit. A surplus consequently is attracted to the point, and the density becoming great, a stream of +ly charged particles is projected at the ball, to which they deliver their small charges, this going on until the ball is practically discharged.

Conclusion.—This article might be indefinitely continued with explanations of other elementary and well-known experiments in electrostatics, etc., based upon the simple theory which was enunciated in the opening paragraphs. Enough has been said, however, to enable the student to do this for himself, and he will find that many results which before appeared vague and difficult of explanation, will be clearly accounted for in the light of the "surplus and deficit" theory. At the same time it should be remembered that this theory is intended only as a practical help to students, and does not pretend to any scientific importance.

UTILISATION OF BLAST-FURNACE GASES.

An article dealing with the utilisation of blast-furnace gases for industrial purposes was published in the last issue of the *Iron and Coal Trades' Review*. The following is abstracted from the article in question:

Of late years a good deal has been done in the way of making provision for leading off the furnace gases for the raising of steam or other calorific purposes, and in all well-regulated works no other fuel is now employed for boiler purposes. But it has been felt and acknowledged that there was still a great waste of gas or calorific power that should be capable of utilisation, and advanced metallurgists have looked hopefully forward to the day when the waste might be expected to cease.

Among the many projects applied or suggested for this purpose we learn that Mr. B. H. Thwaite has recently been undertaking researches which have demonstrated to his satisfaction that a blast furnace of only 300 tons weekly capacity of iron output can produce sufficient power gas to drive internal-combustion or gas engines equal in the sum of power actually available to from 1,600 h.p. to 1,800 h.p. per hour. He has calculated that this large amount of power can be electrically transmitted, with a loss of not more than 15 to 20 per cent., within a 15-mile radius from the furnace to villages, towns, or other centres of manufacturing industry that either can or are likely to be able to absorb such power.

In the system for the utilisation of the gases of blast furnaces designed by Mr. Thwaite the gas is led off to an internal-combustion thermodynamic motor or gas-engine. Where a furnace is worked with 4lb. to 5lb. of blast it is calculated that three times the power that is given by the same expenditure of power for blowing purposes can be generated by the employment of a high-speed gas-motor air-blower to develop 15lb. of air heat pressure, while the output of the furnaces may be largely increased. Mr. Thwaite has made a tabular estimate of the calorific value, for the different purposes to which he proposes to apply it, of the gas generated in blast-furnace working, and the results are really very startling. By substituting gas motors, actuated by blast-furnace gas, for the present steam-power machinery employed in iron and steel works, Mr. Thwaite finds that a large economy can be effected. And in such a case the distance of the mills to be driven from the furnaces that supply the means of driving them is, within certain tolerably wide limits, a matter of comparatively little importance. If the furnaces are not more than five miles distant from the mills to which the power is to be applied, the energy lost in transmission is not likely to be great, because, with high-pressure transmission with transformers, such energy can be transmitted for a distance of quite 100 miles with not more than 30 per cent. loss of energy. But the utilisation of such power is not by any means limited to mills alone. It can also be utilised with advantage for colliery underground work, for pumping, drilling, and hauling; for general lighting and power purposes within a few miles of the furnaces, and for other requirements. It is not at all unlikely that power so supplied would make it possible to sell gas for lighting purposes at much less than any price at which it has hitherto been supplied, while yielding to the hitherto greatly distressed maker of pig iron a residual fund that might ultimately realise the dream of more than one enthusiast on behalf of the latent possibilities of the blast furnace—namely, that of making the manufacture of pig iron merely a by-product.

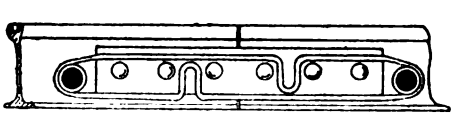
RICHARDSON'S INVERTED ARC LAMP.

In our issue of October 27, 1893, was published a paper "On the Artificial Lighting of Workshops," reference being particularly made to experiments with inverted arc lamps. In this connection a circular has reached us from Mr. A. W. Richardson, of Patricroft, near Manchester, concerning his inverted arc lamp. This lamp, which varies considerably from most others, is a differential focussing brake wheel lamp, of which the following is a brief description. A large wheel gears into two racks, in which a pinion gears, the brake wheel being on

the same arbor. The brake arrangement is attached to a locking lever, at each end of which are fixed the cores of the main and shunt coils of a large area, which allow of a most sensitive and continuous feed. Mr. Richardson states that by taking a room, 24ft. long by 24ft. broad and 12ft. high, having a whitewashed ceiling, and equipping it with a 12-ampere inverted arc lamp placed in the centre, the light is diffused everywhere. The diffusion, he says, is so perfect that men can carry out minute work at benches placed round the room with their backs to the light. This advantage is at once apparent with regard to machinery, as not only is the portion the man may be manipulating plainly visible, but the whole of the machine is equally lighted.

TRAMWAY RAIL BOND.

In the annexed illustration is shown a bond for tramway rails devised by Mr. F. Foley Robinson, A.M.I.C.E., of 48, Elopeth-road, Lavender Hill, S.W., and exhibited at the meeting yesterday (Thursday) evening of the Institution of Electrical Engineers. The terminals consist of short metal tubes



expanded into the webs of the rails in the manner usually employed by boilermakers to secure tubes in tube plates. It is claimed for this bond that it is cheap, as ordinary wrought-iron tube may be used sawn into short lengths and oxide removed by grinding or otherwise, no turning or expensive machinery being thus required, and that the bond affords a large and efficient contact area, the surfaces of holes and tubes being quite bright.

Storage Battery Litigation.—The following communication reached us at the moment of going to press, this referring to a paragraph given in our Business Notes: "We are informed that the Chloride Electrical Storage Syndicate, Messrs. Mather and Platt, Limited, and Dr. John Hopkinson contend that they are fully justified in making and using these [chloride] cells, and that they intend to offer a most strenuous resistance to the claims made on them. We also state that the Chloride Electrical Storage Syndicate are prepared to indemnify all persons who have purchased batteries from them, or who may do so."

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INSTITUTION OF ELECTRICAL ENGINEERS, Nov. 22.

MR. ALEX. SIEMENS (President) in the chair.

At last night's meeting of the Institution the following candidates were balloted for:

Member.—Sir Benjamin Baker, K.C.M.G., F.R.S., 3, Kensington-gate, W.

Associates.—Charles Edwards Atkinson, care of Messrs. Strode and Co., 188, Piccadilly, W.; William Brown, care of Messrs. Siemens Bros. and Co., Woolwich; Herbert Ade Clark, 120, Ruskin-road, Crewe; C. J. Evans, 16, Castelnau-villas, Barnes, S.W.; Arthur H. Gibson, Bryanston, Blandford, Dorset; Ernest Mercer, 137, Stonefield-road, Hastings; John Patrick Mulholland, Eastern Telegraph Company, Gibraltar; Henry Stooke, 19 Room, War Office, Pall Mall, S.W.; Frederic G. Twemlow, 132, Bury New-road, Manchester; Charles Selby Whitehead, 29, Glazbury-road, West Kensington.

Students.—Arthur Verden Anderson, Faraday House, Charing Cross-road, W.C.; Ernest R. Cook, 29, Highbury-hill, N.; Francis Edward Davies, 51, Tregunter-road, South Kensington; Sydney Edward Thacker Ewing, Faraday House, Charing Cross-road, W.C.; David J. Gadsby, 34, Hamlet-road, Chelmsford; Charles D. Le Maistre, Central Institution, Exhibition-road; Charles Henry Marshall, Tileworth, Silverhill, St. Leonards-on-Sea; Arthur Du Pasquier, 28, Emperor's-gate, South Kensington; George W. D. Ricks, 8, Uxbridge-road, Surbiton; Robert Johnstone Scott, Faraday House, Charing Cross-road, W.C.; Benjamin Thomas Squibb, 176, Blackfriars-road, S.E; John Walton Ward, 43, Rutland-road, Ilford, Essex; Edmund Basil Wedmore, 11, Oakland-road, Bristol.

The following paper was then read on

ELECTRICAL STEEP-GRADE TRACTION IN EUROPE.

BY C. S. DU RICHE PRELLER, M.A., PH.D., A.M.I.C.E., MEMBER.

INTRODUCTION.

The rapid growth of electrical traction in Europe, wherever local conditions and reasonable official regulations are conducive to its adoption, is evidenced by the fact that within the last few years it has also been extensively applied, and is in course of further application, on steep-grade or mountain railways properly speaking—that is, on lines which have not only occasional steep-grade sections, such as occur, for instance, on many electrical tramways, but continuous gradients varying from 5 to 25 and upwards of 60 per cent. (1 in 20, 1 in 4, and 1 in 1·6 respectively), and which connect either the base and summit of a given declivity, or different districts separated by a mountain range. It will, therefore, not be inopportune if I place before the Institution a short synopsis of what has been already done in Europe in that branch of electrical engineering, together with certain conclusions and proposals founded on my own experience. Leaving aside for the present, as being more suitable for separate treatment, the question of heavy—viz., 50 to 100 ton—electrical locomotives for trunk railways, the working of steep grades by electricity may be considered under two heads: (1) by cable traction, and (2) by motor cars or locomotives with fixed conductors.

CABLE TRACTION.

Up to a recent period, steep-grade cable railways in various parts of the globe, but notably in Switzerland and in the Alps generally, where they alone exceed 20 in number, have been constructed for being worked either by component of gravity with water ballast in conjunction, on some lines, with a second or compensation cable, or in some cases by fixed hydraulic, gas, or steam motors. The principal disadvantage common to all lines worked by component of gravity consists in the excessive additional dead load due to the water ballast, which entails not only a great deal of additional brake power *per se*, but a variety of complicated safety brakes, involving very careful manipulation; while the three systems of fixed motors are either uneconomical, or unwieldy and obsolete. The superior advantages of cable traction by electrical motors, as compared with all the other systems referred to, have been attested by three lines in Switzerland, all of which have been constructed within the last four or five years—to wit, the Burgenstock, on the Lake of Lucerne; the Monte Salvatore, on the Lake of Lugano; and the Stanserhorn, near the Lake of Lucerne, which last named was opened for traffice only last year. It is not the purpose of this paper to give a detailed description of these lines; suffice it to point out their salient, and more especially their electrical features.

(*a*) *Burgenstock.*—The summit level of this line is 2,884ft. above the sea, the total rise being 1,443ft. in a little over over 1,000 yards, the minimum grade 32, and the maximum 58 per cent. Electric motive power for working the cable and cars is obtained by high-tension (1,600 volt) transmission from a hydro-electric power station 2·5 miles distant, the output of the two series-coupled direct-current Thury dynamos, driven by a high-pressure turbine, being 40 kilowatts, or 60 h.p. Two corresponding series-coupled motors at the summit of the cable railway drive the cable winding drum through belt, countershaft, and bevel gearing; the total reduction being 700 to 5 revolutions, or 140 to 1, corresponding to the regulation car speed of about three miles per hour. The speed is regulated from the motor station, and not by the driver, except in case of emergency.

(*b*) *Monte Salvatore.*—This line has a summit level of 2,900ft., the rise being 2,000ft. in a length of 1·2 mile, the initial grade at the base 17, and the maximum at the summit 60 per cent. The motor station is situated midway up the incline, and the power is derived by a 2,000-volt transmission from a large hydro-electric 1,500-h.p. power station five miles distant. The output of the Oerlikon (Brown) direct-current generator, driven by a high-pressure turbine, being 60 kilowatts. The correspond ing motor on the line drives the cars and cable in precisely the same way as on the preceding line, except that the Salvatore incline is worked in two sections.

(*c*) *Stanserhorn.*—This line ascends an altitude of no less than 6,200ft. above sea-level, and has a total rise of 4,570ft. in a length of 2·5 miles, worked in three sections, having maximum gradients of 30, 60, and 62 per cent. respectively. The requisite power per car is 40 h.p., and a motor station is placed at the summit of each section. The three Thury motors actuate the winding drums as before described, and are fed from the same power station as the Burgenstock line, but by a separate high-tension (2,000-volt) transmission 2·5 miles in length. The total efficiency on this, as on the other lines, is about 60 per cent.

(*d*) *Conclusions.*—The three lines of which I have given a necessarily very incomplete *résumé* mark a conspicuous advance in cable traction. As compared with haulage by the other systems referred to, they show a saving in car weight of no less than 50 per cent., the full car load with 36 passengers being in the former case 12 to 15 tons, and on the electrically-worked lines only six to seven tons. Again, the average cost of construction of the Swiss cable railways worked on the older systems is no less than £41,000 per mile, whilst that of the electrical lines is only £24,000 per mile, or 40 per cent. less. Similarly, the working expenses on the older lines vary, with one or two exceptions, between 60 and 80 per cent., whereas the electrical lines are worked at 45 per cent. of the receipts. These three lines also show a remarkable development due to electrical traction *per se*, inasmuch as, apart from the unprecedented grades, up to 62 per cent., or 1 in 1·6, the length of the incline has been gradually increased from 1,000 to 2,200 and 4,500 yards, which, having regard to the mechanical work performed on the grades, is equivalent to 14, 20, and 44 miles respectively on the straight and level. And, lastly, the superior safety and smoothness of electrical working attested by the Burgenstock and Salvatore lines, has made it possible to dispense on the Stanserhorn incline with the rack used as a safety factor on its two predecessors; so that on Stanserhorn electrical traction has achieved the feat of scaling Alpine altitudes which it was hitherto believed could only be reached by rack railways worked with special steam locomotives, such as those used on the neighbouring mountain Pilatus, at more than double the cost per train mile.

TRACTION BY MOTOR CARS OR LOCOMOTIVES WITH FIXED CONDUCTORS.

The first steep-grade railway worked by electrical traction with fixed conductors in Europe was the Florence and Fiesole line, opened in 1891. It was in succession followed by the Murren mountain railway, in Switzerland, opposite the Jungfrau; by the Mont Salève line, in Savoy, near Geneva; by the Genoa and then by the Zurich steep-grade road railways; and quite recently by a similar line at Barmen, in Rhenish Prussia. Of these lines, those of Florence, Murren, Genoa, and Zurich have continuous grades of 8, 5, 7, and 6 per cent. respectively, and are worked as simple adhesion lines, with overhead contact wires, and return circuit by the electrically bonded rails; while the Salève and Barmen lines having continuous inclines of 25 and 18 per cent., or 1 in 4 and 1 in 6 respectively, are worked with the aid of a rack, and the former has an outside conductor rail in the shape of an inverted ordinary flange rail, while the latter has overhead contact. The Murren line is the only one worked with electrical locomotives; all the others are worked by single-motor cars.

(*a*) At Florence the power station, situated at the foot of the incline, comprises three Tosi boilers, three Oerlikon vertical compound 90-h.p. engines, and three belt-driven Edison bipolar dynamos with a total effective power of 245 h.p., equal to 93 per cent. efficiency. The 12 motor cars are each fitted with two 20-h.p. spring-suspended and series-coupled Sprague-Edison motors, the original ones having double-reduction, the more recent ones single-reduction spur gearing. The contact is by trolley wheel and pole, and the total efficiency of the system is 66 per cent.

(*b*) On the Murren railway, whose altitute is 5,300ft. above sea-level, power is generated by a high-pressure turbine, which drives a direct-coupled Oerlikon (Brown) bipolar dynamo of 120 h.p. The power station is situated about midway of the line, the power being derived from the torrent of the celebrated Staubbach Fall. The four locomotives weigh 7·5 tons each, and carry two 30-h.p. single-reduction spur-geared motors; the

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tractive force of each locomotive being about one-third of its weight, and the total efficiency of the system 68 per cent.

(*c*) The power station of the Mont Salève line (summit level, 3,700ft. above the sea) is situated about a mile from the line, and comprises two low-pressure turbines and two separately-excited Thury multipolar dynamos mounted on the vertical turbine shafts, and giving, at the low turbine speed, 500 h.p., or only a quarter of their combined normal output of 2,000 h.p. The 12 motor cars are each fitted with two 30-h.p. four-pole Thury motors, with double spur gear reduction, and current is taken from the outside conductor rails by metallic slide contact shoes. Owing chiefly to the unnecessarily heavy gearing, the total efficiency is only about 52 per cent.

(*d*) At Genoa the power station is about 1·3 mile distant from the line, and contains at present two boilers, two compound condensing Tosi 160-h.p. engines, and two belt-driven 110-kilowatt Siemens inner-pole dynamos. The present line, which is the nucleus of a projected suburban system, is worked by six cars, each fitted with two 16-h.p. Siemens motors, the reduction being 10 to 1 by chain and toothed wheel. Current is taken from the overhead wire by two Siemens and Halske's rectangular metallic contact frames.

(*e*) The Zurich power station is placed at the upper end of the line, and comprises two boilers, two 100-h.p. Oerlikon vertical engines and dynamos, together with an accumulator battery of 300 Tudor cells for compensating the variations of load of the steam-engine. The 12 motor cars are each fitted with two 12-h.p. Oerlikon motors. The total efficiency of the line is 65 per cent.

(*f*) At Barmen, the power station is situated at the foot of the incline, and contains two 225-h.p. compound condensing engines driving direct two Siemens inner-pole ring dynamos, whose output is 155 kilowatts each. The line is worked by 10 motor cars, each provided with two 36-h.p. Siemens motors, which by single spur gearing actuate the rack pinions mounted direct on the car axles. The total efficiency is like that of the other lines, from 60 to 65 per cent.

(*g*) *Conclusions.*—It is seen that the primary generating power is steam on the Florence, Genoa, Zurich, and Barmen, and hydraulic on the Murren and Mont Salève lines, the dynamos being direct-driven in four, and indirect in the other two cases. Notwithstanding the high cost of fuel in Italy and Switzerland (as much as 30s. per ton), and the steep grades on the Florence, Genoa, and Zurich lines, the running expenses do not exceed 4·5d. per car mile, while the total working expenses, including administration and renewals, are within 7·5d. per car mile, or about 50 per cent. of the receipts. On the Murren and Salève lines the cost of hydraulic power per annum is of course restricted only to wages and repairs. In the former case the working expenses do not exceed 40 per cent. of the receipts, while in the latter they are as much as 80 per cent., this high rate being due chiefly to inadequate fares. A specially noteworthy feature is the steady speed of eight to ten miles per hour with which motor cars run up the steep adhesion inclines of 6, 7, and 8 per cent. at Zurich, Genoa, and Florence; while on the descent a speed of even 15 miles per hour has proved perfectly safe, in conjunction with the powerful and instantaneous action of the electric safety brake constituted by the motors acting as dynamos on the descent, although for all ordinary purposes even the mechanical brake alone suffices to stop the car within its own length. As regards the comparative working cost of steep-grade adhesion or rack railways by steam and by electricity, I can affirm from my own experience, as well as from every other case which I have had occasion to investigate, that irrespective of the immensely greater elasticity of the service, and consequently the far more rapid development of the traffic, electrical working ensures an economy of at least 50 per cent. as compared with steam.

General Conclusions.

With regard to electrical traction on flat as well as steep-grade lines generally, I am led to the following conclusions:

Direct and Indirect Driving of Generators.—Although direct driving, whether by steam-engines or by turbines, is the ideal standard, and therefore always preferable, it cannot, for tractive purposes, be laid down as a dictum *à priori*. On lines having steep, and more especially alternately rising and falling grades coinciding with sharp curves, an intermittent traffic, and frequent stoppages, the variations of load are so great and so rapid—often from zero to maximum in the space of one minute—that vertical high-speed engines suitable for direct driving generally work very unecomically. This is, *e.g.*, the case at Florence, and in an even greater degree at Marseilles, where the high-speed direct-driving engines have actually to be replaced by horizontal low-speed Corliss engines, with belt driving. In the case of hydraulic power, high-pressure turbines always admit of economical direct driving, whereas low-pressure turbines involve for direct driving proportionately larger dynamos, giving only part of their normal output, so that here, too, indirect driving by gearing or belt is generally more economical. The same applies where gas-engines are used.

Steam, Hydraulic, and Gas Generating Power.—The first cost of an hydro-electric installation often exceeds that of steam plant, more especially in the case of a variable volume and small head of water, involving the use of low-pressure turbines. High-pressure turbine installations are always preferable and more economical. Where cheap hydraulic power is not available within a distance of about four miles from the line and fuel is dear, gas manufactured on the spot is much more economical than steam power.

Conductivity of Rails.—Where the rails serve as return circuit, the ordinary fishplates should have the same sectional area as the rails, so that, together with stout fastenings, they make a joint as stiff as the rail itself. In this way, and especially when laid on metallic sleepers, the permanent way gives 80 per cent. of the required conductivity at the joints; so that only 20 per cent. has to be made up by copper bonding, plus an adequate margin of, say, 10 per cent. Solidity, compactness, and careful maintenance of permanent way, as is usually found on electrical lines, as well as on railways generally in Europe, go far to make up for the elaborate copper bonding which the often defective condition of permanent way necessitates on American lines. It is for the same reason that electrolytic action on gas and water pipes, which is so common a phenomenon in the States, is practically unknown in Europe.

Conductor Rail.—Where a conductor rail is used, it should preferably be placed outside, instead of inside, the ordinary rail, because the outside conductor obviates all complications, and the contingency of short-circuit at points and crossings. On specially steep grades, involving the use of a central rack, the rack rail or bar itself, having continuous contact with the pinion wheels, constitutes an excellent conductor, provided it be effectually insulated from the sleepers by porcelain bells serving as supports.

Overhead Trolley Wheel and Slide Contact.—Contact by a trolley wheel whose spindle is rigidly held by the trolley pole is suitable for lines on which straight sections and flat curves predominate; but for lines with numerous and sharp curves, the rectangular single or double slide contact frame, as used by Messrs. Siemens and Halske on their overhead lines, is far preferable. It is lighter and more pleasing in appearance than either the rigid trolley, the flexible South Staffordshire trolley, or the slide contact bars used on the Isle of Man line. It obviates, moreover, many of the objectionable cross and diagonal wires, and hence the infinite variety and complexity of fastenings which the use of the rigid trolley wheel involves, and many of which, however neat as mechanical contrivances *per se*, are not exactly ornamental objects when suspended at a height of only 20ft. above the roadway. The only defect to which the Siemens slide contact is subject consists in the upper, slightly arched, and, of course, renewable contact side of the frame being liable to become grooved, whereby the easy play to right and left of the contact wire is impaired; but this defect can be easily remedied by employing material of adequate resistance. Another and very simple form of slide contact is that used on an electric road railway from the Lake of Lucerne to the foot of Stanserhorn, and consisting in a crescent-shaped grooved contact-piece of bronze, which is loosely hinged to the trolley pole, and thus, in conjunction with the lateral play of the pole, adjusts itself to the sinuosities of the line.

Underground Contact and Accumulator Cars.—It is generally recognised that the overhead trolley system, which in reality is only a makeshift, is unsuited for the central parts of the large towns, and *a fortiori* of the metropolis of this country, and the same applies equally to the other largest capitals of Europe—to wit, Paris, Berlin, and Vienna. In these cases, the conduit system or accumulator cars are therefore at present the only practicable solution of the problem. In Europe, the conduit system, whether it be that of Budapest, or with a central slot, may be estimated to cost complete £10,000 per mile and upwards, according to local conditions, though this is not too costly having regard to the enormous traffic in large towns; but its efficient working presupposes, among other things, very perfect drainage of the trench. As regards accumulator cars, they would really constitute an ideal form of electrical tramway traction, if the present car weight of 12 to 15 tons and the power and traction expenses of 8d. to 10d. per car mile could be reduced to half. As a case in point may be quoted the unwieldy accumulator cars which run on the Madeleine and St.-Denis tramway in Paris, and give fairly satisfactory results, but which, owing to their heavy weight, are not infrequently deficient in torque on the long 1 in 20 grades, when the motors become saturated. The overhead system, on the other hand, is very well adapted for suburban tramways, and eminently so for light railways and road railways in the country. The cost of such road railways, if constructed on the metre or 3ft. 3in. guage, can well be kept within £6,000 per mile, including electrical equipment, and the already quoted road railway from the Lake of Lucerne to the foot of Stanserhorn, which only cost £4,500 per mile, as well as another similar line near Bâle, have demonstrated what a cheap and convenient motor-car service can do in essentially agricultural districts.

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Gearless and Geared Motors.—Gearless motors are eminently suitable for high speeds, while for low speeds they require to be of inconveniently large size. For geared motors single reduction is of course always preferable, although on exceptionally steep grades, where the motors have to develop their maximum power at minimum car speed, double reduction may in some cases be unavoidable. In any case, spur gearing is always preferable to worm gearing or chain motion, both of which involve too much friction and consequent loss of power.

Parallell and Series Coupling of Motors.—This much-debated question cannot be decided *à priori*, but depends on individual cases. For level or easy-grade lines parallel coupling is more suitable; whereas on steep grades, where starting requires always the maximum torque, series coupling is generally called for.

Variations of Load.—On lines with steep or rising and falling grades, these variations cannot be mitigated, much less equalised, simply by increasing the number of cars or trains on the line, since the variations are caused not only by the varying traffic, but by the varying grades and curves, and by the varying degrees of adhesion, more especially in starting. Where separately-excited dynamos are used, a partial means of compensating the variations of load is, as well known, that of varying the excitation by the main current passing through the exciter. But the most effectual remedy is the addition of an accumulator battery, which absorbs an excess of supply from the generator over demand on the line, and, *vice versâ*, makes up for any deficiency of supply, so that the steam-engine and generator can always run at full and constant load. Accumulator batteries have fully vindicated their claim as an important auxiliary and as a means of economical working of traction installations at Zurich, and subsequently in the Isle of Man, and well repay the additional first cost of plant.

Continuous and Alternate Current.—Hitherto continuous current has been exclusively used for electrical traction. But, having regard to the high degree of efficiency and perfection and the ease of starting recently attained in alternate-current motors, thanks notably to the persevering efforts of such constructors as Messrs. Brown, Boveri, and Co., it may be confidently predicted that, as in lighting installations and in power transmissions for industrial purposes, so also in electrical traction alternate is destined to supplant continuous current. Alternate current, whether single or multiphase, will not only admit of electrical traction being applied over much longer distances than is economically possible with continuous current, but it will ensure a saving of something like 30 per cent. in the weight of dynamos and motors, irrespective of the saving in copper of feed and contact wires, and will thus considerably simplify and cheapen electrical installation and equipment for tractive purposes. But whether by alternate or by direct current, on flat as on steep-grade lines, on so-called light railways as on tramroads in town and country, we may be well assured that electrical traction in its various forms has, both in this United Kingdom and throughout Europe, a brilliant and triumphant future.

After Mr. Preller's paper had been read, **Mr. Siemens** voted thanks to him, but hoped when the paper was reproduced in the *Journal* he would leave out some of the interpolations which had been made.

A Member said that the Passadena line in California, was a pleasure railway, leading people from summer to winter, being a line to the top of Mount Wilson, which was 13 miles long, and which reached an elevation of 7,000ft., and which for a time had a gradient of 7½ per cent., and afterwards of 1,600ft. in 3,000ft. The work was done by means of a cable actuated by means of a 75-h.p. electric motor, the motor getting its current from dynamos driven by Pelton water-wheels. It was intended to derive water power 400ft. below the summit, pump it up by electric motors, and let it fall to a considerable depth, whereby it was anticipated that a considerable amount of spare power would be available.

Mr. Robinson only wanted to look at the commercial aspect of the question. His living was partly bound up with the development of electricity, and electric traction was going to be of great magnitude. By the development of electric traction electricians would benefit and so would the public. Not forgetting what had been done in this country, America showed us what could be done in that line. Mr. Robinson praised Mr. Preece for the information which he had given last session, stated that Mr. Wilkinson had assisted in giving valuable information, and Mr. Blackwell interesting details. As one of those who expected something to come of electric traction, he thought thanks were due to the various authors. He considered that Mr. Preller was not quite in touch with the general subject, for he had dealt with mountain railways, which were not well suited for this country. As regarded Mr. Preller's observations about high-speed engines, that point should have been raised some years ago.

Mr. Parshall said that the most important point which had been raised was that of earth return. The result of close study was that the difficulty could have been avoided if engineers had carried out what they knew. When they had an underground contact of copper with iron they could not expect 50 amperes per square inch when they did not expect as much under better circumstances. This was an evident source of trouble. The proportion of the contact between the rail and the bond should be according to the amount of current. The contact area should be 20 times the cross-section. The difficulty could be overcome by the adoption of electric welding, and he recommended the use of an electrically-welded underground system everywhere. The power required on electric lines was, with an average number of stops, one Board of Trade unit per car mile, the deviation in Europe not being more than 15 per cent. The watts per car mile remained constant for various rates of speeds. With a series parallel controller and frequent stoppages two motors were preferable. The speaker advised working cars at the highest rate of speed. In the United States the rate of speed in the crowded streets was three or four miles an hour, and in outlying districts 20 miles an hour. The number of persons killed was in inverse ratio to the speed of the cars. English engineers might demonstrate to the Board of Trade that a higher rate of speed than was now allowed was allowable. As regarded alternators, he did not expect that polyphase motors would be used, the only approach to that being triphase motors. After describing the intramural Chicago Exhibition electric railway, with which he had been connected, he stated that great fluctuations in power should be avoided, and it would result in economy if smaller engines could be used.

Captain H. Sankey started off with the subject of stresses in flywheels, stating that there was no risk with small disc flywheels in a direct-driven set. If a short circuit took place, the engine might suffer, but he thought that the armature would instead. He had worked out the problem, and he showed a diagram indicating the torsional stresses in the crank-shaft due to stoppage by circuit. There was no stoppage possible within one-three-hundredth of a second, and that was the first which would break an ordinary steel crankshaft. In a direct-driven set the only difficuty would be in the armature. All that had to be taken into account was the construction of the armature and of the crank.

Mr. Holroyd Smith, in regard to Mr. Wilkinson's statement that in conduit systems it is better to have them placed in the centre of the track, said that he would not like to be as definite as the author of the paper. The conduit system illustrated on the wall as in operation in the United States was interesting from the fact that it was constantly recurring under different names. He complimented Messrs. Blackwell and Dawson on their paper, because they had not contented themselves with abstract figures, but had shown them how the things were done. After criticising the sliding arrangement of trolley collector, the speaker observed that the fishing rod or trolley pole had originated with Mr. Sprague, and the thanks of the electrical world were due to him for it. In fact, he took that opportunity of expressing his obligation to him. There was, he thought, plenty of scope for a paper dealing with trolley rods and their wires. The methods described in the papers were, however, inapplicable to double deck cars, such as used in this country. In this connection he referred to a trolley arrangement for tramcars having imperials, and which had been tested by him at Bradford. This method, which he sketched on the blackboard, allowed of a uniformity of pressure being obtained. The arrangement consisted in the use at rear of the car of a vertical swivelling rod, having projecting at an angle from it the trolley pole supported by levers and a spring, the spring being put into greater tension when the rod is brought down. Comparing the American form of trolley pulley with that devised by himself, the speaker showed how the latter easily allowed of sharp curves being taken without the trolley pulley coming off. One of the rail bonds described in the papers was very similar to that introduced by him ten years ago in the case of the Blackpool tramway. In this connection it was interesting to note that during the repairs of that line early this year, some of those bonds had been brought to light, and had been found to be in an excellent condition. He had long advocated double-tread rails as being better than those ordinarily used, and he exhibited a type of rail which he stated afforded an effectual means of contact and exceptional facilities for bonding.

The **President**, in adjourning the discussion, said that the next meeting, which would be the annual general assembly, would take place on December 13, and that the next students' assembly would be held on Friday, November 30, when a paper by Mr. G. Wright on "Central Station Working" would be read. At the conclusion of the business of the annual meeting the discussion on the traction papers would be resumed.

Before the regular proceedings of the evening began, **Mr. Siemens** spoke in terms of regret of the death which had occurred of Colonel Armstrong, who, he said, had assisted greatly in the development of submarine telegraphy, and who was the first electrical adviser to the Board of Trade.

Electric Lift for Goods.—An electric lift designed for a load of 10cwt., and having a speed of 1ft. 8in. per second, has been arranged in the works of Messrs. Naglo Bros. in Berlin. The motor, which is of 5 h.p., and runs at 800 revolutions a minute, is coupled to the winding drum by means of gear, and the lift is used for the raising and lowering of goods.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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AN EPIDEMIC OF SHOCKS.

Every now and again there occurs a series of accidents, more or less serious (though usually it is to be feared of the former character), due to the usual foolishness of persons who insist upon looking for a leak of gas with a lighted candle—and find it, when the windows and doors are blown out. Slight misadventures of this kind do not, of course, entirely put an end to the use of gas—it would be absurd if they did; we merely mention them to recall the curious frequency with which there seems to occur a series of such accidents, followed by a short interval of comparative freedom from them, due possibly to the exercise of greater care and common-sense for the time being whilst the moral effect of these explosions yet endures.

It is not in any way remarkable that they should occur: the philosopher will regard them as inevitable accompaniments of any illuminating system where gas is employed, just as slight accidents are certain to happen in electric lighting circuits distributed in similar fashion over an entire town or city for general service. There is, however, at least one very striking point of difference: the ordinary individual or atom of the public mass can in practice never act so foolishly with an electric circuit as to do serious harm either to himself or others.

It has been affirmed that there is more danger to the workmen and others engaged in electric lighting than to the workers employed on a gas-lighting system: we doubt this, in the first place; and, secondly, even if it be true, the men are fully aware of what danger there may be. Still more is this realised by the engineers who have charge of the system: and their efforts are constantly directed to safeguarding the employés as well as the public. One proof of the care with which the latter object at least is effected lies in the fact that Mr. Cook, the engineer of the City of London Electric Lighting Company, stated that a far greater number of people would be maimed and killed by slipping on orange-peel in the streets of London than were ever likely to be injured or killed by electricity. He had not heard of any consumer or other person not connected with the works being killed since the inauguration of the City lighting. Accidents to workmen and employés, moreover, are not and have not been in any way so numerous as those to the general public from leaks of gas, and a proof of this lies in the title we have given to these remarks. To have three or four accidents (of which one has, unfortunately, proved serious) within the past fortnight, prompts us to speak of them as forming an "epidemic."

With regard to the occurrence in the City—particulars of which appear elsewhere in a report of the Board of Trade enquiry—we are, of course, not yet in a position to comment fully upon the facts or the bearing which they may have upon present methods: not only is the enquiry adjourned, but even if it had been concluded we should require to await the publication of Major Cardew's report before venturing any criticism or expression of opinion. Speaking from a general standpoint, we note with pleasure that the electric lighting com-

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pany freely admit the mistake made at their works which caused the short-circuit and subsequent charge of a street and pavement area, leading to the death of a horse and injury to passers-by from shock and contusions due to the broken junction-box lids, etc., and trust sincerely that in this case the well-known adage applies: "a fault confessed is half redressed," so far as concerns the possibility of any future incidents of the same kind.

More serious and regrettable is the fatality referred to in our correspondence columns occurring to an employé of the Taunton electrical works. Even in this case, however, there seems no absolute proof that death was due to shock; it is to our mind essential that the medical evidence should be absolutely conclusive, and a mere opinion is not sufficient to place this lamentable affair in the category of electric accidents. Moreover, as with the case at Blackpool, instanced in our "Notes" column, the fault or responsibility rests clearly upon the employé himself, for all possible precautions appear to have been taken at the Taunton works to prevent the occurrence of any accident whatever; and if the unfortunate man suffered fatal injury from shock, it seems hard to see how this was possible otherwise than through absolute carelessness. The same criticism must be made with regard to the foolhardy lamp-trimmer at Blackpool. Anyone who attempts to wipe out a loaded gun at full cock would be considered, to put it euphemistically, somewhat less wise than Nature intended him to be. Workmen who will not avail themselves—through carelessness, or worse—of the means provided to give them adequate protection, must bear the consequences of their own folly.

At Keswick, the breakage of an overhead line seems to have caused it to be grounded through an iron spout and pathway gutter, but the hardy Northmen rather enjoyed the sensation of shock; and whilst the current was thus more or less short-circuited, the harmless antics of involuntary victims appear to have amused a number of those who had previously suffered. This is a typical instance of the fact, which should be laid well to heart, that the general public run practically no serious risk whatever from any well-conducted electric lighting system: and epidemics of shocks will in all likelihood recur not only very seldom, but after intervals increasing in length of time.

REVIEWS.

Electric Transmission of Energy and its Transformation, Sub-Division, and Distribution. By GISBERT KAPP, M.I.C.E., etc. Fourth edition. Thoroughly revised. Whittaker and Co.

When public appreciation of a book has been so practically demonstrated as to demand a fourth edition, any words of commendation must necessarily appear feeble. The fiat of success has gone forth, and all the critic can say will hardly add or detract from the verdict such a demand shows. In this case, however, the honest critic is perforced to agree with the public verdict, and, if he says anything, to admit that the success is well merited, and, indeed, if anything, is insufficient. Mr. Kapp, if we mistake not, was the first author to attack this problem of transmission, and from his first edition to the present he has kept himself and his readers well abreast of all that has been done in this direction. Mr. Kapp starts with an immense advantage. It is nothing to say he is a painstaking student. He is that and far more. Authors, as a rule, are followers, and not pioneers. Mr. Kapp is not a follower; he is also more than a pioneer—he is an original thinker and a practical man. The ordinary author has usually in mind the requirements of a mere student; this author has another goal, the requirements of the practical constructor and designer. We may admire the late Dr. Todhunter's book on mechanics, but a study of that book never assisted any man to build a steam-engine. Mr. Kapp gives us not the scholastic problem to solve, but the workshop problem, and places in our hands the necessary information to solve such problems. Theory is made a tool, and the way to apply the tool is clearly indicated. In fact, we know of no other author that in this particular subject comes anywhere near Mr. Kapp for practical insight, for terse and clear explanation of all that concerns electrical transmission of energy. This edition has been largely revised. It is almost a new book, and will bear the closest study. Of course, it would not be English-like if we did not introduce at least one grumble, and let us say at once we detest the new symbol for revolutions per second. Bother so much symbolism, and especially such a symbol! Have some consideration for printers and typefounders, whose charges for mathematical work are large enough now without introducing much that is strange. But to return to the book. The first six chapters are somewhat on the same lines as the corresponding chapters in the previous edition, and these constitute the first half of the book, which now, instead of nine chapters, is extended to twelve, the last six being almost all new matter. It is needless to say that this new treatment of alternating current, self-induction, armature reactions, frequency, single and polyphase motors, and similar questions of late becoming prominent, is as able as anything the author has ever written. As we have said, the treatment throughout is with a view to direct practical application, and the needs of the worker are never forgotten; hence this book is one which must of necessity be found in the hands of everyone who desires to become acquainted with the best and latest information on the subject.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

USE OF MICANITE.

SIR,—We notice in your issue of the 2nd inst. a reprint of a circular concerning the manner in which "micanite" should be used. As you therein merely mention the name of our American friends, without giving any address, this might prove misleading to many of our customers or "would-be clients." As you are aware, it was we, as sole European agents for the Mica Insulator Company, who introduced this form of insulation into the European markets, and we are glad to say that our efforts have been very amply rewarded.—Yours, etc.,

13, Walbrook, E.C. BERGTHEIL AND YOUNG.

ELECTRICITY FROM GAS.

SIR,—I have read with interest your article entitled "Electricity from Gas" published in your issue of last week, and referring to the elaborate demonstration station recently erected at Stoke Newington for the Motor Gas Syndicate from designs supplied by Mr. B. H. Thwaite.

With reference to this plant, I may state that having been instructed by the owners to make a lengthy test and report on the general efficiency of the plant under different conditions of working, I devised one of the "ingenious improvements" noticed by your representative in the shape of "a little arrangement attached to the gas-engine, by means of which a tiny piston, acting in a small cylinder connected with the main engine cylinder, actuates a needle so as to punctuate a paper strip at every cylinder explosion." This arrangement was fitted to the gas-engine erected at this station, at my suggestion, with the view of

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determining the horse-power with greater accuracy than is usually done in the case of gas-engines, and it answers its purpose admirably. It could easily be made to form an integral part of indicators intended for gas-engines.—Yours, etc.,

GEO. CAWLEY.

29, Great George-street, S.W., November 19, 1894.

ACCIDENT AT TAUNTON.

SIR,—As there appear to be all sorts of rumours afloat as to the unfortunate fatality at these works, I am sending you the enclosed facts concerning the case for use at your discretion amongst your columns. I am sure you will agree with me that in the interests of the electrical industry it is highly desirable that one avoids any appearance of sensationalism, and therefore I send you the facts.—Yours, etc.,

HAROLD W. COUSENS,
Borough Electrical Engineer.

St. James's-street, Taunton, November 19, 1894.

[ENCLOSURE.]

About 6.45 p.m. on Tuesday, November 6, Warren Upham, a pupil of the Corporation, was seen by a labourer (who was washing a portion of the floor) going towards No. 1 alternator (70-unit Thomson-Houston) with an oil-can to replenish the bearings. A minute later he was found leaning against the bed of the exciter and belt-guard behind, apparently dead. Medical aid was at once summoned, but of no avail. There were no marks on the body, save an abrasion on the left arm caused by the belt of the exciter as the body lay. The doctor made a *post mortem* examination of the body and found the organs healthy. He was of opinion that death was due to an electric shock. There was no evidence to show how the shock was received, as no one witnessed the occurrence. The inspector of factories attended the adjourned inquest on the 15th inst., and expressed himself perfectly satisfied with the precautions that had been taken to guard against accidents. To quote a local paper anent the occurrence: "At the Taunton electrical depôt it would be difficult to provide more precautions than at present exist. It is for the assistants to make use of the precautions offered them and there will be no danger." The jury brought in a verdict of accidental death caused by an electric shock, and wished to add that, if possible, greater care should be taken to insulate the dangerous parts of the machine, and a safer system of oiling should be adopted.

ALTERNATING CURRENTS AND FUSES.

In a recent issue of the *Transactions* of the American Institute of Electrical Engineers is published a paper on this subject by Prof. Dugald C. Jackson and Mr. R. J. Ochsner. The paper, which is illustrated by diagrams, forms a report of an investigation made by Mr. Ochsner in the electrical engineering laboratory of the University of Wisconsin. The work was undertaken with a view to studying the disintegrating effect of alternating currents on fuse metals, and, if possible, to ascertain the cause. As the work done at Cornell University last year showed such a remarkable rise of resistance and a lowering of the fusing points of the fuses placed on the alternating circuits, Mr. Ochsner decided to repeat the experiments, and if any change in the resistances should take place to prolong them.

As a result of his tests on the effect of alternating currents on the resistance of fuses, Mr. Ochsner states that these experiments prove that there is no appreciable rise of resistance in fuses subjected to alternating currents, at least not within a period of 550 hours. More accurate results might undoubtedly have been obtained had the fuses been mounted in such a manner as to avoid contact with any large masses of solid material, but the accuracy is amply sufficient to prove the case. These results are diametrically opposed to those given in the report of similar work, published in the *Transactions*, vol. x., p. 262. While in the latter investigations corrections were made for the standard resistance with which the fuses were compared, no such corrections were made for the fuse wires. The fuses were subjected to larger currents than in his tests, with consequent greater heating. The resistances were apparently measured without allowing sufficient time for the fuses to acquire the temperature of the room, and even if this was done the variation in temperature of the room, as given in the original report of the investigation (which Mr. C. P. Matthews, instructor at Cornell University, kindly sent him), was sufficient to introduce serious errors. The resistances were measured by the fall of potential method. According to the drawing, showing the arrangement of the apparatus, no extra resistance is put in series with the battery to reduce the current strength. This current may have been sufficiently great, in the smaller-sized fuses at least, to cause considersiderable heating. For these and other reasons relating to the accuracy of the tables, he thought that this part of the work reported by Mr. Matthews was not to be relied upon, and, therefore, the conclusions based upon it are of no value.

In regard to the effect of alternating currents on the fusing points, four of the samples exhibited showed a slight lowering, while two show a slight rise in the fusing point, but the differences are of the same order as the differences between individual test pieces. While a test of only a comparatively small number of fuses in this way hardly establishes the correctness of the results, a slight change in the fusing points probably did take place, as is shown by the fair uniformity of the figures in each sample. That such slight change as did occur was due to oxidation there is also little doubt, for all of the old fuses showed slight oxidation, and the effect is too small to be of practical moment. As to the results in the earlier investigation already referred to on the fusing points, only the averages are given, and no mention is made of temperature; therefore it is impossible to properly judge of their accuracy. As far as can be determined from the original report, however, the tests do not seem to be any more reliable than the resistance tests.

In the light of the experiments herein described, and the statements made by Cockburn, Salomons, and Matthews, is it necessary to ascribe a slight change in the properties of the fuse to the disintegrating effect of the alternating current? The author thinks not. In practice, a fuse is seldom obliged to carry a current equal to its full rated capacity. In electric lighting, for instance, the lamps protected by a fuse are not likely to be all turned on at once, and therefore the fuse is seldom carrying more than a small part of its rated capacity. The experiments that he has made, therefore, represent the conditions of ordinary practice, and prove that a fuse as used in practice is not directly affected by the alternating currents. Fuses on alternating-current circuits are sometimes found to blow without apparent reason, but something outside of the disintegrating effect of the current is the cause. Under some conditions the result has come about through the mechanical shaking to which an alternating-current fuse is sometimes subjected when not tightly clamped by the terminal screws.

CITY AND GUILDS OF LONDON INSTITUTE.

LECTURE XI.—GENERAL DESCRIPTIVE KNOWLEDGE OF MAGNETS AND ELECTROMAGNETS.—BEST METHOD OF WINDING ELECTROMAGNET COILS FOR VARIOUS SERVICES.

(Specially contributed.)

Magnets.—I may perhaps be allowed to put the cart before the horse, and begin this portion of my subject with the consideration of the artificial rather than of the natural magnet. My reason for this transposition is that the artificially-made electromagnet is vastly more important in industrial work than is the natural magnet or lodestone, or the artificially-made permanent magnet. I have used the word permanent just now, from which you will—and justly so—infer that the electromagnet is not permanent.

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Field.—When speaking of the voltaic cell, I told you that effects are produced in the space around the external conductor. I have here a very simple circuit, Fig. 1, through which a current is flowing, and I have also a kind of pepper-box, which, instead of pepper, is full of iron filings. I sift these iron filings over the circuit and you see that

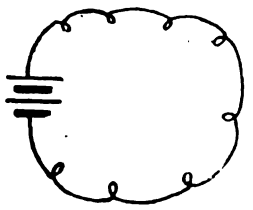

FIG. 1.

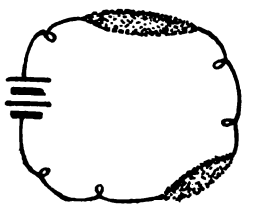

FIG. 2.

some of the filings cling to the wire, Fig. 2. No matter what part of the wire I shake the filings above, you see some of them cling. If I break the circuit, the filings fall off the wire.

I have here a plate of glass, through the centre of which I can pass a conducting wire, Fig. 3. I send a current through

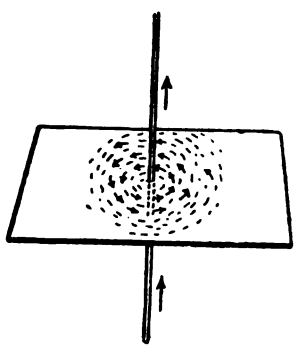

FIG. 3.

this wire, and shake some of the iron filings on to the glass. See, they do not tumble anyhow, but arrange themselves somewhat symmetrically around the wire. They look as if they arrange themselves in concentric circles. I try shaking the filings on a similar piece of glass without the conductor, and, see, they fall anyhow. There is now no arrangement. Now, what caused the filings to arrange themselves symmetrically around the conductor? I do not know. The action, however, is due somehow to the current going through the wire; for if I try with the wire through the glass, but no current in the wire, you see the filings fall unsymmetrically, just as they did upon the glass plate without the wire.

Hence we must suppose that the current has some influence in the air space immediately around the wire. This influence we term *magnetic influence*, and the space around the wire in which this influence is exerted we call the *magnetic field of the conductor*. It is very usual to call this magnetic influence *induction*, and to say the filings are acted upon by induction or inductively. But these filings we shall find not only are influenced themselves, but in their turn, so to speak, become centres of influence, and will act upon other filings.

I have here a small permanent magnet which I will suspend by this silk thread a little above the glass plate while there is no current in the wire. You can see its shadow on the screen. Now, watch while I make contact and send a current through the wire. You see the magnet and shadow move, coming to rest in a certain position. I pin a strip of paper along the centre of the shadow pointing to the ends—that is, pointing in the same direction as the long axis of the magnet. I now reverse the direction of the current as quickly as I can. You see the magnet and shadow turn right round and the magnet comes to rest. The long axis of the shadow is again exactly along the strip of paper. The two ends of the magnet are now just in the opposite direction to their original position, but the line drawn through the ends has not changed. A careful examination of the lines of filings and the position of the magnet will show that the line drawn through the ends of the magnet is tangential to the lines of the filings. These later are circular in form with the wire at the centre, and the filings form a series of concentric rings around the wire. If we had thin plates of glass all along the wire, we should be able to obtain similar phenomena so long as there was a current. The conductor would then be surrounded by circular rings of filings forming a kind of whirl around the wire, Fig. 4. The single whirl with the concentric circles may be shown more clearly by Fig. 5. We

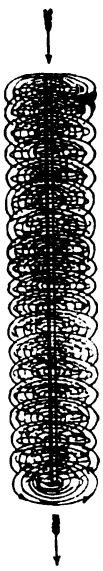

FIG. 4.

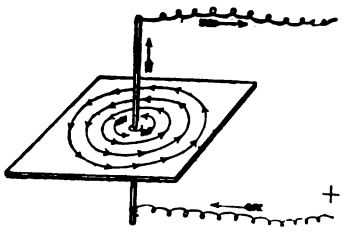

FIG. 5.

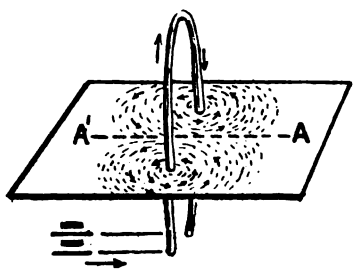

FIG. 6.

may learn something more by bending the wire back on itself, as in Fig. 6. The circles of filings, instead of being concentric around each wire, are now in the space between the wires pushed closer together, and the direction of the filings along the central line between the wires becomes for a short distance almost, or quite, a straight line.

Lines of Force.—As I have said, we do not know the actual cause of these phenomena, but Faraday suggested an excellent working hypothesis, and using this suggestion assists us greatly in understanding the various phenomena of magnetism. He said we might suppose forces radiating from the conductor or from the magnet, each individual force being termed a "line of force." Hence we may suppose the magnetic field to be made up of "lines of force." The greater the number of these lines of force in a given space, or the greater their density, the greater is the strength of the field.

The circular lines of force found along the whole length of conductor are not lost if the conductor be bent completely round upon itself. If Fig. 7 represents the lines

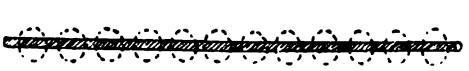

FIG. 7.

of force in the straight conductor, Fig. 8 may be taken to represent a single coil of conductor in which the lines of force will be seen to thread the coil.

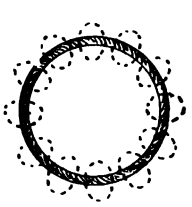

FIG. 8.

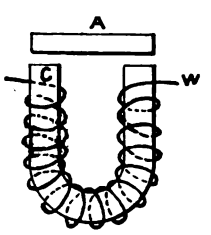

FIG. 9.

All our experiments hitherto have been with air as the material in which the magnetic field is formed, but we may use instead of air something which offers a less resistance to these lines of force, such as soft iron, and then we might expect the current which forced a given number of lines of force through air to force a greater number of "lines

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of force" through the material which has less magnetic resistance. And this is so. Thus in magnetism, as in voltaic electricity, we have three principal phenomena to investigate.

In voltaic electricity we had to consider a *pressure* to force a *current* through a *resistance*.

In magnetism, also, we have to consider a *pressure* to create or push "lines of force" in or through a given *resistance*.

The magnetic pressure in the electromagnet is due to the current in the coils surrounding the core.

The lines of force created answer to the current in the voltaic circuit; and

The magnetic resistance of the iron core of the air space between the armature, Fig. 9, and the core and of the armature combine to make up the total magnetic resistance of the magnetic circuit.

Thus we get in magnetism a law similar to Ohm's law in voltaic electricity. It may be written:

$$\text{Number of lines of force} = \frac{\text{Pressure due to current in magnet coils}}{\text{magnetic resistance}}$$

I have shown you that a single loop of conductor has a circular field around it. If a second loop be added to the first, and another to that, and so on, the magnetic field, Fig. 10, if found to exist all round the loops. A careful

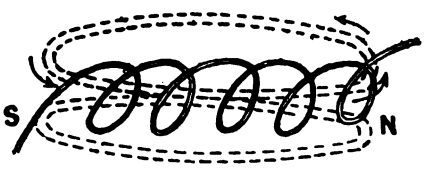

FIG. 10.

examination of the iron filings shows that they form closed curves of filings, and we therefore assume that all lines of force formed closed curves of force. Each of these curves threads the loops. If I arrange the loops, Fig. 11, so as to form

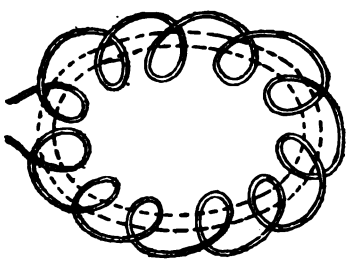

FIG. 11.

a ring of loops, the whole of the lines of force are found in the interior of the loops, as that circuit forms a complete circuit, and is the shortest, hence offers the least resistance.

With the conductor loops as I have shown them the lines of force have to traverse the air, and air offers a great resistance to them. If, then, a series of loops carrying a current, as in Fig. 10, act as a magnet, we must come to the conclusion that the magnetic action is due to the lines of force.

Now a magnet has certain characteristics:

1. If freely suspended it will take up a position so that its ends point towards the magnetic poles of the earth. This is a direction not quite the same, but nearly so, as the geographical poles.

α. If an apparatus consisting of a series of coils, as shown in Fig. 12, be freely suspended by immersing the terminals of the wire in mercury-cups, as in the diagram, and a current is sent through the coils, the conductor does take up a position pointing north and south, as indicated. A series of coils of this kind is termed a *solenoid*.

2. A magnet pulls small pieces of iron towards itself when the small pieces of iron are placed within the influence of its field. I say small pieces of iron advisedly, because if the pieces of iron be very much larger than the magnet, the magnet will go to the iron instead of the iron going to the magnet. From this it will be assumed that the pull—if pull it is—is mutual. The action really arises from the property existing to shorten the magnetic circuit, or to lessen its resistance when the conditions are favourable. The pull of the magnet upon the iron is due to an effort to bring the iron into the circuit, and so lessen its resistance.

β. If small pieces of iron be brought within the influence of the field of the solenoid, there is an effort to pull the iron towards the centre of the coils.

The solenoid then acts as a magnet, and is a magnet. It is possible for us, roughly, to show the effect of placing a piece of iron in the circuit, and so decreasing the resistance of the magnetic circuit.

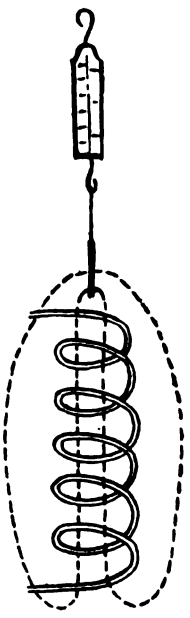

FIG. 13.

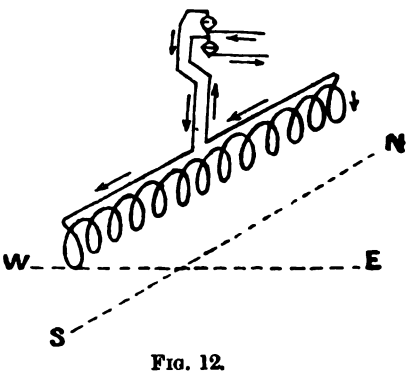

FIG. 12.

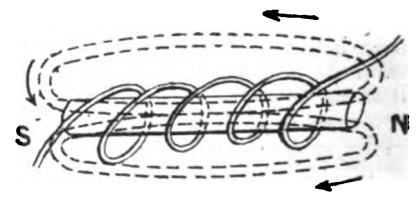

FIG 14.

Take the solenoid, Fig. 13; we place this small piece of iron at a certain point near the end of the solenoid. The iron is fixed to a delicate spring balance. Sending the current through the solenoid we see there is a pull upon the balance. Note what it is. The current sent through the coils is measured by this instrument. You see the indication upon its dial. I now break the circuit, and place this soft iron core in the solenoid. The piece of iron to be acted upon is exactly on the same spot, and we now send an exactly similar current through the coils. You see the pull on the balance is greater. The resistance of the magnetic circuit is lessened. The number of lines of force around the coils is increased; hence the number acting or pulling on the piece of iron are increased, and this increased number causes an increased pull.

It being found that air has a much greater magnetic resistance than iron, we usually fill up the core of the coils with soft iron, Fig. 14, curving the coils, or otherwise arranging them, so that the air space between the ends, or, as they called, the *poles*, is as small as possible, Fig. 15.

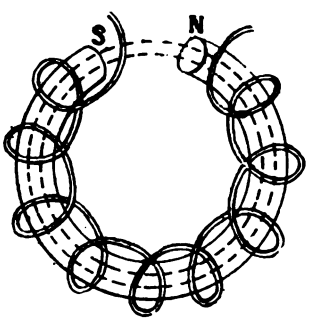

FIG. 15.

Later on we shall see it is impossible to do away with this air space in most instances if we want to utilise the "lines of force," otherwise the greatest number could be had, or the least resistance of the magnetic circuit would be obtained by making the core and coil circular.

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INSTITUTION OF JUNIOR ENGINEERS.

ABSTRACT OF PRESIDENTIAL ADDRESS, BY ALEXANDER SIEMENS, M.I.C.E., PRESIDENT OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

It is not my intention to say anything to-night about the education of civil engineers, as this topic has been deal with by two of my predecessors not very many years ago, but I wish to draw your attention to a particular class of problems which from their very nature cannot be easily dealt with at a college. These problems are not confined to any branch of engineering, but are common to all of them, and have to do with the advancement of our knowledge and of our ability to utilise the forces of nature. When we look round and see how the civil engineer has transformed the conditions of living during the last hundred years, we cannot help being impressed with the change that has been brought about, and nothing is more natural than the thought that a further development of our resources and an increased command over natural forces are in store for us, and only wait for the right man to reveal them to mankind. That such men deserve special recognition has long since been admitted, and when, in the reign of James I., all monopolies were abolished, an exception was made by granting the privilege of the "sole working or making of any manner of new manufacture within the realm to the true and first inventor of such manufacture, which others, at the time of making such letters patent and grants, should not use, so they be not contrary to law, nor mischievous to the State by raising of the prices of commodities at home, or hurt of trade, or generally inconvenient." On this statute all the patent legislation of this country is based, and the effect of the law is that inventors are granted a monopoly for a limited number of years, on condition that they fully describe and make patent to everybody the particular nature of the useful novelty which they claim to have discovered or invented.

It is rightly assumed that, on the one hand, the time and money expended during the development of the novelty give the inventor a claim for compensation, and that, on the other hand, the usefulness of the invention is greatly enhanced if an opportunity is provided for everybody to obtain the description and full explanation of the latest developments in manufacture. A proof of the correctness of these principles is the unanimity with which all civilised nations have adopted them, although the methods of applying them vary a good deal. The success which has attended the efforts of many inventors and the constantly widening field for the utilisation of natural forces exert an ever-increasing fascination over our imagination, and when a young engineer enters practical life it is not to be wondered at if he dreams of the improvements he may introduce, and of the reward he will earn for his ingenuity. This is the right spirit with which to enter on life's work, for all true progress is based on genuine enthusiasm and proper self-confidence, which enable us to devote to our studies that earnestness and thoroughness without which no real advancement is possible. It is a popular superstition that inventors are heaven-made, and that they can produce useful novelties to order in any branch of manufacture, where a want exists, if only their attention be drawn to it.

The history of the invention of the steam-engine is a well-known illustration of the point I wish to emphasise. According to the popular version, Watt, as a small boy, saw the lid of the tea-kettle move up and down when the water was boiling, and this suggested to him the construction of the steam-engine. As a matter of fact, Watt made himself acquainted with what had been done before (a point altogether ignored in the popular version), and had to work very hard before he brought his invention to a successful issue. His example is typical of the true method of progress, and we may say generally, that in order to approach a problem with the best prospect of success it is necessary (1) to define as accurately as possible the want that exists, or the particular object that is to be attained; (2) to be well acquainted with the scientific principles which come into play; (3) to know how the want is met, or the object attained in practical life; (4) to find out what proposals have been made by others in the same or in a similar case. A careful attention to these requirements will prevent much disappointment and waste of energy, as will be obvious to all of you without further explanation.

It may, indeed, seem curious to you that I should dwell on such palpable truths, which must be patent to everybody who gives his attention to the subject, but you will very soon find out that inventions are brought forward every day by zealous people who have neglected to make themselves masters of one or more of these necessary preliminaries to bringing out a successful invention. In some systems of patent legislation, endeavours have been made to aid the struggling inventor by a preliminary examination into the novelty of the invention, but this is avowedly nôt conclusive, and does not protect the patent against attacks for want of novelty or lack of utility. It is, therefore, difficult to comprehend what object is served by this preliminary examination, and it is easily seen that this benevolent intention of assisting the inventor becomes really nothing more than an additional obstacle in his path. As a result of this we see that lawsuits about patents are quite as frequent in countries which have instituted a preliminary examination, as in those where patents are granted without it. In fact, a new type of patent suits is created by inviting opposing parties to lay their arguments before the examiner, and by requiring the inventor to refute them. Between such a suit and a suit for infringement before a law court there is little difference as far as time and money are concerned, but a gained lawsuit establishes your claim to an invention, while the favourable decision of a patent examiner carries practically no weight at all. There is the initial difficulty of determining whether a modification that somebody suggests in a manufacturing process is a patentable invention or not. Such a question was raised in connection with the famous Bessemer process of making steel.

In other countries, this question is treated differently. For instance, in France, an inventor can prevent other people using well-known devices if he is the first to apply them in a novel way or to a novel machine. By such an interpretation of his patent, Mr. Gramme succeeded in securing for himself the monopoly of using copper-wire brushes to take the current off at the commutator of dynamo-electric machines. It was of no avail to prove the use of such brushes in telegraph instruments or in magneto-electric machines; the French law recognised that Gramme was the first to utilise such brushes in dynamos, and confirmed his monopoly. In this particular case the privilege was of no great value, for copper plates served the same purpose equally well, and did not fall under the patent.

In all cases we have contemplated up to now the advancement of manufacture was attempted by men who devoted their lives to a particular branch of industry, and were actively engaged in carrying it on. As it is to be expected, the subject-matter of their proposals has in most cases a solid foundation, meeting an existing want, or extending the application of known devices; for such men are well versed in the practical requirements of their daily work, and of necessity make themselves acquainted with all that is new to their own branch of industry. Nearly all the large establishments have nowadays a special staff of workers, who do nothing but investigate inventions or experiment with modifications of manufacturing devices and processes. In addition to these private investigators, most technical colleges undertake similar research, and accounts of their work are published in the technical journals of all countries, resulting in a rapidity of advance that could not be realised without the aid of our modern means of communication. A natural consequence of this mutual reaction on each other of many workers is the subdivision of labour, which is carried further every day, and makes civilised man increasingly dependent on his fellow-workers. At the same time, it is evident that the share of each worker in the advancement of his art, or in the introduction of useful novelties, must become smaller and smaller, as each step is at once made known to most of the persons concerned.

To an attentive observer it must be quite obvious that those people have the least chance in the race who are not well acquainted with the branch of industry in which they wish to introduce improvements, and who do not study the technical literature bearing on the subject. Contrary to expectation, these are precisely the people who clamoured for cheap patents, and who inundate the Patent Office with their inventions. In 1883, the cheap patents were at last granted, and the effect has been that the number of patents taken out which, during the 10 years ending 1882, was on the average 3,506 annually, has grown to 25,000 during the year 1893, their number having steadily increased ever since the new law was introduced. This class of inventors not only ignores what is already known, but they treat with very little respect the so-called details which have to be worked out before any proposals assume a practical shape. Unfortunately for them, it is the question how these details are to be carried out, which decides, in most cases, the fate of an invention, and a seemingly brilliant idea will often prove delusive because some small factor in the problem has been overlooked. In a similar manner they do not realise that the knowledge of scientific principles might be an assistance in their efforts, or if they study science at all they think they can acquire the necessary knowledge by a short study and without much trouble. Some of these inventors even go further, and claim that their ideas are genuine novelties in every respect, and that objections based on scientific reasons are only expressions of professional jealousy.

Poor Galileo is quoted as an example of a man whose ideas were in advance of his age, who was not appreciated by his contemporaries, and who has been proved to have been in the right by posterity. When a man brings this argument forward it is quite useless to quote the natural laws which make the carrying out of his invention impossible. He will gravely assure you that scientific men will have to reconsider the conclusions which are not in accordance with the new invention

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and that they will find out the error of their ways. It would not be surprising if you thought that nowadays education is so universal, and the means of learning all about a branch of industry so easily attainable, as to prevent people from falling into the errors I am speaking about. But some examples of proposals seriously laid before my firm will convince you that a sanguine inventor is quite independent of college or of workshop, and that in this case, as in many others, truth is stranger than fiction. The extracts have been chosen from letters actually received over 10 years ago; for obvious reasons, all dates and names are omitted. About 14 years ago my firm fitted up the Royal Albert Dock with a system of arc lights, and not long after the following communication was received:

"Having studied the subject of the 'utilisation of natural forces for the purposes of electric lighting,' we have found a method, which is as cheap as it is possible. We understand that you have under your control the lighting of the Royal Albert Dock by electricity. For that purpose there are, we believe, four engines, to each of which there is an average of three men. As a matter of course, electricians and other operatives directedly connected with the production of light are omitted. Well, gentlemen, the result of our studies is that we have constructed a machine which will produce sufficient motive power to work as many electric machines as would be required to light the Royal Albert Dock and Victoria Docks for 16 continuous hours without expenses of coals, etc. Another decided advantage is, that two men are all required. The money simply spent in coals for one week to supply the steam-engines at present there would be sufficient to keep one of our engines or machines going for a month, including the expense of labour! It is with great pleasure that we submit this idea (to you in the first place) to be approved of or otherwise. Lack of funds prevents us as inventors from patenting our discovery, but if suitable arrangements can be made, it will be parted with on moderate terms. This is an invention the principles of which are simple, construction cheap, and mode of working easy. The machine can be constructed in nearly every town in the kingdom. The 'machine,' together with 'purchase' connected with it, may be easily patented; and, thus defended, the patentee may go to work without fearing any piratical attacks from others. There is a rough model of one of the machines in London, where it may be seen; as soon as this letter is satisfactorily answered, the address will be sent."

From the tone of the letter it is evident that the writers had some idea of business, and were prepared to make moderate terms with anybody who would help them to bring out their invention. This is not always the case, as the next example will show: "I believe I am in possession of a valuable idea to which electricity may be applied with enormous advantages, and if it succeed no doubt would be largely used. Having had the matter before one or two gentlemen who have made electricity considerable study, I may say that they are perfectly satisfied as to its success if properly carried out, and suggested my laying it before you with a view to an experiment. The machinery required would not consist of much. If you are disposed to assist me so as to ensure a proper experiment being made, I should, of course, give you the necessary information under secrecy, as, of course, if it turned out a success, I should like to patent it if possible."

No offer is made of a share in the profits in return for assisting in carrying out the experiments, most probably because such inventors have no idea of the difficulties attending experiments and their cost. The popular idea is that a truly great invention ought to be made on the lines that Prof. Hughes followed when he constructed the first microphone by the help of a matchbox and a few pieces of broken carbons. It is certainly true that a genius will accomplish much with apparently insignificant means, nevertheless, a good many experiments were necessary before a practical form of microphone was settled upon—but of these the general public knows nothing.

When I came to England in 1867 I made the acquaintance of one of our workmen, whose business it was to lacquer brass-work. He had the peculiarity of coming to his work only long enough to earn sufficient to keep him from starving; the rest of his time he devoted to the construction of a machine for generating power. He had been a lawyer of good standing in one of the minor German States, but unluckily for him he had a "mechanical turn of mind," which induced him to give up his practice and to come over to England, where he hoped to realise a fortune from his invention. In 1867 he assured me another fortnight's work would complete the machine, and a new era would commence in the world's history. In spite of all arguments, of all ridicule, and of all the disappointments, he continued working at this machine until he died about two years ago without being any nearer to his goal than he was 20 years ago. Other professional men have had peculiar views with regard to mechanical problems, as the next letter will show:

"I was yesterday in the Crystal Palace and saw what I believe was a multiplier of power. I have had a dynamo-electric magnetic apparatus working on the sulphuric acid and zinc system, and it has frequently occurred to me that if the gathered-up wire or power thrust into the machine could be increased to an indefinite extent it could be productive of wonderful effects. Now this appeared to me done in the machine I saw in the Palace, but it appeared to me the thing required was velocity and common use. I have made a diagram on paper of a pail of water turning a small waterwheel regulated by the tap in the pail. This would give velocity, but no power to speak of, but if this velocity could be communicated by a pair of hydraulic bellows, then power and velocity would both be gained. If the idea is feasible, and you would like to take it up, I would be glad to form a company to carry it out on any terms you may approve of. I cannot carry out the idea myself for three reasons: advancing age, defective money, and I am sorry to say, considerable laziness. I am a registered medical practitioner and a Crystal Palace season-ticket holder, and the reason I apply to you is because I have a friend in one of your employés named Mr. J— H—, although as I do not know his address, of course I could not communicate with him."

There are some cases where a really useful invention seems to lie within the grasp of the inventor, but his want of thorough knowledge of the subject stands in his way. From numerous examples of such failures I will only mention the following:

"For some little time back I have been considering the practicability of lighting railway carriages by electricity and procuring the electricity by friction on the wheels of the carriages when in motion, with an accumulator in each carriage, so that when the train stopped at any station the accumulator would have a sufficient storage of the electric fluid to keep up the supply for a few hours if necessary. This mode of lighting carriages would be a great economy to the railway companies, not only in oil but in labour, and it would be a benefit from its superior light. The electric light could also be used for the lamps in front and stern of the train, thereby showing the lights at a much greater distance than at present. Before applying for a patent for the application of the electric light, I would feel greatly obliged by you giving me your opinion on the same, and if you approve it, would you have any objection to join with me."

You know, of course, that train-lighting is being carried out successfully on these lines; only the accumulators are charged by a dynamo driven from the axle, instead of generating the electricity by friction as proposed. A very attractive scheme is unfolded in the next letter:

"I beg leave respectfully to submit to you a plan for constructing the wheels of steamboats, etc., on a new principle, and also to adopt the system in other propellers. The plan proposes to form a wheel having on its outer sides or periphery a powerful magnetic principle to act on the water with this power or friction as the wheels of an engine on the rails. The magnets may be of unlimited power so as to act (*sic*) the largest attractive force on the water, and the wheels may be constructed on any plan. The object is to obtain greater efficiency and speed."

Strange as this proposal may sound, the last letter which I shall lay before you surpasses it in originality and vigour of expression: "I am not a madman—I am not an inventor—nor am I a mechanic—but I have been thrown amongst engines, stationary, locomotive, and marine, a great deal. A simple accident has revealed to me the *modus operandi* by which steam can be generated with any degree of power and employed in the propulsion of vessels without the cumbrous details of boiler or steam-chest, etc. I do not go to some capitalist who may rob me of the thought—nor some other who would wish to clap me into an asylum as a dangerous lunatic—but to practical engineers like yourselves who can if my idea is the mere dream of a fool instantly annihilate it with practical objections. If you will permit me to call upon you—five minutes is all I want—if I cannot satisfy you that I have not wasted your time, I will submit to be kicked out of your premises."

All these letters were received by my firm within the space of two years, and a great many more could be found, without doubt, if a further search were made, as the stream of such letters has been flowing in uninterruptedly ever since I can remember. It is certain, therefore, that a numerous class of people exist who are under the impression that they can advance a branch of industry by suggesting ideas that are plausible to them, quite irrespective of the existing experience or of natural laws. As a rule very little is heard of them in public, because these ideas are seldom of any value, but if by chance an outsider makes a successful suggestion, the most is made of it, and the example is quoted by everybody as a proof that special knowledge is by no means required. My object to-night has not been to hold up to ridicule the endeavours of people who may be mistaken, but who worked hard enough and earnestly enough in many instances to deserve a better fate, nor do I wish in any way to discourage you from trying your hand at inventing, but I want to impress upon you the necessity of making yourselves throughly acquainted both with natural laws and existing practice. You cannot master your subject without careful study and hard work, but if you devote your time to the acquisition of this knowledge you will be well fitted to contribute your share to the progress of engineering.

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THE LIME STREET EXCHANGE OF THE NATIONAL TELEPHONE COMPANY.

On Monday afternoon last a Press view was given by the National Telephone Company, Limited, of their new exchange in Lime-street, E.C., to which on last Bank Holiday the business of their East India-avenue exchange was transferred. The company have 30 exchanges in London, all connected with each other, and of these 10 are now using the twin-wire system, so that a complete metallic circuit is established. The remaining exchanges are also to be altered to this system, the introduction of which is no doubt due to the result of the report of the Parliamentary Joint Committee on Electric Power (Protection) Clauses, which virtually left telephone companies to protect themselves against earth or other currents.

The alteration which is being effected will no doubt prove gratifying to the subscribers of the system, and it is stated that the whole metropolitan area, which covers more than 600 square miles, will soon be working on the improved plan. The cost of the work is estimated at about £200,000.

The building in Lime-street was originally a warehouse, and has been adapted to its present purpose by considerable structural alterations. A new roof has been built, upon which is constructed an octagonal standard composed of 39 tubular iron poles. The poles are braced together with iron arms, and securely fastened to the outside walls by iron rope stays. The circumference of the standard is 190ft., and is capable of carrying 6,000 wires; besides this, provision has been made for leading in a considerable number of wires in cables, each cable containing 104 wires, equal to 52 subscribers. At present there are 2,050 subscribers connected with the exchange, besides 240 junction wires and private wires. The standard carries 2,300 insulators for open No. 18 phosphor bronze wires, apart from the wires in cables. From the roof the wires are led through cables to the test-room on the topmost floor, and are there attached to brass springs arranged in numerical order corresponding with the subscribers' numbers. It is here that the subscribers' lines are tested for faults, and the faults localised.

From the test-room the wires are led in a lighter class of cable into the switch-room which is on a lower floor. This room has been fitted with the latest and most approved pattern of multiple switchboards made by the Western Electric Company, of Chicago, and has been designed to meet the requirements of 7,000 subscribers. At present it is fitted for 3,000 subscribers, besides the necessary wires giving connections to other exchanges of the company, both in London and other important towns in the country—viz., Liverpool, Manchester, Leeds, Birmingham, etc. The switchboard is divided into numerous sections, every wire coming into the exchange being led on to the first section, and thence to the second, third, and every other section in the room, each of 3,000 subscribers' wires being attached to a separate spring jack on each section throughout the room. This, together with the necessary junction wires, involves the use of 73,540 spring jacks, and as each spring jack requires five wires to be soldered to it, there are in all, including the soldered connections to the indicators, over 500,000 soldered joints in the room, and the length of wire is over 800 miles. Two hundred indicators are brought on to each section, and four operators attend to a section. By a new arrangement, when an operator connects any two subscribers' lines, the indicator automatically closes. A third indicator is provided in order to signal to the operator when a subscriber rings his bell after finishing his conversation.

On the floor under the switch-room are provided a dining-room, kitchen, etc., for the operators. On the same floor is an engine-room for a Tangye gas-engine, which drives a dynamo for charging the E.P.S. accumulators which supply current for the working of the exchange.

The electric light has been installed throughout the exchange, current being obtained for this purpose from the mains of the City of London Electric Lighting Company.

WIRING REGULATIONS IN MANCHESTER.

By the courtesy of Mr. C. H. Wordingham, electrical engineer to the Manchester Corporation, we are enabled to reproduce the following wiring regulations drawn up by him for use in that city:

Internal Fittings.—The Corporation will not supply or fix any internal fittings except the meter and main fuses on consumers' premises. It is necessary that the wiring on consumers' premises should conform to certain conditions and tests, both for the protection of the Corporation and also for the protection of the consumer himself. The following provisions, however, are intended for the protection of the Corporation and of the whole number of consumers collectively, although they are incidentally beneficial to the particular consumers; but the Corporation will take no responsibility in respect of testing a consumer's premises for his own protection.

Terminals.—Electricity will be supplied, at the option of the consumer, at the pressure of 100, 200, 300, or 400 volts. Except by special arrangement, not more than 50 amperes may be supplied at 100 volts from a single pair of service terminals. When more current is to be supplied, the lamps or other consuming devices must be divided between different pairs of the five conductors. If this rule be departed from, there is danger that the pressure of the supply will not be so uniform as it should be. The installation must be divided up into circuits of not more than 50 amperes each, even when the current exceeds 200 amperes.

Cut-outs.—All conductors must be protected by double-pole cut-outs, which must be competent to cut off the current, if this exceeds the normal current by 50 per cent. It must be impossible for an arc to be maintained between the terminals of any cut-out.

Double-Pole Main Switch.—The contractor to the consumer must in all cases provide and connect up within 3ft. of the Corporation's double-pole fuse, or in such other available position as shall be approved by the Corporation's engineer or his representative, a double-pole quick-break switch of approved design.

Effectual Insulation of all Cut-out and Switch Covers.—It is essential that the covers, handles, or levers of all cut-outs or switches should be of porcelain or other non-conducting material, and any metal parts whatsoever likely to be touched by the hand must be effectually insulated from the electrical circuit.

Switches.—The switches must be so constructed that they do not heat with the full current; that it is impossible for them to remain in a position between full on and full off; and that it is impossible for an arc under any circumstances to be maintained on the switch.

Insulation.—Before connecting the premises of any consumer, the installation will be tested for insulation, and it will be tested from time to time to ascertain that the insulation has not deteriorated. The whole of the lamps or other consuming devices being connected to the conductors and all fuses being in, the insulation resistance between the whole system and earth will be measured after not less than one minute's electrification. The following conditions must then be fulfilled—viz., the insulation resistance for incandescent lamps shall not be less than 50 megohms, divided by the number of lamps fixed irrespective of their power up to 50 candles—that is to say, for installations of

	Ohms.
25 lamps the insulation resistance must be	2,000,000
50 ,, ,, ,, ,, ,,	1,000,000
75 ,, ,, ,, ,, ,,	666,000
100 ,, ,, ,, ,, ,,	500,000
200 ,, ,, ,, ,, ,,	250,000
300 ,, ,, ,, ,, ,,	167,000
400 ,, ,, ,, ,, ,,	125,000

When lamps of higher candle-power are fixed, their equivalent in 50-c.p. lamps will be taken as the number of lamps for the purposes of this test. In cases where the lamps are divided up into separate circuits, in order to comply with Rule 1, each circuit will be treated as a separate installation, provided that no part of it is in electrical connection with any other circuit before being joined to the mains. When buildings are wired on the three wire, four-wire, or five-wire systems the installation will be measured as a whole. The insulation resistance for arc lamps shall not be less than five megohms divided by the number of lamps fixed, for lamps taking current up to 10 amperes; for larger sizes their equivalent in 10-ampere lamps will be taken for the purposes of this test. The insulation resistance of any part of a motor which carries current, together with all leads, sliding contacts or metal work connected to the circuits of the motor, shall not be less than one megohm. If it is desired to use current for purposes other than those specified above, special conditions, which may be obtained on application at the Town Hall, will be enforced. In any case, whatever may be the number of incandescent lamps, arc lamps, motors, or other consuming devices, the insulation resistance shall not be less than 10,000 ohms, even if such an insulation resistance involves a higher insulation resistance per lamp or per motor than that specified in the above rules.

Termination of Service Conductors.—The Corporation's service conductors will terminate in a double-pole fuse supplied and fixed by the Corporation; this fuse will be placed as near as practicable to the outer wall of the building, but in cases where the consumer occupies elevated premises or premises at the back of the building (unless the back of the building abuts on a street in which mains are laid) the Corporation will run the service conductors into such premises, provided the consumer agrees to pay the cost of providing and fixing so much of the conductors and their protection as is within the outer wall of the building.

Entry of Service Pipe.—The hole in the wall for the admission of the service pipe must be cut by the consumer.

Service Pipe on Property other than Consumer's.—In cases where permission has to be obtained from owners of property to allow the service pipe to be carried through such property, it rests with the consumer to obtain this permission, and the owner of the premises will be required to sign an agreement indemnifying the Corporation from any damage that may arise from such portion of the service conductors being fixed within the building.

Service Main not to be Interfered With.—In no case will the Corporation on any consideration allow anyone but their own officials to run any portion of a service main or to make a connection of any description on the main side of the main fuse.

Position of Meter.—The Corporation will provide a suitable meter, for which a rent, varying in amount according to the size of the meter, will be charged, and they will fix this meter free of expense in any convenient position, as near the main fuse as possible.

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Sealing of Meter.—The consumer must provide conductors long enough to reach to the meter, and must efficiently protect them from mechanical injury, but they must be affixed to the meter by the Corporation officials, and the seals of the meter must on no account be broken by the consumer.

Fittings, etc., to be Approved.—All wiring, electrical fittings, and appliances of every description, situate on any premises intended to be used in connection with the supply of electricity from the Corporation must be approved by the Corporation's engineer before the installation is connected with the electric conductors belonging to the Corporation; and in order to avoid risk of work done having to be altered, samples should be submitted to the engineer for approval before the work is begun. Consumers should communicate with the Corporation before the wiring of their premises is begun in order that the position of the service pipe may be decided upon, otherwise alterations may have to be effected.

Conductors.—All conductors must be of tinned copper, must be covered first with a layer of pure rubber, then with a layer of vulcanised rubber of approved thickness, and the whole must be protected with braiding or taping rendered impervious to moisture. All conductors must further be efficiently protected either by incombustible tubes or by hard wood casing. The use of flexible conductors, except for wiring fittings and pendants, must be avoided, and in all cases where it is used the sanction of the Corporation's engineer must be obtained. In no case must the insulation resistance be less than 600 megohms per mile when tested after one minute's electrification, the coil being immersed in water. Contractors must satisfy the engineer that the wire will actually pass this test.

Flexible Conductors.—When twin flexible wire is used it must be insulated with first, a layer of pure rubber and then a layer of vulcanised rubber. No flexible wire insulated with silk or cotton only will be passed.

Wires to be Stranded.—All conductors having a greater sectional area than that of a No. 16 standard wire gauge must be stranded.

Gas Fittings.—No gas fittings may on any account be adapted to electric lamps unless they are efficiently insulated from the gas-pipes at the point at which they are attached to the same, and their use, even when so insulated, should be avoided as far as possible.

Alterations in Number of Lamps.—When it is desired to add to the number of lights already installed, notice in writing must be sent to the Corporation of the consumer's intention to do so, and the new work must on no account be connected on to the old until it has been inspected and passed by the Corporation's engineer or his representative. In cases where it is intended to diminish the number of lights fixed, notice in writing must be sent to the Corporation.

Temporary Work.—In no case will work of a temporary nature be permitted to be connected to the mains.

Staples.—Staples must not be used under any circumstances, nor may flexible wire be threaded through metallic eyes. The capping of all casing must be secured by screws and not by nails.

Arc Lamps.—Arc lamps must be insulated as a whole from earth, and must be so fixed that it is impossible for them to swing into contact with any metalwork connected to earth. When fixed in positions exposed to the weather, the conductors joined to them must be provided with specially thick insulation, which must be further protected by a covering of lead, and every care must be taken to avoid abrasion of the insulation.

Motors.—All motors must be provided with a switch and starting resistance to be approved by the Corporation's engineer, and to be such that in no case can the current through the motor, when at rest, exceed 10 amperes, or increase by greater steps than 10 amperes at a time as the starting resistance is cut out. Each motor must further be provided with a double-pole switch.

Consumers Responsible for Fittings.—The Corporation do not undertake any responsibility for the efficiency and proper execution of any work by a contractor on a consumer's premises. The inspection and insulation test is made for the purpose of the Corporation only.

Building Occupied by More than One Tenant.—In cases where a large building occupied by several tenants is wired, either of two courses may be adopted at the option of the consumers—viz.: (*a*) The conductors may be run from the premises of each tenant to some convenient point in the building to be approved by the Corporation's engineer. In this case a separate main fuse for each tenant and a separate meter will be provided and fixed by the Corporation, the usual meter rent being charged in each case, and the tenants will be regarded as separate consumers dealing direct with the Corporation, and each must fill up an application form for his own lights. A double-pole main switch must be provided and fixed by each tenant, as in the case of ordinary consumers. (*b*) The building as a whole may be wired and the conductors of the several tenants tapped off wherever desired. In this case a double-pole fuse and double-pole switch must be provided and fixed by each tenant where his conductors branch off from the main wiring of the building, and a meter will be provided and fixed on the tenant's premises by the Corporation. A master meter will also be fixed for the whole building. The Corporation charge rent for all meters fixed, and will send their meter reader to read them, but the account will be rendered on the reading of the master meter only, the tenants not being recognised as separate consumers. In this case the proprietor of the building must apply for the whole number of lamps required by the tenants. He will be furnished with the readings of the meters, and he must himself recover from the tenants the various amounts for the quantity consumed, the Corporation accepting no responsibility in the matter whatever.

LIGHTING INSTALLATIONS.

In our last issue we reproduced a paper on this subject read by Mr. H. A. Henderson, member, before the Northern Society of Electrical Engineers. We now give a report of the discussion:

Mr. Eidsforth: The point which struck me most forcibly was the system of testing joints. Of course in installation work proper I have not had much experience, but I used to have a great deal to do in the cable line, and at that time joints were tested under water, and it seems to me to be a great mistake that this is not the case now. I don't know the system which is at present in use, but Mr. Henderson said he had tested something like 500 installations, and he seems to have got hold of a good few bad joints out of that number.

Mr. Claremont: The only thing in Mr. Henderson's paper which has struck me is the paragraph, or few words which he said about the consumer having to pay high prices for fittings unless he goes to a manufacturing firm. This should not be the case if the manufacturer is sufficiently fair to allow discount to the trade only.

Mr. H. Wooler: The only thing I have to find fault with in the paper is the remark made about Manchester being in a better position than any other town for the supply of current, having the alternative of wiring either on the three or five wire systems. Mr. Henderson said that owing to having two or three different voltages to select from they should be able now to supply current cheaper than anywhere else, and he mentioned the Free Trade Hall as a case in point. I very much doubt that. We all know that the higher the voltage the less the current, or should be; but in Manchester, where they have a fixed contract, and charge you for the whole of the lamps connected, and possibly you do not use half of them, it becomes rather arbitrary, and they certainly have not had a very small bill at the Free Trade Hall.

Mr. C. S. Northcote: I should like to correct Mr. Wooler in one or two of his statements. He points out that at the Free Trade Hall the charge for current is high. This is on account of their being wrongly advised. I am rather surprised that he should draw attention to the fact. The installation has never been properly metered, and, furthermore, when the Manchester Corporation meter such installations more satisfactorily than they are at present there should be less grumbling. There is nothing, in my opinion, in the paper about the saving of current to the consumer, but a suggestion as to the price of installations. I beg pardon, it is mentioned, but I should call it an error.

Mr. Wooler: The only point I can make out by using the three-wire or multiple-wire system is that you can afford to put in larger cables.

Mr. Northcote: I may say that I quite agree with Mr. Henderson's remarks *re* the sub circuit system. I myself know that very little work has been done up to the last few months on this system. When the electric light first came into use the tree system was mostly employed, but undoubtedly that has been altered in Manchester lately; most buildings are now wired on the multiple system, with sub-distribution boards for alternate circuits. I think Mr. Henderson is right in remarking that this is a good system, and should be more generally used. With regard to Mr. Claremont's suggestion as to manufacturers maintaining discounts, I think it is a very great pity that we cannot all combine together and get the prices raised instead of cutting them down so. I have a case in point which I happen to know of, where a large manufacturer of a certain article in which we were interested and supplying to consumers, quoted us £500 for certain goods. I was asked our price, and on mentioning this was shown a telegram from the makers direct allowing, say, 5 per cent. off this price. Such instances as this make things very awkward sometimes.

Mr. Thomas: There is only one point in the paper which I should just like to mention, and that is the action of cement on indiarubber; it seems to have a very strange effect. For instance, if you put a wire into a bucket of water you get no leakage through it at all, but if you put that same wire upon a damp wall, whether there are any joints in it or not, you get a leakage through it after it has been up possibly only a few hours, and I never had this explained. Perhaps some of the gentlemen in the cable line will be able to assist us in this matter.

Mr. Fawcus: I have myself noticed considerable action having taken place with casing fixed against enamelled bricks, and there can be nothing in enamelled bricks that can attack the wires, but there seems to be some kind of cement or other used for attaching these enamelled bricks. We have had several cases of wires being completely eaten through.

Mr. George Broughall: The only point which I should like to mention is the price at which work is at present being put in. It appears to me that the lasting power of installations lies in the quality of the material which is put in, and it is to me wonderful, at prices which I know several installations have been put in, how they have passed inspection at all. Of course some of them may pass inspection when first installed and new, whereas, perhaps, in a few months they would not pass another inspection of the work. Then what about the consumers? Most likely they have to take out a portion of the work, if not all, and go to the expense of having it done over again. I think everything possible should be done to improve the quality of work, instead of bringing it down, as is the case at present, with the low prices that are going. It seems to be the rule nowadays to take the lowest tender and

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cut down the prices. If good work is to be put in, I think a fair price ought to be paid.

Mr. A. Eckstein: I have just one thing to mention, and that is that Mr. Henderson seems to think that fitting manufacturers should do installation work, whilst cable manufacturers should not. Now, I think this is the other way about. He seems to think that the reason why fitting manufacturers ought to do installation work is because their clients cannot get fittings at reasonable prices. I think if any manufacturer does installation work it should only be on one supposition, and that is, that more justice could be done to the quality of his manufactures by putting in the work himself, but not at all on account of price.

Mr. J. Conolly: With reference to the action of cement upon indiarubber, which was mentioned a little while back, I have heard very often of this, but have never seen any cable that has been affected in that way. If any gentleman has any samples by him, I should like very much to see them; I would try and find out the cause of the trouble. Mr. Eidsforth asked the reason why joints in electrical installations were not tested by immersion in water the same they are in telegraph work? I may say that I do not think this feasible at all; I think it is impossible to test a joint in a strange building with all the complexities of electrical fittings, etc., in the way; as a matter of fact, I think it is altogether out of the question. The main point is to try and improve the condition of the wireman at present employed, and I quite agree with Mr. Henderson that as a rule he is entirely incompetent.

Mr. E. H. Nisbett: With the present method of house wiring, joints are undoubtedly a weak point, but I do not see that water-tight joints can be made at all, and I do not think that any house joint could be tested under water, whether it was intended for a damp place or dry. Undoubtedly with some of the joints that are put in at the present time there is going to be trouble in the future. If pure rubber only lasts a few years, and vulcanised rubber, say, 15 or 20 years, what is going to happen? What is the good of putting in wire to last 20 years, and putting in joints that will only last a tenth of that time? I think it is for the vulcanised cable manufacturers to advise something, and help out the contractors in this matter. We are thinking of doing something very shortly in the matter of lead-covered cable for house wiring.

Mr. Fawcus: Has any gentleman present had any experience with Andrews's system of concentric wiring?

Mr. Nisbett: I saw something of it when I was second engineer to the City Company on several installations, and there are one or points that are perhaps worthy of attention. One is that owing to the iron return in Andrews's system, the self-induction with alternating currents is very great, and the resistance of the return conductors is in consequence very much higher. Mr. Nisbett then went on to criticise one or two more points of Andrews's system.

Mr. Broughall: I should like to mention one other point, and that is: that as the weak points in installations are apparently in the joints, I think the number of joints should be reduced as far as possible, and I quite agree with Mr. Henderson that the only way to do this is to run the wires back to distributing boards. This may cost a little more money in the first instance, but at the same time I think it would be a great saving in the long run.

Mr. Andrew: May I make a suggestion to the effect that if periodical inspection were made of electrical installations the trouble might be very much reduced, as it seems to me that if the contractor had in his mind the possibility of his installations being inspected at any time he would probably be more careful in putting in good work in the first instance.

Mr. Henderson, in reply, said: Mr. Eidsforth has suggested that in his opinion joints should be immersed in water for testing purposes. This would undoubtedly be a very good thing if it could be done, but for housework it is almost an impossibility. I am afraid that very few joints at present made would stand any test of the kind at all. The obvious thing to do is to vulcanise the joints, and I am given to understand that a very simple and expeditious method of vulcanising joints has lately been brought out. It is undoubtedly a very important point, as joints certainly have more to do with bringing down the insulation resistance than anything else. Mr. Claremont said something about the price of fittings which I did not quite catch. I think he said that manufacturers of fittings should supply them at a moderate price, provided they took care to allow trade discount, but I think there are very few firms who allow trade discount to private individuals; perhaps there are a few exceptions. Mr. Wooler has made reference to the amount of current used at the Free Trade Hall, but I think I am right in saying that with regard to the Free Trade Hall there is an actual saving of current through having adopted the five-wire system. Probably the reason why the Free Trade Hall seems to consume more current than it should is because it was never properly metered. It was metered in earlier days by two Thomson meters on the outers, which was practically of no use whatever. Now, a five-wire meter has been adopted, but this does not seem to be of any practical use, as it seems to register whether the lamps are being burnt or not. Mr. Thomas alluded to the action of cement on rubber insulating material. I think that it is perhaps not altogether the action of cement. I think you would find that you got the same result if you embedded the wire in any kind of plaster or concrete, or anything else of the kind. Very often it is due to the electrolytic action through exposure to moisture. Mr. Fawcus has asked for instances of corrosion with enamelled bricks. I have a very vivid case before me where we had a meter which got an earth leakage—that is to say, we got 200 volts to earth. The meter was fixed on a pine board, and the board was fixed on enamelled bricks. It had been fixed some six or eight months, with probably an average current of 1½ to 2 amperes leakage to earth, and when we came to inspect it we found the board almost destroyed, and behind the board when taken down we found that the glazed surface of the bricks was entirely destroyed and broken up, and just the ordinary brick surface left beneath. Mr. Broughall has made some allusions to the price at which work is going. I think he said that a fair price ought to be paid for fair work, and this is quite right, but I am afraid we have many contractors who put in good work and good material, but at ridiculous prices, obviously in order to get established. Mr. Eckstein has said that cable manufacturers should do installation work in preference to fitting manufacturers. Considering that two-thirds of the capital outlay goes in any case to the cable maker, I think it is only fair that the fitting maker should be in a position to pull back something on the one-third that is his share. Mr. Conolly spoke of improving the condition of the wireman amongst other things, and this I consider a most important point. Why not have schools, etc., for teaching the work, and then we might possibly be able to get hold of some really qualified men. His other remarks I have already spoken about. I quite agree with Mr. Andrews's remarks with regard to periodical inspections, and in future in Manchester this will be carried into effect, I believe. Once in six months each installation in the town will be inspected, tested, and a record kept of anything broken down, insulation resistance, etc.

Mr. Fawcus (the chairman): I am sure that we have obtained some good from Mr. Henderson's paper, although I had hoped for a far more animated discussion upon some of the points than we have had. One or two things have been brought out which are undoubtedly of importance, but I consider that one of the most important probably is (to contractors at all events) the low prices at which work is going at the present time. We are constantly hearing of jobs being taken, mostly by young firms who are endeavouring to get established, as Mr. Henderson said, at prices at which it is simply impossible to make it pay. I think we should all endeavour to keep prices up as much as possible. If a man is not pinched in prices he is not likely to get any bad work. As to the question of joints, of course we cannot help getting any number of bad joints in the best installations, as we cannot possibly follow wiremen through every joint that is made, and if we are pushed, as Mr. Henderson mentioned, we are bound to reduce practically our supervision, as we have got more men on, and we have to take men on some of whom we know nothing at all about. This probably is the most fruitful cause of bad joints. I quite see Mr. Nisbett's point as to the uselessness of vulcanised rubber if we make pure rubber joints, but, of course, in house work it is impossible to carry fire about the place. Until we get higher prices we can hardly hope for these refinements in workmanship. In conclusion, I would like to move a very hearty vote of thanks to Mr. Henderson for his very interesting paper.

Mr. Henderson: I hoped to have had a little more discussion on the subject, but, nevertheless, I would just like to add that, with regard to the system of vulcanised joints for houses, Mr. Fawcus said that it would be impossible to carry fire about on installation work, but I think the new process I spoke about does away with this entirely; I believe it is not necessary to have any heat. I presume we shall be hearing more of it in the electrical papers; if it can be brought to any state of perfection, it will no doubt be a very good thing. I beg to thank you very heartily for the vote of thanks and kind reception of my paper.

THE RECENT EXPLOSION IN THE CITY.

Our readers will perhaps have had their attention sufficiently directed by the daily Press to the somewhat remarkable accident that occurred last Saturday week at the corner of Budge-row and Cannon-street, when a horse passing along the roadway was killed by an electric shock, and a number of foot passengers also received shocks or were injured by two explosions which followed soon after in a couple of junction-boxes situated at this point. In order to put the facts on record, however, and so that our readers may afterwards follow such remarks as we find occasion to make both now and when the Board of Trade inspector's report on the accident is published, we append herewith an abstract of the evidence giving salient points of a technical nature brought out at the official enquiry instituted by the Board of Trade.

The enquiry was opened on Monday last at Winchester House, and being of a public nature there was a large attendance. Major Cardew, R.E., the Board of Trade inspector in charge of the investigation, presided over the enquiry; Mr. R. W. Wallace (instructed by Messrs Ashurst, Morris, Crisp, and Co.) appeared for the City of London Electric Lighting Company, Limited; Mr. Russell Griffith for the aldermen and City Commissioner of Police; and Mr. Baylis for the City Commissioners of Sewers.

George Clarke, the first witness called, said that on the 10th inst. he was driving a mare attached to a brougham into Budge-row from Cannon-street when suddenly the animal fell forward and then rolled over on its side. He had the reins in his hands at the time, but felt nothing until he alighted. As soon as his feet touched the ground he felt a severe shock pass through his whole body. He saw no smoke and heard no noise. After feebly struggling for about four minutes the mare died, but before it expired it foamed and bled at the mouth and nostrils. Since the explosion he had been unable to do any work, and was at the present time in the doctor's hands. Replying to **Mr. Griffiths**, witness stated that he did not drive over any metal plate. It was about 1 o'clock when the accident occurred, and he was driving very carefully, as the wood roadway was wet.

James Hutchings, a warehouseman, said that he was standing on the loophole at 21, Budge-row, where he was employed, looking

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into Cannon-street, when he saw the mare fall down. He hastened to render what assistance he could, but when alongside the animal he experienced a shock which nearly knocked him down. He placed his hand on the ground to save himself from falling, and for the moment he thought his arm was broken. There was a rumbling sound audible under the ground, and shortly afterwards the explosion in Budge-row occurred. The force of the explosion blew the lid of a street box, situate near the late offices of the Liberator Society, about 2ft. off the ground. In reply to **Mr. Griffiths**, he said he neither touched the horse nor the brougham. After recovering a little from the shock he did all he could to warn people from coming near the spot. In answer to **Mr. Wallace**, witness was unable to say which explosion happened first—that in Walbrook or that in Budge-row. In answer to **Mr. Baylis**, witness said that after receiving the shock he returned to his office and superintended the loading-up of some goods on to a railway van.

C. J. Willy, a postman, said that while passing along Cannon-street on the day in question he saw several people standing round a horse which had fallen down. In trying to pass on he trod on the iron cover of a street box in Budge-row, and imme diately received a shock through the whole of his body which nearly threw him to the ground. While standing subsequently talking to some people in Walbrook he saw pieces of flagstone fly up into the air. One fragment struck him on the finger, and some iron hit him on the toe. His mouth was filled with concrete, and he was hurled across the road. Replying to **Mr. Griffiths**, he said he was rendered almost insensible. He did not recollect smelling any gas at the time of the explosion, but the pavement was much disturbed, and the cover of the box was blown to pieces. In answer to **Mr. Wallace**, he said he was now doing his ordinary work.

Several other witnesses gave similar evidence.

A. Haslett, mining engineer, 64, Cannon-street, said that when on his way to keep an engagement in Walbrook he noticed a boy suffering from a slight shock near where the horse was lying. He told Police-constable Bradley of the danger he suspected, and while he was speaking to him the explosion took place in Budge-row. He saw the lid of the box lifted about 12in. or 14in., and then apparently fall down into the hole again. This was followed by reports like three guns going off, one after the other. A blue flame shot out of the manhole near where he was standing, followed by dark smoke. He felt sure it was not a gas flame. In his opinion the explosions in Walbrook and Budge-row were simultaneous. In hurrying to the pavement he received a shock in his left leg, the pain from which extended up one side of his body. He was taken to Guy's Hospital, and there treated for partial paralysis but he had not fully recovered yet from the effects of the shock In answer to **Mr. Wallace**, witness said he had never suffered from rheumatism.

Thomas Cowley, carman, of Barnsbury ; **A. Neal**, an errand boy ; and **Police-constable Bradley**, gave evidence of a corroborative character.

F. Withers said he was in his father's shop at the corner of Walbrook on the 10th inst., about 1 o'clock, when he heard a subterranean noise, followed by an explosion which blew in one of the basement windows of his father's shop and damaged the iron of a sunblind. He received no shock.

H. Freeman, assistant to the last witness, said that between 11 and 1 o'clock on the day of the accident he noticed several times a smell like that of burning indiarubber when going into the basement of the shop. It was not overpowering. There was a similar smell in the basement when the explosion took place.

Mr. Griffiths then put in reports of previous explosions of gas in electric light manholes which had taken place in the City—one in Great Tower-street, another opposite St. Paul's-churchyard, and a third at the crossing of Creed-lane, near Ludgate-hill. In the first case it was stated that the lid in the manhole was blown 20ft. into the air, and that a man was injured.

District-Inspector Eve said that two witnesses of the explosion in Walbrook, named Loveland and Moody, were still too unwell to attend the enquiry.

Mr. David Cook, manager and engineer of the City of London Electric Light Company, Limited, handed in plans of circuits and diagrams giving the connections of the main which broke down in the City, etc. He said the primary cause of the accident was the crossing of two high-pressure cables which were being tested and put to work for the first time. One of these cables was for the supply of current to the Watling-street transformer station, the other for the Milk-street transformer station. The Milk-street cable was inadvertently put into the Watling-street terminals at Bankside, while the Watling-street cable was laid with its inner conductor touching the lead covering of the third inner cable. For convenience, the Watling-street cable was made alive by current from the transformer station. When the signal was given, the man at the transformer station switched on. The inner of the conductor, as already explained, was against the lead covering of another cable, and, therefore, the inner of the whole high-pressure system was put to earth, throwing an unusual strain upon the insulation of the primary mains. The company's cables were all tested to a much higher pressure than anything that could be put upon them by a mistake of this kind ; but, unfortunately, a rubber cable supplying the Benetfink transformer station broke down in the junction-box at the corner of Cannon-street and Budge-row. The cause of the breakdown appeared to have been due to mechanical abrasion of the outside covering. When the mistake was discovered the attendant at the transformer station cut the cables out, but before this was done the leak in the junction-box had developed into a short-circuit. This fired some gas which was in the conduits and blew up the cover of the box at the corner of Walbrook, some 60ft. distant, and also moved the box cover opposite 20, Budge-row. Since the explosion occurred at St. Paul's-churchyard his company had had men constantly employed searching for gas in their conduits. Four times since March last they had written to the gas company complaining of gas leakages in Cannon-street, within 100 yards of the spot where the explosion took place, and since January last they had written to the gas company 88 times calling their attention to similar leakages all over the City. He wished to call the attention of the Board of Trade in the strongest manner to the question of the responsibility of the gas company in respect of these explosions.

Major Cardew said the gas company had not put in any appearance, and he did not think he could go into that. No one had detected any smell of gas in the present case.

Mr. Cook replied that he merely wished to point out the difficulty his company had in keeping their conduits free from gas. He had not a word to say against the gas company, but the men they sent to look after leakages did not always wait till they found them. Hitherto it was thought that the safety of the public was assured by systematic inspection, but to increase that safety he should recommend his directors at their meeting the next day to provide a complete system of ventilation of the conduits at a cost of about £2,000.

The enquiry was then adjourned until the following day, when **Mr. Cook**, continuing his evidence, said the company's high-pressure cables were all concentric and were tested to a very high pressure.

Major Cardew, referring to the witness's statement on the previous day, that the breakdown appeared to be due to a mechanical abrasion on the outside covering of a cable, asked whether the cable was bent sharply at that point.

Mr. Cook replied that as far as he knew it was not bent very sharply, but men had been working a good deal in that box drawing low-pressure and other cables, and his opinion was that they had rubbed the cable against the edge of the iron pipe. The cable which broke down was supplied under a specification which required it to stand the test of 5,000 volts pressure between the inner and the outer, and 5,000 volts between the outer and the earth. Immediately the accident occurred he had all the other cables tested to a very high pressure, and found they were all sound. The accident was not an absolute short-circuit, but an arc. There was no ventilation of the street boxes where the explosion occurred, but there were a number of telephone tubes, which provided a current of air between the boxes, and they had been frequently inspected.

Major Cardew enquired if there were any appliance to indicate that the pressure had risen to a dangerous extent upon the outer conductor?

Mr. Cook answered that there was a statical voltmeter, showing the pressure between the outer and the earth, at the company's station, but it did not give any notice of the state of the pressure automatically. It had now been found better to put in armoured cables, and he had given orders for covering all the parts of the cable not laid in iron pipes and passing through the street boxes with several layers of copper strips, securely connected to both ends of the iron pipes. This must not be taken as an admission that they had been very much at fault for not doing so earlier, as this was only one of the points to be learnt by experience.

Major Cardew asked the witness if, with his present experience, he had come to the conclusion that it was not sufficient to trust to the thickness of indiarubber insulation between a highly-charged cable and an iron street box.

Mr. Cook said his experience tended to show that high-pressure alternating-current mains should be concentric and protected by a strong metal covering throughout their whole length. A lead-covered cable drawn through an iron pipe would answer as well.

Major Cardew enquired if the witness did not think a steel armouring outside the lead, if close and continuous, would be a desirable extra precaution?

Mr. Cook replied that they must not adopt too many extra precautions He did not think it was necessary, but if the Board of Trade made such a recommendation they would carry it out. Continuing, he said a man went round constantly to examine the street boxes. They had no ventilating pipes running up the sides of houses. In reply to **Mr. Wallace**, the witness said everything that could be thought of was done to prevent the percolation of gas into the conduits of the electric lighting company. It was his opinion that if the City Commissioners of Sewers permitted his company to ventilate the explosive mixture of gas and air which went into their conduits by replacing some of the guard posts at the corners of the streets with hollow posts, some arranged to take the air down and some with an up draught, there would be no further danger to the public by explosions. No one had any idea of the money his company had spent to make their system safe. They supplied more high-pressure current than any other electric lighting company in the world, and they did it in a very densely-populated area. As the consequence of these unique circumstances, problems which had not been solved elsewhere were constantly presenting themselves for solution to the City of London Electric Lighting Company. He had no doubt, however, that a far greater number of people would be maimed and killed by slipping on orange peel in the streets of London than were ever likely to be injured or killed by electricity. He had not heard of any consumer or other person not connected with the works being killed since the inauguration of the undertaking.

Mr. G. F. L. Foulger, chief distributing engineer of the Gas-light and Coke Company, said that owing to certain evidence given on the previous day he appeared to state that there was no gas in the boxes which exploded or in the vicinity. Immediately

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after the accident the ground was examined by means of searching rods and Ansell's leak detectors, but no trace of gas was found, and the experiments were repeated the next day with a like result. Although he could not say this was an infallible means of detecting gas, yet under a hermetically sealed pavement, as in this case, it was bound to do so. Replying to **Mr. Wallace**, the witness said he thought the ventilating scheme suggested by Mr. Cook a very bad one, as owing to the height of the posts a person might strike a match against them with disastrous results. He considered a better plan would be to use their arc posts, which were about 20ft. high, for the purpose. These posts should be filled up with earth or sawdust. To prevent the gas firing back, a 1½in. or 2in. ventilating pipe should be carried up them with an outlet to the atmosphere at about 10ft. high.

General Webber, C.B., said the whole question of the ventilation of the street boxes in the City had been gone into by him carefully, following on many years' experience both in connection with telegraph street boxes and those of other electric light companies in London and elsewhere. The prevention of the entrance of gas into the boxes appeared to be the one measure essential to public safety, seeing that more than one House of Commons committee had declined to allow street boxes to be ventilated by attachments to private houses. He did not dispute for one moment that ventilation by means of inlet and outlet pipes would be an excellent thing if they were arranged so as to secure a strong current of air to pass up and down; but he was sure the very next best thing was to construct the boxes gas-tight, with glazed bricks or other suitable materials, and close all the unused pipes by wooden plugs or tarred yarn, or something of that kind. He thought it should not go before the public from this enquiry that these street boxes, even without ventilation, were a source of danger, because they were not so, except in the most unusual circumstances. That was the conclusion he had arrived at, and it was particularly the case if the boxes were constructed in an air-tight manner themselves and the passages between box and box closed by plugs.

Mr. W. G. Wagner, analytical chemist, said that on the previous day he took samples of air contained in the electric lighting company's street boxes at the corner of Walbrook and at the corner of Dowgate-hill. In the latter box he found approximately 12 per cent. of coal gas, but none in the Walbrook box. As there was communication between the two boxes he thought there would also have been coal gas in the Walbrook box, but there was not.

Mr. J. Lister, outdoor superintendent to a firm of electrical engineers, said that about 11 o'clock on the 10th inst. he noticed a strong smell of gas near the street box against the old offices of the Liberator Building Society.

The enquiry was then adjourned until to-day (Friday).

LONDON COUNTY COUNCIL AND ELECTRIC LIGHTING LOANS.

At Tuesday's meeting of the London County Council the following report was submitted by the Finance Committee:

We have again to report upon the question of the periods for the repayment of loans obtained by vestries and districts boards for electric lighting. It may be well, first of all, to remind the Council of the history of this question and of its present position.

In 1891 the Vestry of St. Pancras applied to the Council for loans of £10,000 for the purchase of a site and £60,000 for the construction of electric lighting works, the repayment of the former to be spread over 60 years and of the latter over 42 years. At that time the Council had power to lend to vestries for 60 years for the purchase of land, but only for 30 years for the erection of buildings. The Council, being anxious to meet the views of the Vestry, sanctioned the borrowing of the latter sum for 42 years, and as it could not itself lend for that period, resolved to apply to Parliament for powers to advance money for electric lighting purposes for periods not exceeding 50 years. This power was applied for in 1892 and obtained, but it was understood as between the Treasury and the Council that the period to be actually fixed under the provisions of the Act should be determined as freely as if the extended period had not been named by the Act.

On July 25, 1893, we recommended the Council to sanction and make a further loan of £15,400 to the Vestry of St. Pancras, repayable in 42 years. The sanction was given, but the Vestry did not take up the loan from the Council. On January 30, 1894, the Council considered a further application by the Vestry for the loan of £30,000 (including the above-mentioned £15,400), but on this occasion, after consideration of the whole subject, and of the views expressed by the Treasury, we recommended that the loan should be granted to the extent of £29,700 (on condition that the previous sanction of the Council to the borrowing of £15,400 should not be further acted upon), and that the repayment should be restricted to various periods according to the life of each portion of the works. After discussion in the Council this report was withdrawn. We again reconsidered the whole matter, and brought up a report to the Council on February 12, 1894, recommending that the repayment of the whole should be spread over 25 years. An amendment to substitute 30 for 25 was lost, and our recommendation was ultimately adopted.

On June 26, 1894, the Council considered an application by the Vestry of Hampstead for sanction to a loan of £24,400. We recommended that the sanction should be granted subject to the repayment of the whole sum being spread over 25 years, but the Council in this instance substituted 42 for 25 years.

After this decision of the Council, we felt bound to adopt in all cases the period of 42 years for initial electric lighting works, and therefore recommended the Council to advance to the St. Pancras Vestry for 42 years the sum of £14,300, the difference between the £29,700 sanctioned on February, 12, 1894, for 25 years, and the £15,400 on July 25, 1893, for 42 years. The Council adopted this recommendation, and application was accordingly made to the Treasury for approval of the advance by the Council. The Treasury replied (see letter dated July 28, 1894) practically to the effect that they could not sanction the advance of this loan by the Council for so long a period as 42 years, and we therefore directed our attention to the question whether any new proposal could be made which would be acceptable to the Treasury and which the Council might be willing to adopt.

The contention of the Treasury was that no period should be granted which was disproportionate to the life of the works, and in order to arrive at a definite understanding on that point we carefully investigated, with the assistance of the engineer, the question of the durability of each portion of the work in greater detail than had hitherto been done. We were advised that the following division of the work in the St. Pancras case might be taken as being fairly accurate: £3,800 for meters and connections lasting five years; £4,000 for batteries lasting eight years; £2,000 for arc lamps and cooling apparatus lasting 10 years; £13,000 for boilers, covered mains, etc., lasting 15 years; £24,000 for engines and dynamos lasting 20 years; £33,000 for culverts and bare copper mains lasting 40 years; £9,000 for buildings lasting 60 years; £10,500 for land; total 99,300.

We thought that it might fairly be argued that as Parliament extended the maximum period for electric lighting purposes from 30 to 50 years, it was intended that at any rate some portion of the expenditure should be spread over 50 years. On the other hand, it could not be considered right to spread over 50 years expenditure of so short-lived a nature as meters and apparatus of that kind. We therefore came to the conclusion that the Council might be advised to adopt two periods for loans for the initial cost of electric lighting—viz, 50 years for all expenditure on land, buildings, culverts, bare copper mains, and patent royalties, and 20 years for expenditure for all other purposes.

The comptroller, by our instructions, communicated with the Treasury suggesting these terms and stating the considerations which had led us to decide upon them, and the Treasury has, with only a slight modification, agreed to our proposal. We present copies of the correspondence with the Treasury. We think the Council would desire that a definite agreement should now be arrived at between the Treasury and the Council as to the terms for which these loans are to be sanctioned and made, and as the Treasury has signified its consent to the more favourable proposals of the committee, we recommend the Council to pass the following resolution: "That the periods of repayment of all loans for the initial cost of electric lighting undertakings be limited as follows: for land, buildings, culverts, bare copper mains, and royalty licenses relating to such purposes, 50 years; for all other purposes, 20 years."

This proposal was agreed to by the Council.

THE PROPOSED PACIFIC CABLE.

The question of the projected Pacific cable is much exercising the mind of Sir John Pender, who has unburdened himself to representatives of the Press.

When referred to the statement, which was reported in our last issue, that Lord Ripon contemplated calling another inter-colonial conference on the subject, Sir John said that he was in favour of the extension of submarine telegraphy whenever and wherever it could be shown that it was necessary and desirable. In this instance, however he could not but think that a good many foolish ideas were obtaining currency. The subject was one to which he was giving close attention at the present time, and he did not desire to make any statement which might be subjected to misconstruction. At the same time, looking at the matter from the point of view of an investor, he said they had a striking illustration in the Atlantic of the need to act with caution. The cables in the Atlantic were not making anything like an adequate return on the amounts spent in their construction.

In the course of another interview, Sir John Pender said there was an impression abroad that he was opposed to a Pacific cable. He was not opposed to the extension of submarine telegraphy wherever it was required and wherever it could be used for the development of commerce, and if the colonies and Great Britain decided to have a cable by the Pacific no doubt that cable would eventually be laid. But in the present depression of trade in the colonies he doubted if they would be disposed to commit themselves to additional outlay for submarine cables, when at the present moment they possessed all the advantages which submarine cables could give them. There was a sort of craze at the present time over this Pacific cable, and an attempt had been made to show that it was an absolute necessity, and that the want of the cable was rather retarding the progress of the colonies. He thought that as a telegram between Canada and Australia, or the Cape of Good Hope, *vid* London, occupied only about two hours in transit, the laying of a Pacific cable immediately was not imperative, and considering that the amount of money involved would be about two millions, or, if the cable were duplicated, four millions sterling, he believed that the shrewd and wise men who were at the head of the respective Governments would seriously consider the cost before they agreed

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to expend such a large sum of money unless they could see that such an expenditure would largely benefit the trading interests of the empire. But if the Governments determined to have this additional cable, he believed that his company was in a position to undertake the work on better terms than any other company could do it, and he would warmly co-operate with those Governments to extend the system without damaging the companies which, they all admitted, had given them such a satisfactory and beneficial telegraph service.

TENDERS FOR THE PACIFIC CABLE.

The *Ottawa Citizen* of the 10th inst. gives the following additional information on this subject: "As announced some days ago, a number of tenders was received at the Department of Trade and Commerce in response to the call for proposals for the laying and maintenance of the Pacific cable.

"The Hon. Mr. Bowell postponed the opening of these tenders until the arrival of Mr. Sandford Fleming and Mr. Mercer, of the British Colonial Office, the cable commissioners from Hawaii. The commissioners returned Wednesday evening, and yesterday the opening and examination of the tenders took place in the office of the Minister of Trade and Commerce. Six definite proposals were sent in They are made by the following companies:

"Francis A. Bowen, 3, King's Arms-yard, London.
"The Telegraph Construction and Maintenance Company, 38, Old Broad-street, London.
"Messrs. Siemens Bros., 12, Queen Anne's-gate, London.
"The Fowler-Waring Cable Company, 32, Victoria-street, London.
"W. T. Henley's Telegraph Works Company, 27, Martin's-lane, Cannon-street, London.
"The India Rubber, Gutta Percha, and Telegraph Company, 106, Cannon-street, London.

"These are the leading cable manufacturers and cable-construction companies of the world, and their proposals are said to indicate a thorough examination of the whole great project.

"The offers are of the most satisfactory character. They apply to each of the eight routes proposed, and in every case are below the estimates of Mr. Sandford Fleming already made public. As the offers are accompanied by very elaborate details which will require to be examined carefully, compared and reported upon in order to submit full information to the various Governments interested, the Hon. Mr. Bowell said he did not deem it advisable to make the figures public at present. It is said, however, that the proposals are in each case very much more favourable than was anticipated by those who discussed the matter at the recent Colonial Conference, and on the whole they are regarded as completely removing every obstacle which had been urged against the feasibility of the Pacific cable."

COMPANIES' MEETINGS.

COUNTY OF LONDON AND BRUSH PROVINCIAL COMPANY, LIMITED.

The annual general meeting of the above Company was held at Cannon-street Hotel on Monday, the Right Hon. D. R. Plunket, Q.C., M.P., occupying the chair.

The Chairman, in moving the adoption of the report, which was printed in our last issue, said he might congratulate the shareholders on the position of the Company, and on the encouraging nature of the immediate future. There had only six months passed since the reconstruction and capitalisation of the Company had put it into a position really to go to work. They had now made considerable progress. and while within the county of London their preparations had advanced as quickly as was consistent with the exercise of care and prudence, their experience in the more distant districts where they were working had been fortunate even beyond their expectations. With reference to the county of London, the contracts with the Brush Company and the Electric Construction Company, which were mentioned in the prospectus under which they made their first issue of capital last spring, were being executed, so that before that time next year they would have a supply of generating plant equal to the service of 90,000 incandescent lamps. They had obtained at moderate prices two admirable sites for the erection of generating stations for their London business, one of them, for the north side of the river, on the Regent's Canal basin, and the other, for the southern side on the bank of the Thames, near Wandsworth. At both of these they obtained the economy of water carriage for their coal, and the advantage of an abundant supply of water. The directors intended to lay not only sufficient mains to provide for their immediate requirements, but also a large number of spare pipes, into which, without further breaking up of the roadway, additional cables could be drawn when they became necessary. There was a large and increasing demand in the metropolitan districts which they had acquired, while the progress of the Bournemouth Company had been very rapid and the plant had been increased At Dover their prospects were extremely hopeful, while at Windermere they had entered upon an interesting and what they believed would prove to be a very profitable enterprise. They had secured the use of the water power where the River Leven flowed out of the lake, and they proposed to utilise this to supply the electric light to such of the towns in the neighbourhood as chose to avail themselves of the Company's offers. They had also made and would continue to make applications for provisional orders for other places within and without the county of London, and applications had been made to the Company for financial assistance in carrying out electricity supply undertakings in various parts of the country. They intended, as far as they could, to follow the wise policy of management of the City of London Electric Lighting Company.

Mr. A. Thompson seconded the motion, which was agreed to.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY, LIMITED.

The twenty-eighth ordinary general meeting of the shareholders of the Western and Brazilian Telegraph Company, Limited, was held on Friday last at Winchester House, Mr. W. S. Andrew in the chair.

The Chairman, in moving the adoption of the report, said that compared with the half-year ended June, 1893, the increase of words transmitted was 628,295—almost a large business in itself. If this business had been done under normal conditions, they would have been able to pay a dividend of 3½ per cent. instead of 1 per cent. for the half-year, and they would see that their only trouble was the question of exchange, in which he hoped there was going to be an improvement. Referring to the prospect of their concern being taken over by the Government, he said that it was undoubtedly the fact that Brazil had power under their concession to acquire their lines. As they understood it, there was an official report on the part of a Government Commission, recommending the Government to purchase the undertaking, and although they felt that this proposal was made just as the clouds were beginning to pass away, they could not but recognise that with the affair in its own hands the Government would derive large financial advantages. The recommendations in the report would be submitted to the Chambers, and if they were approved a resolution would probably be passed authorising the Government to negotiate and purchase.

The adoption of the report, having been seconded by **Lord Richard Browne**, was agreed to.

GENERAL ELECTRIC POWER AND TRACTION COMPANY, LIMITED.

An extraordinary general meeting of this Company was held on Wednesday at the Cannon-street Hotel, Lord Egerton of Tatton occupying the chair.

The Chairman said he had stated at the last meeting that some reorganisation of the Company was necessary in view of the large loss of capital as shown in previous balance-sheets, and that the directors were giving serious consideration to the subject. It was agreed that the realisation of the Company's assets should be proceeded with as soon as possible, and since that time the directors had made considerable progress in that matter. The manufacturing department had been transferred to the Acme and Immisch Electric Works, Limited, in consideration of £12,500 in fully-paid shares of that company, and the electric launch business had been taken by the Immisch Electric Launch Company, Limited, in consideration of £8,965 in fully-paid shares. In the opinion of the Board, the further realisation of the assets could best be carried out under voluntary liquidation, and that he had now to propose. With regard to the copper works, when they were first started they promised to be very remunerative; but the fall in the price of copper had entirely altered the conditions. He concluded by formally moving that the Company be wound up voluntarily under the provision of the Companies Acts.

Mr. Immisch seconded the motion, and remarked that the Company was started originally with the idea that electric traction was coming to the fore, and his firm sold its lucrative business to the Company entirely for shares; so that he was a considerable sufferer.

Messrs. Benjamin Nicholson and Dunn expressed the opinion that the business must have been very badly managed to have entailed such a heavy loss, and another **Shareholder** suggested that a committee should have been appointed to go into the affairs of the Company.

Mr. Garcke, who explained that he represented a large interest, and had been called in to consult with the Board, said a large amount of the capital lost was represented by shares paid to Messrs. Immisch. The companies which had taken over the manufacturing and launch businesses had been created specially for the purpose, and this Company owned the shares. He thought the directors had acted in the best interests of all concerned in recommending the liquidation.

The motion was ultimately agreed to *nem. con.*

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Madrid.—Tenders are invited by December 8 by the Spanish Government for the construction of a telephone system at Santa Cruz, Teneriffe. Tenders are to be sent to the Ministère d'Outre Mer, Madrid.

York.—Tenders are invited by the directors of the North-Eastern Railway Company for telegraph apparatus and for telegraph wire and line stores. Forms of tender may be obtained on application

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to Mr. Graves, Telegraph Department, York, and tenders must be sent in to the secretary at York by Tuesday, 27th inst.

Blyth.—The Cowpen District Local Board (Blyth, Northumberland) invite tenders for the efficient lighting, by electricity or otherwise, of the lighting area within their district for a period of seven or ten years respectively, commencing from August 15, 1895. A plan of the district can be seen and further information obtained at the Surveyor's Office, Commercial-buildings, Waterloo, Blyth. Tenders, endorsed "Lighting," to be sent to Mr. Robt. T. Guthrie, clerk to the Board, not later than December 20.

Hampstead.—The Vestry of St. John, Hampstead, invite tenders for wiring the buildings in the stoneyard, Lithos-road, Finchley-road, N.W., for the electric light, including the supply and fixing of all cables, casings, and electrical fittings; but not lamps. A form of tender, with copy of specification and a description of the general routes to be followed, may be obtained at the office of the vestry clerk, Vestry Hall, Haverstock Hill, N.W., upon the deposit of £1. 1s., which will be returned on receipt of a *bonâ fide* tender. The various buildings at the stoneyard may be inspected on presentation of an order to do so, signed by the vestry clerk. Tenders must be delivered by Thursday, 29th inst.

RESULTS OF TENDERS.

Portsmouth—The contract for the complete equipment of the electrical and physical laboratories of the Portsmouth Corporation has been awarded to Mr. Robert W. Paul, 44, Hatton-garden, E.C., the price being £477.

St. Pancras.—The Electricity Committee of the Vestry have accepted the tender of the Electric Construction Company, Limited, for switchboard, motors, transformers, electrical instruments, etc., at King's-road station, the amount being £3,489. 11s. 8d.

BUSINESS NOTES.

Milford Haven.—The electric light has been installed in St. Catherine's Church.

Gainsborough.—The Albert Theatre is receiving an installation of the electric light.

Rochdale.—It is probable that the public buildings will be lighted by electricity.

Tuam.—A company proposes to apply for an order for the electric lighting of Tuam.

Western and Brazilian Telegraph Company.—For the past week the receipts were £3,181.

Dunrobin.—Dunrobin Castle, the seat of the Duke of Sutherland, is to be lighted electrically.

Monmouth.—Combination fittings for gas and electric lighting are to be installed at the post office.

Appointment.—A pupil is wanted in the central station of the Exeter Electric Light Company, Limited.

Hanley.—The Electric Lighting Committee of the Town Council are considering the advisability of providing additional plant.

Conway.—A scheme is under consideration for using the water power of the Conway for electric lighting and power purposes.

Pontypool.—The Pontypool Electric Light and Power Company, Limited, are applying to the Board of Trade for a provisional order.

Bradford.—Mr. W. C. Dixon has been elected chairman and Mr. James Kay vice-chairman of the Gas and Electricity Committee of the Town Council.

Mullingar.—A company is going to apply for powers to introduce the electric light. The Town Commissioners have given their approval to the scheme.

Portishead.—The chairman of the Local Board has informed them that he has received two or three offers by private companies to light the district electrically.

Glasgow.—Councillor Ure has been appointed convener and Councillor Shearer sub-convener of the Gas and Electric Lighting Committee of the Town Council.

St. Bride Foundation Institute.—This institute, situated in St. Bride's-lane, E.C., which was opened on Tuesday by the Lord Mayor, is to be lighted electrically.

Stockport.—The Guardians of the Stockport Union have decided that the workhouse to be erected at Stepping Hill, Hazel Grove, is to be lighted by electricity.

Aberdeen.—Mr. W. F. Price, late of the Preston National Electric Supply Company, has been appointed, from among 50 candidates, as assistant to Mr. Ruthven-Murray.

Ashington.—The new Grand Hotel. New Hirst, Ashington, which has just been opened, is lighted throughout by electricity. A Crossley oil-engine and a Charleton dynamo are used.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 18th inst. amounted to £881, as compared with £553 in the corresponding week of last year.

Randall's Phonautograph Company, Limited.—This Company has been registered with a capital of £25,000 in £1 shares to manufacture and deal in phonautographs, or phonographs, or other apparatus.

Salford.—Mr. Alderman Mottram, who has been chosen mayor, in referring to local improvements which are being carried out, mentioned the system of electric lighting, which he said would soon be completed.

Folkestone.—The new Lighting Committee consists of Alderman Salter and Councillors Pursey, Payer, Jones, Thompson, Holden, and Mercer. There seemed to be no desire on the part of any of the councillors to be placed on this committee.

Kensington.—Application is to be made to the Board of Trade in the coming session of Parliament for a provisional order to extend the area of the Notting Hill Electric Light Company, Limited, so as to include a part of the parish of St. Mary Abbotts, Kensington.

Bishopsgate.—The electric light installation at the Bishopsgat Polytechnic, which was opened on Saturday by Lord Rosebery, has been carried out by Mr. A. H. Wood, of Westminster, and the fittings have been supplied by Messrs. Verity and Sons, of King-street, Covent Garden.

Snowdon Mountain Tramroad and Hotels Company, Limited. This Company has been registered with a capital of £70,000 to construct a tramroad from Llanberis, to a point near the summit of Snowdon; to erect an hotel near the summit, and to construct and maintain tram and railroads, telegraphs, etc.

Paddington.—The Local Government Board have agreed to the sealing of the contract by the Paddington Guardians, without advertising for tenders, with Messrs Spagnoletti and Crookes for the supply of electric light wiring for the male wards and administrative block at £145 and £115. 10s. respectively.

New Firm.—A new firm of electrical engineers and contractors has been started at 22, Charing-cross, S.W., by Messrs. J. A. Russell, A I E.E., and R. F. Barrett Lennard, A.I.E E Mr. Russell was recently with Messrs. J. G. Statter and Co., Limited, and Mr. Lennard with Messrs. Latimer Clark, Muirhead, and Co.

The Snowdon Railway.—According to present arrangements, the first sod of the Snowdon electric railway will be cut on the 5th prox. Mr. Assheton Smith, the owner of the land, who extends to the promoters all facilities for the successful carrying out of the scheme, will be asked to perform the inaugural ceremony.

Turbines.—Messrs. Carrick and Ritchie, Waverley Engineering Works, Edinburgh, send us a catalogue of their improved turbines, in which particulars are given of the Waverley turbine in its various designs, of Ritchie's new double-gate turbine, of the Girard turbine, of a combined turbine and dynamo, and of jet waterwheels.

Leslie and Co., Limited.—This Company has been registered, with a capital of £50,000, to acquire as a going concern the business of builders, contractors etc., as hitherto carried on under the respective styles of Leslie and Co., and Aldin Bros. and Davies, and to carry on business as builders and contractors, electric light contractors, etc.

Mansion-Lighting.—Among the more important installations Messrs Drake and Gorham have in hand at the present time may be mentioned Londonderry House, for Lord Londonderry, who entrusted the same firm with the lighting of Wynyard Park two years ago. A large number of lights is being put in, and the current will be obtained from the outside supply.

Storage Battery Litigation.—We are requested to state that "The Electrical Power Storage Company, Limited, has commenced a suit for infringement of the Swan patent, and has issued a writ for injunction against the Chloride Electrical Storage Syndicate, Limited. The other defendants are Messrs. Mather and Platt, Limited, and Dr. John Hopkinson, F.R.S."

J. G. Statter and Co.—The Bedford Engineering Company, this week, petitioned for the winding up of J. G. Statter and Co., electrical engineers. Mr. Theobalds said negotiations were pending for the sale of the company's business on terms which would be very favourable, and he therefore asked that the petition should stand over. Mr. Justice Williams: Very well. Adjourned for a month.

Smithfield Market—The new installation of arc lamps round the Smithfield Markets of the Corporation of the City of London is being supplied with current from the City of London Electric Lighting Company, and one of Heathman's patent wheeled extension ladders is used for the recarboning. This ladder, although it reaches 32ft. high, is easily handled by one man, and thus the labour bill is kept at the minimum.

Windsor.—The Town Council have, after considering Mr. Shoolbred's report and the information supplied by the town clerk, decided to apply for a provisional order. The following streets comprise the compulsory area—namely, High-street, Thames-street, and Peascod-street, as far as the junction with Victoria-street, Windsor, and High-street, Eton, as far as the gateway entrance to Weston's yard in Eton.

Woking.—The Sanitary Committee of the Local Board reported that at their meeting a letter was read from Messrs. New and Mayne in reference to the delay caused by inability to obtain the bases, and also a telegram stating that the same would be sent on the 9th. The clerk was instructed to write, informing them that a piecemeal installation would not be accepted, and pressing on them the necessity of using the utmost despatch. The report was adopted.

Coventry.—The General Works Committee have presented to the Town Council a report on the delays which had arisen in the equipment of the tramways for electric traction, and recommended that notice be given to the proprietors of the tramways requiring the tramways to be equipped within three months The report was approved. The Town Council announce that they will be able to supply current to private consumers about January next. The price to be charged is 6d. per unit.

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Marylebone.—The St. Marylebone Vestry have received a letter enclosing an account for £10 for fixing electric lighting fittings in Trinity Church, the rector of which suggested that this expense should be borne by the Vestry; also that in future the Vestry should pay at least the same amount for the maintenance of the electric light as they had paid in the past for the gas burners displaced. The letter, which was from the churchwarden of Trinity Church, was sent to the Church Committee.

Moss Side.—The Local Board have received a letter from Messrs. Fowden, Newton, and Varey, solicitors, applying for the consent of the Board to make an application to the Board of Trade for a provisional order for the construction of tram lines through the district, commencing at Brook's Bar and going along Upper Chorlton-road and Barlow Moor-road to Didsbury village. The method of traction proposed would be either gas motor or electricity. The General Purposes Committee of the Board will meet a deputation of the promoters shortly.

Bournemouth.—The Corporation have accepted the offer of the Bournemouth and District Electric Light Company to supply current to the Winter Gardens at 25 per cent. reduction in cost. This is in consequence of the report of the borough engineer, which was confirmed by Mr. E. Matthew Lacey, consulting electrical engineer, proposing a scheme for the Corporation to supply their own current by which a saving of £150 per annum was shown. Mr. E. Matthew Lacey also reported on the proposed lighting scheme for the pier and pleasure grounds.

Llandudno.—A special meeting of the Improvement Commissioners has been held to consider the advisability of applying to the Board of Trade for a provisional order authorising the local authority to supply their district with the electric light. The following resolution was passed: "That application be made to the Board of Trade to grant to the Improvement Commissioners a provisional order authorising them to supply electricity within the whole of the urban sanitary district of Llandudno, and that a committee be appointed to-day with full power to act in carrying out the same."

Colwyn Bay.—Mr. J. Roberts has stated at a meeting of the Local Authority that a private company was applying for powers to light Colwyn Bay by electricity. If a private company got the provisional order they would do as they liked. He thought that Authority should follow the example of Llandudno. He did not want that Authority to deal with the electric supply, but if the brilliant light was to come to Colwyn Bay he proposed that the Board have the power to make terms with a company, and that they therefore apply for a provisional order. Mr. J. Porter seconded, and it was carried.

Southwark.—The surveyor (Mr. Norrish) has read, at the meeting of the St. Saviour's Board of Works, an application from the National Telephone Company asking for power to lay cables in the parish. The route they proposed went right through the whole of the new asphalte footway in Southwark Bridge-road, in which they proposed to insert no fewer than 13 test-boxes. The electric lighting company and the Postal Telegraph Department had already laid mains and boxes in these footways, and the surface of the footways themselves would, he said, if this application be granted, soon be composed of little else than covers to test-boxes.

Royal Electric Company, Montreal.—Messrs. Coates, Son, and Co. are authorised by the directors of the Royal Electric Company, of Montreal, to receive at their offices, 99, Gresham-street, E.C., subscriptions for £120,000 4½ per cent. debentures at par. The debentures will be redeemed to the extent of £6,000 per annum by annual drawings of 105, commencing April 1, 1896, but the company reserves the right to redeem at any time on six months' notice at 110 the whole of the debentures not previously redeemed by drawings or purchase. The prospectus states that "the authorised capital of the Company is 1,500,000dol., and the paid-up capital is 1,000,000dol., upon which quarterly dividends at the rate of 8 per cent. per annum have for some time past been regularly paid."

Epstein Accumulators.—The Epstein Electric Accumulator Company, Limited, of 21A, Blythe-road, West Kensington, inform us that in order to cope with the increasing demand for their accumulators, they have taken new and extensive works at Milton, in Staffordshire, where their plant to the extent of 600 h.p. will enable them to quickly execute even very large orders The company are in a position to give their customers the benefit of the greater facilities for manufacture which the new works offer, and they have therefore materially reduced their prices. The history of the Epstein accumulators, which were first manufactured in England about four years ago, presents an uninterrupted record of success, and the company have recently again introduced important improvements in them.

Dock-Lighting.—The entrance to the Cessnock Dock, Govan, was lighted by the electric light for the first time last week. The lights are two in number, and are placed one on each side of the entrance to the new graving dock, at present under construction They are each of 4,000 c.p., and are carried on poles at a height of 50ft. above the quay wall. The electrical energy is supplied from a dynamo and gas-engine within the shed at dock entrance. The dynamo is of the Faraday type, and is driven by an Acme gas-engine, made by Bailie Burt The installation has been designed and carried out by the Faraday Electrical Engineering Company, Limited, of Govan, under the supervision of Mr. M'Whirter, their engineer, and to the specification of Mr. G. H. Baxter, mechanical engineer to the Clyde Trustees.

Dublin.—A start is about to be made with the construction of the electric tramway which will run between Haddington-road and Dalkey. Within the past few days Mr. J. Clifton Robinson, C.E., managing director of the company, who will act as electrical engineer of the works during their construction, has arrived from London, accompanied by Mr. J. Winslow, C.E., constructing electrical engineer, and Mr. August Kreuss, the tramway contractor. The new line will consist of eight miles of double track. The works will be commenced in a month, the contractor undertaking to complete the construction and electrical equipment of the entire system by May 1 next. The outlay will be about £120,000. The company will arrange the Ball's Bridge depôt as a power station, and the cars will be lighted by electricity.

Bath.—The Town Council have received a report from the Lighting Committee which referred to the recent failure of the electric light. The Council have accepted an offer made by the company to supply the required extra lighting by the street arc lamps at the rate of ½d. per lamp for each continual quarter of an hour they are alight. The company is to be offered £10 per month for increasing the lighting for half an hour per day from the present time to the end of February, 1895. The Mayor on Thursday last week issued a notice that the city would be in darkness that night, as it was thought that neither the electric light company nor the gas company would be able to maintain their supply owing to the floods. The warning proved correct as far as the gas company was concerned, but the electric light company rose to the emergency, and by dint of working all day up to their waist in water the men at the station got matters into such a satisfactory condition that the electric current was supplied as usual. Mr. Metzger, the engineer to the station, can be congratulated on the manner in which he coped with most remarkable difficulties.

Morecambe.—A committee of the Local Board reported that a certificate had been read of the medical officer of health that a certain building in Edward-street and Union-street, Morecambe, used for the manufacture of gas causing effluvia, the trade wherein was carried on by the Morecambe Electric Light and Power Company, Limited, was a nuisance and injurious to the health of the inhabitants of New-street and Edward-street in the district. It was unanimously resolved that the authority do direct John Bond, surveyor, for and on behalf of the authority, to make complaint before a justice, in order that the persons by whom the trade complained of is carried on may be summoned to appear before a court of summary jurisdiction to enquire into the complaint, and to proceed therein according to the provisions of the statute in that case made and provided. When the minutes of the Sanitary Committee came up for confirmation the Chairman said he wished to produce notices from two householders complaining of the electric light nuisance. Mr. H. Baxter thought that the Board had now an opportunity to take up the matter. The medical officer had not previously reported anything that could be made out to be a complaint, and he hoped that the matter would now be dealt with effectually. Mr. Bennett said that no time should be lost. The minutes of the committee were confirmed.

Worcester.—Upon the re-election of the Selection Committee, at a meeting of the Town Council, Mr. J. Millington moved a resolution instructing the Selection Committee to nominate a special committee to take entire charge and control of the electric work at Powick, and also all matters connected with electricity in the city, and that such committee should consist of seven members. Mr. Millington remarked that there was a vast amount of work to be done in connection with the electrical works, and there would have probably to be weekly meetings for the next year or two before the scheme got thoroughly to work. They had now spent £52,000 on the scheme, and the cost of extensions of mains which would come up at the next meeting of the Council, would bring the expenditure up to what he always said it would be, £60 000. In reply to Alderman Hill, Mr. Millington said he proposed that the business of the special committee should include the management of the accounts of the electrical department. Mr. Blackford suggested the desirability of a special rate for the electric light, in order that the citizens might appreciate the profit or loss on the enormous expenditure on the scheme. The Mayor pointed out that this did not bear upon the question of the appointment of a special committee, and Mr. Chaplin said that committee would consider the suggestion. Mr. Millington's proposition was agreed to.

City and South London Railway.—The receipts of the Company for the week ended November 18 were £972, against £882 for the corresponding week of 1893, or an increase of £90. The total receipts for the current period of the present half-year amount to £17,691, as against £16,473 in the corresponding period of 1893, an increase of £1 218. "Increases of from £50 to £100 per week, the *Financial Times* remarks, "have been regularly reported of late by the City and South London Railway. They might not look much in the Brighton market, but on a three-mile line like the City and South London they mean a good deal more than meets the eye. They represent on last year's traffic a growth of 10 per cent., and foreshadow a moderate addition to the ordinary dividend. But that is only by the way. Very much more important developments are in view. As the directors intimated in their last report, experiments have been made with a view to substituting car-motors for the locomotives hitherto used. It has been proved on the Liverpool Overhead Railway that such motors work cheaper than separate locomotives, and a still more valuable consideration for the City and South London is that they occupy less room. By adopting them the Company will be able to add a fourth carriage to their trains, and proportionately increase their carrying power at the busy times of the day. Another easy means of swelling their revenue would be to introduce two classes of fares, as at Liverpool.

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Many City passengers would rather pay a penny extra for a little better accommodation, and we understand that the Company is likely to be memorialised to that effect."

Radcliffe.—The Electric Lighting Committee of the Local Board have reported that at a meeting of the committee held on the 15th ult. the chairman stated that he and Mr. R. Walker had had an interview with the Earl of Wilton's agent with reference to the purchase of a small plot of land in the Mount Sion-road, and that the only promise they could get was that it should be leased to them at 1½d. per yard, or sold at £600 per acre. Mr. Bennett waited upon the committee and advised with reference to the limits of the area of supplying, the compulsory area, and various other details of the scheme necessary to be inserted in the provisional order. It was resolved that the area of supply shall be the whole of the area included within the district of this Local Board; that the streets within which the distributing mains shall be laid within the period of two years shall be Blackburn-street, Stand-lane to corner of the New-road, Water-street to the canal bridge, Spring-lane to the railway bridge, Church-street to the railway bridge; Sion-street to the railway bridge and Whittaker-street; that the lists of streets not repairable by the inhabitants at large which may be broken up by this Board under the order shall be the whole of the streets in the district which are not repairable by this Board, the bridges of the Lancashire and Yorkshire Railway Company, and the bridges of the Manchester, Bury, and Bolton Canal, owned by the Lancashire and Yorkshire Railway Company. It was also resolved that the charge for current be 8d. per Board of Trade unit, with a minimum charge of 10s. per quarter. A long discussion was opened by Mr. Brooks as to whether the electric light would be taken down to Radcliffe Hall, and it was understood that as soon as ever practicable the mains would be laid to the extent of the Board's electric lighting boundaries.

Cardiff.—On Friday afternoon last preliminary trials of the electric light installation were made under the superintendence of the representatives of the engineers to the scheme and members of the Lighting Committee. The Town Council have announced that after that date they were prepared to supply current to the public. The first circuit was switched on about four o'clock by the chairman of the Lighting Committee (Councillor Vaughan), who was accompanied by the Mayor (Alderman P. W. Carey) and Alderman Jacobs, and subsequently the other three circuits were tested right along the streets in which the lines have been laid down—namely, Queen-street, Castle-street, High-street, St. Mary-street, Custom House-street, the top part of Bute-street, the Hayes, and St. John's square. A considerable number of houses and shops is being fitted with connections. The subject of extending the electric light installation beyond the limits of the present area was briefly discussed at a meeting of the Cardiff Lighting Committee on Tuesday, under the chairmanship of Councillor Vaughan. Councillor Riches strongly urged that a broad and comprehensive view should be taken by the committee of their electric lighting undertaking. If it were to become popular and remunerative, it would have to be placed within the reach of a much larger constituency than at present. The Borough Engineer (Mr. W. Harpur) agreed with Mr. Riches. He remarked that in a comparatively small town like Derby no fewer than 90,000 lamps were being supplied, although the light had only been in existence there for seven months. Councillor Riches and the Mayor said the experience of Manchester and Dublin was favourable to the suggestion to develop the scheme at Cardiff. It was understood that the borough engineer will draw up an estimate of and specifications for an extension of the light to the houses in Cathedral-road, Newport-road (as far as Clifton-street), Castle-road, and Richmond-road. The Borough Engineer stated, in reply to Councillor Riches, that he would be prepared to put the electric light into the Aberdare Hall in the course of three weeks. Mr. Massey said the Engineers' Institute, which is now electrically lighted from Lord Bute's mains, will be served at once from the Corporation central station. The Mayor said the opinion prevailed that the glass of the street arc lamps was too dense. Mr. Massey said the lamps were of the type seen by the sub-committee in Victoria-street, London, and, being deemed the best, they were selected. Councillor Riches suggested that the upper part of the glass, above the point of combustion, should be of transparent glass, the lower part to remain opaque as at present, to obviate a dazzling glare. In this way he thought the light would be more diffused. It was agreed to make the experiment.

Proposed Electric Tramway at Acton.—The Joint (Works and Electric Lighting) Committee of the Hammersmith Vestry reported to the Vestry last week as follows: "That with reference to the West Metropolitan Tramways Order, 1887, which authorises the use of electric or mechanical power on the tramways in this district, subject to the consent of the local and road authorities being obtained, your committee have carefully considered the application of the London United Tramways, Limited, for the consent of the Vestry to the use of electric traction on the line from Shepherd's Bush to Acton. The system proposed to be adopted by the company is the overhead-wire system. Your committee are informed that this system is already in full service in the most fashionable streets and boulevards in various cities. The system admits of the use of improved and electrically-lighted cars run at an accelerated pace and at more frequent intervals with safety and comfort. The company also propose to give the Vestry the free use of the standards for the purpose of carrying arc lamps for electric lighting. A considerable number of your committee have visited the system in working order at Havre, and are of opinion that the reconstruction of the Uxbridge-road line presents an opportunity which would be advantageous to that portion of the parish. Your committee therefore recommend the Vestry to give its consent to the use of electric traction on the tramways in Uxbridge-road, subject to such terms, conditions, and safeguards as may be considered necessary by the Vestry, and subject to the provisions of the Overhead Wires Act, 1891, and the by-laws of the London County Council under that Act." A report was then read from Mr H. Mair, the surveyor, who in the course of his remarks stated from enquiries made, including one from the Mayor of Havre, that although the electric installation at the outset was viewed with considerable apprehension, the result of the working has now merited unqualified approval, and on no account would a return to the old mode of traction be tolerated. Since the inauguration of the electric system the fares had been considerably reduced and the traffic has been greatly augmented, notwithstanding which the company have thereby been placed in a more satisfactory state. He therefore recommended the Vestry to grant the permission asked for, subject to such terms and conditions as the Vestry think desirable. Mr. T. Chamberlen, at the meeting of the Vestry last week, moved the adoption of the report. He referred in high terms to the success of the electric tramway system in Havre. He hoped there would be no difficulty about giving the company a good lift, and the company, he believed, would do all they could to assist the Vestry. If the company got the consent of the London County Council, it would do much to help Uxbridge road out of a slough of despond. Mr. Morrison seconded the motion, which, after further discussion, was passed unanimously. A motion was also agreed to urging the London County Council to take into favourable consideration the application of the company.

Taunton.—An enquiry has been held by Colonel Hasted, an inspector of the Local Government Board, in respect to an application made by the Taunton Town Council for permission to borrow a loan of £5,000, for the purpose of making certain extensions to the electric lighting of the town. The following are the particulars of the works intended to be carried out by means of the £5,000:

No. 2 sub-station in St. James's-street.			
Cables	£827	14	9
Laying cables and making connections	123	7	5
Two 30 kilowatt transformers and switches	261	16	0
Altering building for transformers	58	10	0
Instruments and fittings	68	1	0
Incidentals	90	0	0
or, say, about	£1,450	0	0
No. 3 sub-station at East-gate.			
Cellar to be constructed	1,500	0	0
Coal-shed, weighing machinery, and other works at depôt	300	0	0
New boiler, large engine, etc.	1,750	0	0
Total..	£5,000	0	0

The Town Clerk made the usual statement respecting the position of the town, and mentioned that the Town Council asked for a loan originally of £16,000 for the purchase and arrangement of the works, but £15,000 was granted, the balance amount for working capital not being allowed. The works had been under the Corporation for about 12 months, and were working satisfactorily, the balance-sheet showing a much improved position. Of the present loan of £5,000, only £2,000 would be spent at first, the rest being held over until No. 3 sub-station at East gate was required, which would be about 12 months hence, or as soon as the hospital authorities decided to light that institution with electricity. The Borough Surveyor explained that No. 2 station in St. James's-street would be placed in a cottage which they proposed to lease, and would be connected with the depôt by means of a high-tension cable, and it would then send off low-tension cables over the bridge as far as the George Inn, back to North-street and the Parade, and then back to the central depôt. No. 3 sub-station would be similarly connected with the central station by means of a high-tension cable along Harmony-row, and would give out the current by low-tension wires along East-reach, East-street, and Silver-street. It was also contemplated to provide a new coal-shed, with weighing apparatus and also new boilers, dynamos, a large engine, etc. Councillor Potter pointed out that the new boiler would not be obtained until No. 3 sub-station was put down in East-gate. The whole of the extensions were recommended by Dr. Fleming for economical reasons before they were adopted by the Town Council. The inspector afterwards looked round the works and the sites of the proposed sub-stations.

Yarmouth.—The Electric Lighting Committee of the Town Council have submitted lengthy reports. The substance of these was as under: The committee ordered the lighting of 134 gas lamps to be discontinued. The surveyor was authorised to engage an engine-driver, lamp-trimmer, and switchboardman who have been working at the station. He made complaint that none of the plant for private lighting had been delivered, and customers who had wired up their premises could not be supplied with current. The town clerk was directed to ask Mr. Preece to call the attention of the contractors to the penalties under their contract. In reply, Mr. A. H. Preece wrote that the lighting of the fish wharf might be commenced, and that it would not affect the penalties for non-completion of contract. Four arc lights were ordered to be discontinued on the beach. Four meters, costing £35, and joint and fuse boxes at £50, were ordered to be procured. The customers for the light now numbered 20, taking 1,000 lamps. The receipts from these and from the lighting of Corporation property would be £1,500, and the expenditure would be about

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£2,650 per annum, a deficiency of £1,150 per annum. A letter was read from Messrs. Grout and Co. asking when an application for a supply of current would be received by the Corporation. The surveyor stated that there were no leads passing Messrs. Grout and Co.'s premises, and that the nearest point was Regent-road. The cost of laying mains to Messrs. Grout and Co.'s premises along by Nelson-road, which was the shorter route, would be £90, but he recommended that the mains should be laid by Langham and Euston roads at a cost of £160. The committee instructed the surveyor to write Messrs. Grout and Co. and ascertain what amount of current they would require. With reference to previous correspondence on the subject of the electric lights on the Parade at Yarmouth, which were reported to interfere with the efficiency of the Caister leading lights, and to the interview with certain members of the Corporation at Yarmouth with a committee of the Trinity Board, on the Trinity House steam-vessel "Argus," on September 13 last, Mr. C. A. Kent, of the Trinity House, wrote as follows to the town clerk: "I am directed to acquaint you that the Elder Brethren are of opinion that the screening to seawards of certain of the lights, as agreed upon at the conference above referred to, will answer the purpose which they had in view. I am at the same time to request that you will convey to your Corporation the thanks of this Board for their courteous compliance with the suggestions of the Visiting Committee." At a meeting on the 6th, the committee instructed the town clerk to write to the contractors, and to take such action as he might consider desirable to compel the completion of the contract at an early date. Mr. Wiltshire: There is a serious delay in the completion of the contract, but no reason is given for it. The Deputy-Mayor: The contractors say they have been unable to get the required material. The Surveyor: Private customers are coming up better than I expected. By additional customers taking the light there will practically be no loss. The report was then adopted.

PROVISIONAL PATENTS, 1894.

NOVEMBER 12.

21782. **Improvements in automatic electrical rheostats.** Thomas Caink, Woodland View, London-Road, Worcester.

21814. **Improvements in electric arc lamps.** Julius Torge, 47, Lincoln's-inn-fields, London.

21821. **Improvements in two-pole single-limb dynamo-electric machines and electrometers having vertical magnets with the poles downwards.** Thomas Parker, Limited, and Thomas Parker, 55, Chancery-lane, London.

21822. **A vessel for the electrolytic separation and alloying of metals in the molten state.** John Clayton Mewburn, 55, Chancery-lane, London. (The firm of Fr. Hornig and Wilhelm Borchers, Germany.)

21827. **A method and apparatus for exciting dynamo-electric generators.** John Imray, 28, Southampton-buildings, Chancery-lane, London. (La Société Anonyme pour la Transmission de la Force par l'Electricité, France.)

21838. **New or improved process for electrolysing chemical combinations and winning the products of decomposition formed by the electrolysis.** Willy Bein, 54, Fleet-street, London. (Complete specification.)

21845. **Improvements in dry batteries.** Richard Myers, 323, High Holborn, London.

NOVEMBER 13.

21855. **Improvements in tools or appliances for use in the trueing up, scouring, or like treatments of dynamo-electric machine cylinders and the like.** Walter Poynter Adams and Rookes Evelyn Bell Crompton, 55, Chancerylane, London.

21879. **Improved methods of effecting the electro-fusion of metals and in apparatus therefor.** Benjamin Howarth Thwaite and Horace Allen, 95, Finsbury-pavement, London.

21893. **Improvements in autographic telegraphs.** John O'Neil, 52, Chancery-lane, London. (Complete specification.)

21929. **Improvements in electric-current regulators.** Herbert Vivian Keeson, 40, Loudon-road, St. John's Wood, London.

21948. **Improvements in holders for incandescent electric lamps.** James Yate Johnson, 47, Lincoln's-inn-fields, London. (Alfred Swan, United States.)

NOVEMBER 14.

21991. **Improvements in or connected with electric tramways and vehicles.** Henry Edmunds, 47, Lincoln's-inn-fields, London.

22029. **Improvements in electrically-propelled fans.** James Henry Pickup and James Henry Hindle, 47, Lincoln's-inn-fields, London.

22030. **Improvements in or connected with electrically-propelled carriages for common roads.** Frank King, 47, Lincoln's-inn-fields, London.

NOVEMBER 15.

22043. **Improvements in means to be employed in connection with the electrical heating of metals for various operations.** William Holland, jun., 6, Livery-street, Birmingham.

22046. **Improvements in arc lamps.** Frank Michael Lewis, 2, East-parade, Leeds.

22070. **An improved process and apparatus for the electrolytic decomposition of metallic salts, and for treating products therefrom.** James Hargreaves and Thomas Bird, Farnworth-in-Widnes, Lancashire.

22119. **An improved method of connecting electrically the rails of tram or rail ways.** Frederic Foley Robinson, 24, Southampton-buildings, Chancery-lane, London.

22134. **Improvements in the electrical propulsion of boats and vessels.** Anthony George New and Arthur James Mayne, 55, Chancery-lane, London.

NOVEMBER 16.

22157. **Improvements in electrical switches.** William McGeoch, jun., 6, Livery-street, Birmingham.

22192. **An electric exploder.** Siemens Bros. and Co., Limited, and Alexander Selgius Schloemer, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

22197. **Improvements in recording telegraphic apparatus.** Antoine Damaskinos, 65, Chancery-lane, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1893.

22327. **Electric lamp fittings.** Howes.

24606. **Suspending electric lamps and fittings.** Claremont.

24730. **Indicating time of consumption of gas or electricity.** Curtis.

1894.

2321. **Dynamos.** Yates and Clegg.

7116. **Telegraphic or telephonic call.** Bradbury. (Trinks.)

9763. **Electricity, air, etc., meters.** Cadot and Charron.

9975. **Heating, etc., metals by electricity.** Thompson. (Coffin.)

11439. **Electric indicator or signal.** Wagg.

13499. **Electrolytical decomposition of alkali salts.** Sinding-Larsen.

16243. **Electric propulsion of cars.** Brintnell.

18288. **Secondary batteries.** Riordan.

18339. **Carbons for electric lamps, etc.** Acheson.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	5	5⅜-6
Bournemouth Electric Company	—	—
Brush Company, Ordinary	2	2½-2¾
—— Nom. Cum., 6 per cent. Pref.	2	2½-2¾
—— 4½ Debenture Stock	100	110-113
Charing Cross and Strand	5	4½-5½
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	12½-13½
—— 6 per cent. Cumulative Pref.	10	14½-15½
—— 5 per cent. Debenture Stock	115	131-133
City and South London Railway, Consolidated Ordinary	100	39-41
—— 4 per cent. Debenture Stock	100	120-122
—— 5 per cent. Pref. Shares	10	13½-14
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2⅝-3½
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	95-100
Electric Construction, Limited	2	⅜-½
—— 6 per cent. Debentures	—	87-92
—— 7 per cent. Cumulative Pref.	2	1½-2
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1⅛-1⅜
Elmore's French Company	2	½-1
Elmore's Wire Company	2	1⅛-1⅜
Fowler-Waring Cables	5	½-1½
W. T. Henley's Telegraph Works, Ordinary	10	8-9
House-to-House Company, Ordinary	5	2½-2¾
—— 7 per cent. Preference	5	6½-6¾
India Rubber and Gutta Percha Works	10	25-26
—— 4½ per cent. Debentures	100	102-104
International Okonite, Ordinary	—	—
Kensington and Knightsbridge	5	4¾-5½
—— 6 per cent. Pref.	—	6½-6¾
Liverpool Electric Supply, Ordinary	5	7-7⅜
—— Pref.	—	—
Liverpool Overhead Railway	10	7 15/16-8 1/16
—— Pref.	10	13-13½
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric	5	¾-1½
Metropolitan Electric Supply	10	9½-9¾
—— 5 per cent. Reg. Debentures, 1-10,000 in Bonds of £10, £20, and £40	—	—
National Telephone, Ordinary	5	4¾-5⅛
—— 6 per cent. Cum. First Pref.	10	15-16
—— 6 per cent. Cum. Second Pref.	10	15-16
—— 5 per cent. Nom. Cum. Third Pref.	5	5⅛ 5⅜
—— 4½ per cent. Deb. Stock	—	110-113
Notting Hill Company	10	6½-7½
Oriental and Electric Company, £1 shares	1	1-1⅛
—— £5 Shares	—	6½-7½
—— £4½ shares	—	5½-6½
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7⅞-8
—— 7 per cent. Pref.	5	8½-9
Swan United	—	—
Telegraph Construction and Maintenance	12	41-43
—— 5 per cent. Bonds	100	106-109
Westminster Electric Supply, Ordinary	5	7-7½
Yorkshire House-to-House	4½	4¼-4¾

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NOTES.

Telephony in Spain.—Telephonic communication has been established between Madrid and Barcelona.

Telegraphy in Australia.—The Murchison telegraph line has been constructed to within 40 miles of Mullowa and 12 miles of Cue.

Price Reduction in the States.—The American steel rail makers have reduced their prices for 1895 to 24dol. for girder rails for electric tramways.

Society of Arts.—At the ordinary meeting of this society to be held on Wednesday evening next, December 5, a paper will be read by Mr. Edwin Sachs on "Fire Protection."

Test for Lightning Conductors.—The Government of India has decided to adopt Mr. E. O. Walker's apparatus for testing lightning conductors. A set has been taken also by the Mysore Government.

Telephony in Ceylon.—Major Savage, commanding the Royal Engineers at Trincomalee, has been making some telephonic experiments to make communication complete between Colombo, Kandy, and Trincomalee.

Electric Launch.—Mr. Thomas Orr, jun., Greenock, has received an order to build an electric launch to attain a high rate of speed, and the motor of which, according to a Glasgow paper, is to be on a new principle.

Institution of Junior Engineers.—The next meeting of this society will be held at the Westminster Palace Hotel on the evening of Friday, December 7, when a paper will be read by Mr. William Mallock on "Waterworks and Appliances."

Electrical Instruments.—Mr. H. T. Cheswright, 18, Rue de Mauberge, Paris, has issued a French price-list of the electrical and scientific measuring apparatus and instruments made by Mr. Robert W. Paul, of Hatton-garden, E.C.

Cyanide Process in South Africa.—A communication from Johannesburg, dated 5th inst., referring to the Metropolitan Gold Mining Company, states that their cyanide works—which utilise the Siemens-Halske process—commenced operations the previous week.

Electric Lighting in India.—The *Indian Engineer* learns that Mr. Lester Betts, the agent of the Oriental Telephone and Electric Company, Limited, who has just returned to Calcutta from up country, has secured several good orders for lighting in Agra and district.

Length of Electric Tramways in Europe.—It should have been mentioned in the "Note" given on this subject in our last issue that the figures were in kilometres, and not in miles, as might perhaps have been inferred from the fact of no definite statement having been made.

African Telegraphs.—Reuter's Agency states that Mr. Cecil Rhodes is ordering 650 miles of materials to be sent out for the construction of his Cape-to-Cairo telegraph line. It is estimated that this additional material will suffice to build the line from Blantyre to Ujiji on Lake Tanganyika.

Dividends.—The Allgemeine Elektricitäts-Gesellschaft, of Berlin, have just declared a dividend of 9 per cent. for the year 1893-94, as compared with 8¼ per cent. in the previous year; and the Berliner Elektricitäts Werke have just paid a dividend of 10½ per cent. on the past year's operations.

Economiser Trials.—Trials are shortly to be made at the City of London electric lighting station at Bankside of Messrs. Green's economiser and Mr. Calvert's circular economiser. The City Company have retained the services of Prof. Alexander B. W. Kennedy to make these tests.

Telephony in Belgium.—A Brussels telegram says: "It has been decided to connect this city with The Hague, Rotterdam, Amsterdam, and Flushing by telephone. The convention between Belgium and Holland will be signed at The Hague in the course of a few days. A proposal is also on foot to establish similar communication with Hamburg and Copenhagen."

Surplus and Deficit Theory of Electricity.—With reference to this article, Mr. W. Perren Maycock, M.I.E.E., desires to make the following corrections: November 16—p. 576, second column, line 1, for *Fig. 2* read *Fig. 10*; line 18, for *circuits* read *circuit*; p. 577, first column, line 26, for *article* read *section*; November 23—p. 599, first column, line 7, for *section* (*b*) read *section* (*f*).

Royal Statistical Society.—A special meeting will be held in the lecture theatre of the Museum of Practical Geology, 28, Jermyn-street, S.W., on Tuesday, December 4, 1894, at 4.45 p.m., when a paper on "The Eleventh United States Census" will be read by the Hon. Robert P. Porter, superintendent, and an exhibition of the Hollerith electrical counting-machine will be given by Dr. Herman Hollerith, Washington, D.C., U.S.A.

High Tide in the Thames.—On Tuesday afternoon the tide in the Thames attained an extraordinary height. Some idea of the height of the tide may be gathered from the fact that the water at its flood reached within 1ft. of the platform erected on piles some distance from the southern extremity of Blackfriars Bridge for the purpose of sinking the shaft for the excavation of the Mansion House and Waterloo Railway tunnel.

Patents, Designs, and Trade Marks.—The *Gazette* has published an order in Council applying the Patents, Designs, and Trade Marks (Amendment) Act, 1883, and subsequent amending Acts, to Denmark, including the Faröe Islands. The order is to take effect, so far as regards patents, at the expiration of seven months, and, so far as regards designs and trade marks, at the expiration of four months from the 25th inst.

A New Suggestion.—The Board of Guardians at Brighton find a difficulty in providing work for the inmates which shall be profitable, oakum-picking not fulfilling that purpose. Mr. Merry—evidently a merry man—stated, in the course of a discussion on the subject on Tuesday, that it had been suggested that the inmates "should be employed in generating electricity," and he thought that another guardian, Mr. Dutton Briant, could develop the idea.

London Chamber of Commerce.—A meeting of the Electrical Trade Section will be held at the offices this (Friday) afternoon at 3 p.m. to consider the following agenda: (1) to consider the attitude of the London County Council in regard to placing transformer-chambers in streets; (2) notice of motion by Mr. Sydney Morse as to the methods adopted in the Courts of hearing actions involving electrical questions; and (3) any other matters.

Electric Traction in France.—The success of electric traction on the Lyons-Oullins-St.-Genis line has determined the Lyons Omnibus and Tramway Company to adopt electric traction on their line from the Place Bellecour to St. Fous Vénissieux, on which at present Francq locomotives are employed. The length of this line is 5¼ miles. Mr. Favre intends to construct at Saint-Etienne an electric tramway line on the overhead trolley system.

Society of Engineers.—The next ordinary meeting of this society will be held at the Town Hall, Westminster,

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on Monday, December 3, when a paper will be read on "The Principles and Practice of Hydro-Extraction," by Mr. H. B. Ransom. The council of the society have unanimously elected Mr. S. Herbert Cox as one of the vice-presidents in the place of Mr. Henry Faija deceased, and Messrs. Henry O'Connor and William Bradford as members of council.

The Electro-Harmonic Society.—There will be a ladies' night this evening (Friday) at the St. James's Hall Restaurant (Banquet-room), Regent-street, W., at eight o'clock, when the artistes will include Miss Mary Harris, Miss Vena Galbraith, and Mr. Reginald Groome. Recitations will be given by Miss Charlotte Boucher, and whistling solos by Mr. C. Capper. The pianist will be Mr. Alfred E. Izard, and musical sketches will be rendered by Mr. Roland Henry.

Utilisation of Niagara Falls.—The following is from the current issue of *Judy*: Stranger (at Niagara): "What a pity it is that up to the present all this water should have gone to waste." Lord Milbank: "Yes, but you know they are going to utilise it for the electric transmission of power." Stranger: "Yes, I know that, but it could have been used more advantageously." Lord Milbank: "Are you an engineer with a new idea?" Stranger: "No; I am a dairyman."

A Curious Argument.—A gentleman writing in a gas organ on the subject of the beauty and utility of the incandescent gas lamp states that in Leith the Police Commissioners, who have adopted some such burners in the streets, are going "to double the number of lamps they are using in street-lighting." This is surely a very strong evidence of the unsatisfactory light given by the street gas lamps. If the writer had hailed from Ireland, it might have been supposed that he had simply made a bull; but he appears to be a Scotchman, so that cannot be the case.

The Madras Electric Tramways.—"With reference to the paragraph which appeared under this heading in our issue of October 20," says the *Indian Engineer*, "we have received a letter from the assistant secretary of the company calling upon us to contradict the concluding sentence, which was as follows: a local paper says, 'There is a general feeling prevalent that the delay manifested in laying down the line is in some degree due to a shortness of funds.' The statement, it appears, was quite untrue and injurious to the company, and we readily express our regret for publishing it."

The Epping Forest Railway.—Notice has been given by the parliamentary agents of the London, Walthamstow, and Epping Forest Railway announcing their intention in the next session to ask authority to abandon the line, to release the deposit, and to dissolve the company. It will be remembered that the promoters last session had a tough controversy with the London County Council on the question of workmen's fares, declaring that it would be impossible to raise the capital under the conditions sought to be imposed upon them, but the Bill was eventually passed on a compromise being arrived at between the promoters and the County Council.

City and South London Railway.—This Company have given notice that they will apply to Parliament to extend the time limited by the City and South London Railway Act, 1890, as extended by the City and South London Railway Act, 1893, for the compulsory purchase of lands for the purposes of the underground railway described in, and authorised by, the first-mentioned Act, and for the completion of the said railway; also to empower the Company to make an additional approach to their King William-street Station, commencing under Arthur-street East, at the eastern end of the station; and to empower the Company to raise additional capital by the creation of new shares or stock.

Trafalgar-square Advertising.—An obviously inspired paragraph has appeared in the *Daily Chronicle* this week to the effect that as a result of the overtures made by the St. Martin's Vestry, her Majesty's Office of Works has, it is stated, decided to take action to secure the suppression of the "nuisance and desecration" (*sic*) caused by the search-light advertisement thrown on Nelson's Column and the neighbouring public buildings. As the Office of Works has at present no power to authorise the abatement of the "nuisance," it is understood that a Bill for that special purpose will be brought into Parliament. Another conference between the solicitors of the St. Martin's Vestry and the Office of Works has been arranged to take place.

Storage Battery Traction.—A German contemporary recently referred to the proposed introduction in Vienna of storage batteries for use on the Hütteldorf-Mariahilf circle. In this connection Dr. J. Stricker, the general representative in Vienna of the Akkumulatoren Fabrik Aktiengesellschaft, writes that the cars will be operated in conjunction with steam cars, which are already in service on that line. The batteries to be used are of the new copper-zinc type of the Waddel Entz Company, which are said to possess all the requirements necessary for successful street traction work. Not being content with the anticipated working results from the company's point of view, an independent committee of 10 technical men has been appointed to follow the experiments and to draw up a report on the subject.

The Pacific Cable.—The *Gazette* of Montreal says: "Referring to Sir John Pender's public statement that the Atlantic cables do not earn adequate returns, and that this ought to be a warning to Governments in the case of the Pacific cable, those who know the facts are in no way surprised that some of the Atlantic companies do not pay good dividends considering the extent to which their stock is watered. Sir John will not be able to get the Commercial Cable Company's statement that Atlantic cables are not a profitable investment, as this company has kept out of the ring with which he is associated. Sir John characterises the Pacific cable as a foolish project, but he has of late repeatedly evinced great anxiety in carrying it out. The warning which he gives may, however, have its use in a way he does not intend in determining the Governments to take such steps as will render it impossible for the Pacific cable to get into the category of water-logged companies, like so many other companies with which Sir John is familiar."

A Curious Scare.—A daily contemporary says: "The success which has already attended the subjugation of Niagara, to obtain power for paper-mill and electric lighting purposes, has brought about the inevitable result. No fewer than six companies are now in existence, formed to utilise the great Falls—that is to say, to divert water from the river's course into turbine pits. The local authorities have become alarmed, and have appealed to the Canadian and United States Governments to exercise some control in order to preserve the rapids. That such an appeal should even have been suggested is almost as remarkable as the original idea of exploiting the great cataract as an engineering enterprise. We may sympathise with those who are organising an opposition to the construction of a railway up Snowdon, but we decline to believe that Niagara is in danger. The preparations on both the American and Canadian shores afford a striking exemplification of the modern utilisation of waste products,

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for whatever may be said about the grandeur of the Falls, their power has certainly been wasted for centuries."

Bordeaux Exhibition.—A meeting of the committee which has been appointed by the council of the London Chamber of Commerce to further the success of this exhibition, has been held at the offices of that institution, under the presidency of Sir Albert K. Rollit, LL.D., M.P. Those present included Sir Walter Gilbey, Sir Bernhard Samuelson, M.P., Sir Charles M. Kennedy, Messrs. Henry V. Trapp, Paul Aubert, R. W. Fithian, Ernest Clarke, E. Burney Young, and others. It was reported to the committee that the executive of the Bordeaux Exhibition do not propose allocating space for international sections, but that if any desire were expressed for the formation of a British section, proper accommodation might be provided in a separate annexe. Sir Bernhard Samuelson suggested, and the committee agreed, that it would probably be more satisfactory to adhere to the intentions of the Bordeaux executive in classifying the goods of all nations according to groups. The secretary of the Chamber of Commerce is, by direction of the committee, communicating with the Bordeaux executive as to the appointment of a British committee in Bordeaux who will protect the interest of exhibitors. It was stated that all applications for space at this exhibition must be lodged not later than the end of December. Firms who are interested in this exhibition should put themselves in communication at once with the secretary of the London Chamber of Commerce, at Botolph House, Eastcheap, E.C.

Electrocution in America.—A Reuter's telegram states that: "Dr. Gibbons, of Syracuse, who professes to be able to restore animation to a person who has been executed in the usual manner by means of electricity, has arrived in New York for the purpose of explaining to members of the medical profession his apparatus. It is a species of double bellows, about 2ft. in length. By pulling the handle after the indiarubber tube has been inserted into the throat one bellows is filled with fresh air or oxygen, while the other extracts from the lungs whatever air they may contain. By another movement of the handle pure air is projected into the lungs, and vitiated air thrown out of the bellows. Notwithstanding the decision of the Attorney-General for the State of New York, that it would not be legal to experiment upon the body of an 'electrocuted' man, Dr. Gibbons hopes to be afforded an opportunity to carry out such experiments within the next two or three months. He declares that he is satisfied that the alternating current of 1,700 volts now applied does not kill, but only suspends animation, and that it is really the knives used by surgeons at the autopsy that cause death. He says he has experimented largely upon dogs, rabbits, cats, sheep, and cattle, applying from 1,500 to 2,500 volts, and that the animals under his treatment subsequently revived. Dr. Gibbons adds that the apparent death varied from a few moments to several hours, and that he has an assistant who has been similarly revived after receiving 1,500 volts."

Free and Independent Inspiration.—The *Acton and Chiswick Gazette* says that "there is little doubt now that the articles in the *Electrical Engineer* advocating the use of electric traction on the tramways between Shepherd's Bush and Acton were inspired and were intended to deprecate opposition to the Bill which the London United Tramways Company are promoting, and which, if passed, will empower the company to use steam or electric traction on all their lines." Our contemporary is a little "out" in its facts. In the first place, the columns of the *Electrical Engineer* are specially and primarily intended for, and are filled with, matter advocating electrical progress of all kinds, and they are always "inspired" in the best sense. The temptation of a large advertising order from any particular interest is not—and never has been—sufficient (the *Acton Gazette* would soon have found this out if it had made enquiries) to secure favourable mention for a project of any kind in these pages, and we trust our contemporary can say as much; at any rate we note with pleasure its eventual advocacy of the selfsame line we have pleaded for, whatever the inducing cause. In the second place, the Bill now before Parliament is, we are informed on making enquiry, *not* for the purpose of empowering the use of steam power in any shape or form—or electric traction either, for that matter—except on the small piece of new line proposed to be run through Acton High-street. Parliamentary powers authorising the use of electric traction were long ago obtained for all the old West Metropolitan lines, and still hold good. The idea of employing steam traction is absurd, and we even understand that the tramway company is practically pledged to the use of one particular form of electric traction—the overhead trolley—as being on the whole the least objectionable to all concerned.

He Took 4,600 Volts.—Mr. James E. Cutler, of the Stanley Electric Manufacturing Company, U.S.A., writes to the New York *Electrical Review* as follows: "Regarding my recent experience with 4,600 volts, I give you the following facts: The accident was the result of a misunderstanding, and occurred when I attempted to examine a transformer that was being tested with a pressure of 4,600 volts. I leaned over the transformer, and the wires being somewhat in the way I attempted to push them one side, and in so doing got the full shock through my body. For a brief instant I experienced a sensation as if being drawn downward by the arms, then everything became black and remained so for about seven minutes, during which time efforts were being made to restore respiration, the method used being that recommended by D'Arsonval, working the arms and diaphragm to the time of natural breathing. Those standing near said I gave two agonising groans as I fell over, but I have no recollection of having done so. One of the wires had to be pulled out of my hand. Before this could be done I received a further shock through the hips while lying on the floor. For seven minutes there was no sign of a pulse beat, and there was every indication of death. As I slowly regained consciousness, I repeated over and over again incoherent remarks pertaining to the accident. When I first opened my eyes all I could see was a huge black spot, which gradually diminished in size and disappeared. At one time I recognised several people by their hats; the faces I could not see. Half an hour after the accident I could recall every incident happening before and after the few moments of total unconsciousness, that period being a total blank and a painless one as well. I remained quiet the rest of the day—the accident occurred about 10 a.m.—and was around as usual the day after. My nerves were not affected to any appreciable extent, and I shall experience no ill effects other than the scars from the burns, one of which went to the bone.'

Berlin and Vienna Telephone.—A Vienna correspondent of the *Daily Chronicle* says that the telephone between Vienna and Berlin has just been finished, and the first experimental conversation which was carried on between the two cities on Friday last was said to be successful. The line will be opened for public use in a day or two. It is expected that there will be a very large amount of patronage for the line, especially in the way of communications between the two Bourses—so large that it

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is anticipated that a second and, perhaps, even a third line will very soon be required. During business hours the present line will be exclusively at the disposal of the Bourses in the two cities. The Berlin correspondent of the same paper states that the telephone line, which is about 800 kilometres, or 500 English miles, in length, does not act very satisfactorily. Another Vienna correspondent states that the first conversations were between Austrian and Prussian officials. A slight improvement is, however, necessary before the formal opening of the line. The Vienna correspondent of the *Daily News* stated on Thursday that the previous day at a private trial there were still some disturbing noises. It has been ascertained that the defect is in the line from Berlin to the frontier, whereas the line from Vienna to the frontier work to perfection. He adds: "Our telephone system would appear to be the best that exists. Whenever an Englishman has watched me use the telephone, his expressions of surprise and delight became quite un-English in their enthusiasm. Not only do we set our watches by the telephone, communicate the latest pun, correct mistakes in pronunciation, but set the boys their work, and correct their mathematics on the little desk fixed to the telephone. The ever willing young ladies at the central office often take a lively interest in what is going on, give us pieces of information we might not otherwise obtain, and lovingly ask how we are when we have not called for a couple of days. The telephone in Vienna is perfection, and the connection with Berlin will perhaps have a good effect on the telephone there, which is generally complained of."

Lectures.—Mr. W. H. Preece, C.B., F.R.S., has delivered an address on "The Electric Light" before a large audience at the Young Men's Christian Association, Willoughby-road, N.W. Mr. Hugh M. Matheson, J.P., occupied the chair, and the audience included several members of the Hampstead Vestry and others interested in electric lighting in the parish. At the conclusion of his address Mr. Preece expressed his thanks to Mr. G. Binswanger, general manager of the General Electric Company, of Queen Victoria-street, and Mr. J. T. Niblett, general manager of the Lithanode and General Electric Company, Millbank-street, for the loan of the electrical appliances with which he had illustrated his lecture, and to Mr. I. Probert, superintendent of the electric lighting at the General Post Office, and his assistant, Mr. T. Heather, for their arrangement of the numerous experiments.—A paper has been read before the Glasgow Philosophical Society by Dr. William Smart on "The Municipal Industries of Glasgow," these industries including that of the supply of electric current.—In the course of a paper read by M. Eissler before the Institute of Mining and Metallurgy on "The Practical Operation of the Cyanide Process on the Witwatersrand Goldfields," he stated that it was a strange fact that whilst gold was one of the most difficult of metals to dissolve in acids, it was extremely susceptible to the weakest solutions of cyanide when copper and other metals might remain unaffected in it. In 1887 Dr. Siemens, of Berlin, found that the gold anodes used in electro-plating at his works lost weight when standing in the cyanide liquor without any electric current having passed through the bath. That fact backed up the statements made by chemical authorities that gold was soluble in cyanides, and induced him to try the use of cyanide solutions for the extraction of gold from ores. In order to precipitate the gold from cyanide solutions, only a very weak electric current was required, a density of about 0·06 ampere per square foot being mostly sufficient for the purpose.—Mr. C. J. Jenkin, manager at Nettlefold's works, has delivered a lecture before the Newport (Mon.) Literary Society on "The Electric Current."—A lecture on "Telegraphy" has been given to the students of the evening continuation schools of the Tottenham Board by Mr. A. L. de Lattre, of the engineer-in-chief's office of the Post Office.

Carborundum Electric Light Carbons.—Efforts are constantly being made to improve the quality of carbons, for the purpose of lengthening the life of the filaments, rods, or points, and also to produce a combination of carbon with other substances that would give more light for the electrical energy consumed. Many combinations of materials have been made, both in the mass of the filament, rod, or point, and in the coating of the mass. The main object of inventors has always been to produce a carbon containing a material having an excessively high fusing point and equally difficult of oxidation, and at the same time having a high luminescent value. Mr. E. G. Acheson, the inventor of carborundum, has recently produced a carbon in which he claims to have covered these points. According to the New York *Electrical Engineer* he takes pure carbon and carbide of silicon (carborundum), reduces both to fine powder and mixes them in the proportions of nine parts of the former to one of the latter, together with tar or any other good binding material. The mixture is then baked and moulded into the proper form for use. In order to get the full and complete effect of the illuminating qualities of the carbide of silicon more distinctly separated from that of the carbon, the ordinary cored carbon rod or point is used and the core is filled with the carbide of silicon, either alone or with a binding agent. For the filaments of incandescent lamps, the carbide of silicon, in a very fine powder, is mixed with and suspended in the oil used in the oil bath, for the treatment and building up of the carbons, and in the process of depositing the carbon from the oil bath into the filament, the fine particles of carbide of silicon become fixed to the filament simultaneously with the deposit of carbon. As carborundum is formed at a temperature approximately that of the electric arc, it is necessarily free from all volatile matters and eminently fitted (as the result of having already existed at these high temperatures) for the light-giving body. It has also been demonstrated that it resists oxidation to a greater extent than any other known material, having resisted such chemical action when highly heated and exposed to a stream of oxygen gas. Associated with these two essential qualifications of infusibility and non-oxidisability, is a third equally valuable one, that of luminescence, as it is claimed to produce a greater amount of light for the electrical energy consumed than any illuminating body heretofore used.

Electric Lighting in Germany.—It is proposed to establish a central electric light station at Bunzlau.—The Municipality of Eltville have appointed a committee to enquire into the subject of the electric lighting of the town.—A scheme is projected for the electric lighting of Wirges.—Messrs. Siemens and Halske intend to erect a central station at Warnsdorf.—A large central station is to be erected in Heringsdorf, a sea-bathing resort near Stettin, which will supply current to private consumers, the hotels, and for street-lighting.—The tender of the Allgemeine Elektricitäts-Gesellschaft, of Berlin, has been selected from among a number for the erection of a central station at Kamenz for lighting and power purposes.—The sawmills of Mr. Mathis at Müttersholz have been lighted by electricity for some time, and it is now intended to adopt the electric light in the streets of the town.—A central station has been set in operation at Simbach-on-the-Inn. Various business firms and hotels are taking current, and the streets will also be shortly lighted electrically.—The work in connection with the central station which is

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being erected by the Offenburg Colliery Company for the electric lighting of Gegenbach, Baden, is making good progress. The conductors are all ready, but the plant at the works has still to be installed. Orders have been received for 800 incandescent lamps, various arc lamps and electric motors, and, in addition, the local authorities have decided to introduce the electric light in the streets.—Work is to be commenced immediately on the central station for Friederichroda.—At Frankfort-on-the-Maine the central station is now giving a day and night supply. There are about 8,000 incandescent lamps connected.—Mr. E. Palmer, gas manufacturer, proposes to erect a central electric light station at Ratzeburg.—A central station has been established by Messrs. Siemens and Halske at Soden, which supplies current to Soden and the neighbouring villages of Kronberg, Königstein, and Mammolshain, and the Friederichshof Palace. There are two Kuhn steam-engines, each of 150 h.p,, and each driving by belting a Siemens alternating-current dynamo. The two machines are run alternately during the evening, while for the day load a third dynamo is employed driven by an 80-h.p. portable engine. The dynamos supply current at 250 volts, and this is raised by five or six transformers to a pressure of 5,000 volts, at which the current is distributed to the various villages, where it is stepped down again to 250 volts in transformer stations. There are 1,000 incandescent lamps installed in the Friederichshof Palace alone. A number of electric motors is connected to the system.

Applications for Provisional Orders.—Notices are now being given in the *London Gazette* of intention to apply for provisional orders for electric lighting in the coming session of Parliament. The following are those which have been announced: by the Corporation of Carlisle, to distribute electricity within the city of Carlisle; by the Walthamstow Local Board, within the district of Walthamstow; by the Swindon New Town Local Board, within the district of the Local Board; by the Pontypool Electric Light and Power Company, Limited, Club chambers, Pontypool, within the district of the Pontypool Local Board; by the Winchester Corporation within the city of Winchester; by the Notting Hill Electric Lighting Company, Limited, to extend their area of supply in the Notting Hill district; by the New Windsor Corporation, within the borough of New Windsor and the district of the Eton Local Board of Health; by the Corporation of Bootle, within the borough of Bootle; by the Victoria Newmarket Gaslight and Coke Company, Limited, to make provision for enabling the company to obtain powers to produce and supply electricity for lighting and other purposes, and to empower them to construct and acquire works, rights, and machinery for the purposes aforesaid, and to apply their capital or funds to all or any of those purposes; by the Liverpool Electric Supply Company, Limited, within the city of Liverpool and in the Local Government district of Toxteth Park; by the Local Board for the urban sanitary district of Radcliffe, within the district of the Local Board; by the Corporation of Worthing, within the district and borough; by the City Commissioners of Sewers to supply proposed baths, wash-houses, and buildings with electricity; by the Southampton Electric Light and Power Company, Limited, within the county borough of Southampton; by the Improvement Commissioners of Llandudno, within the district of the Commissioners; by the County of London and Brush Provincial Electric Lighting Company, Limited, within the district of the Urban Sanitary Authority of Devonport, within the parish of St. Mary, Newington, London, within the district of the St. Olave's Board of Works, London, within the parish of St. Mary, Battersea; by the Local Board for the Urban Sanitary District of St. George, Gloucester, within the district of the Local Board; by the Leigh Urban Sanitary Authority, within their district; by the Charing Cross and Strand Electricity Supply Corporation, Limited, within the district of the Strand District Board of Works; by the Luton Corporation, within the borough of Luton; by the Salisbury Electric Light and Supply Company, Limited, for Salisbury; and by the Windermere Electricity Supply Company, Limited, within portions of the counties of Westmoreland and Lancashire.

"Electric Light and Power."—This was the subject of a lecture delivered on Friday last before the Warrington Literary and Philosophical Society by Mr. F. G. Baily, M.A., lecturer in University College, Liverpool. The lecturer remarked at the outset that the present age had been called generally the age of steam, and if one looked round in Lancashire and all parts of the North of England he would be quite convinced of the truth of the saying. Pretty nearly everything was done by steam, and all the sources of their power were practically summed up in the words "steam-engine." There were a few exceptions perhaps, the gas-engine being the most important, but still they could say that the age was essentially that of the steam-engine. But there were considerable signs that the subsequent ages—the next immediate time—would be to a much larger extent not the age of steam, but the age of coal transferred into electrical power, and that electricity would be the immediate source of all their power in their everyday life. Even at present the various ways in which electricity was applied was one of the most surprising occurrences of the latter end of the century. There was hardly any branch of life to which electricity had not been applied, although the application was only to a limited extent. In most large towns electric lighting was an accomplished fact, and there was to be seen street-lighting, lighting in houses, and all sorts of artificial lighting, down to microscopic slides and illuminating for medical purposes. Heating was thus also done, although to a small extent, with its various applications to cooking and so on. The transmission of power, the carrying of power from one place to another, had received an enormous improvement, notably in the case of the Niagara scheme, and to a limited extent it had been applied in England. There were also wide possibilities in the way of smelting and forging and welding, and nearly all the copper was now purified by electricity. It had a wide application in the medical interest, part of which was of doubtful utility, whilst other applications were based on a thoroughly sound scientific basis. Although he had said that the next age would be one of electricity, they would never get rid in England, at all events, of the coalfields; they could never rely on anything but coal for a source of power, simply because they had no other source. The great advantage of electricity was to simplify the transmission of power very much. It gave them a very much wider range of distance, and a wider range of application at the other end. In conclusion, he said they could expect a large extension of various applications in a few years' time, as soon as people more fully appreciated the benefits to be obtained from electricity, both in electric lighting and in power. Electricity was really one of the most hopeful means of getting rid of the appalling trouble of smoke. It was almost a disgrace to the science of the country that it had not done something material to get rid of it, whereas, as a matter of fact, nothing had been done. One could abolish seven-tenths of the smoke by the use of electricity and good stoking; it would make Lancashire a Garden of Eden if electricity were more generally used.

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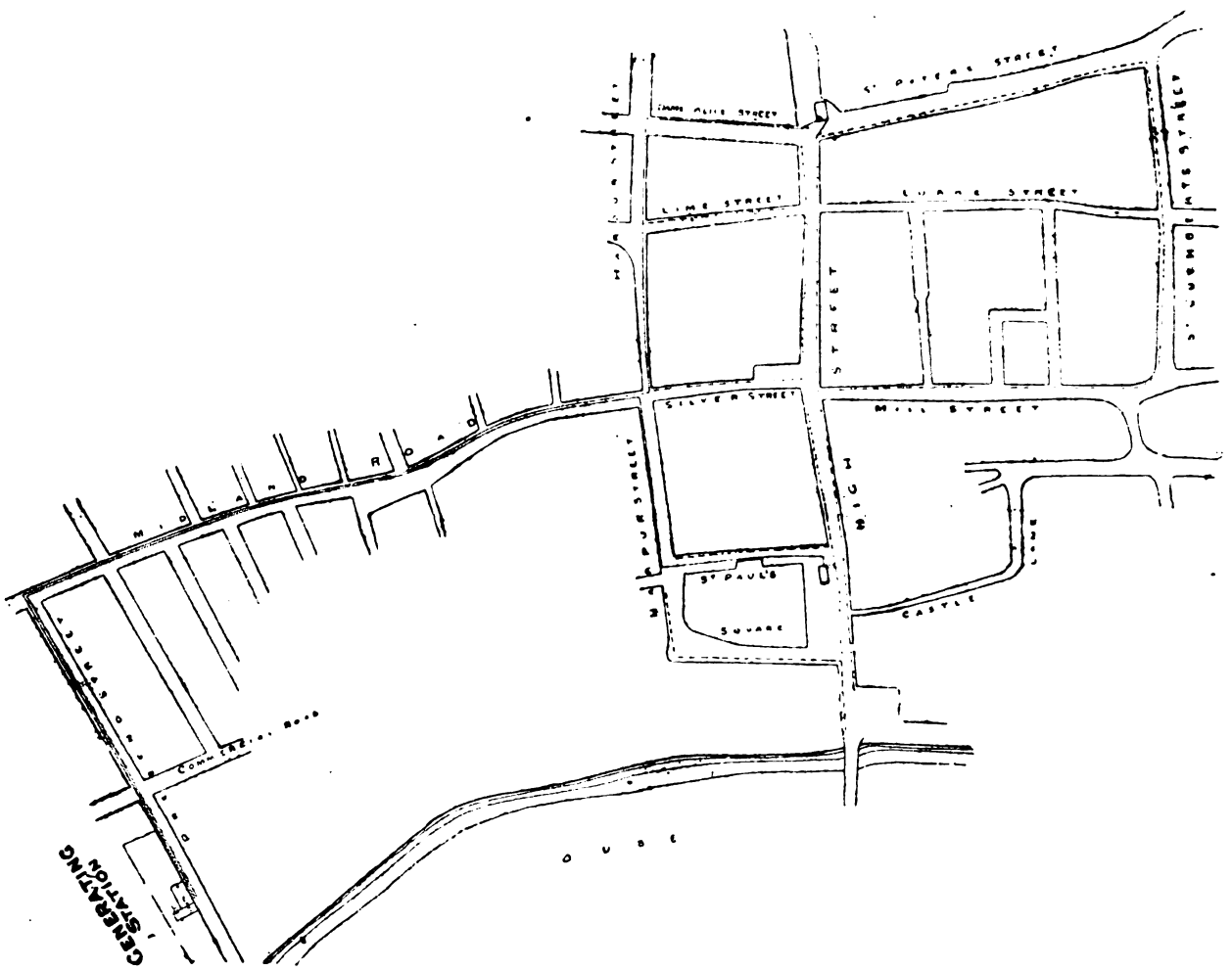
THE ELECTRICITY WORKS AT BEDFORD.

General Remarks.

The prominent characteristics of the town of Bedford are more of an educational than of a manufacturing nature, and hence it has established a wide reputation for the bringing up of the youth of both sexes. Bedford has a long and eventful history, and the district is rich in objects of interest to the antiquarian. Situated on the banks of the Ouse, which passes through the town, it is in direct communication with the Metropolis, the journey to London by rail only occupying about one hour. The town is well paved, and an ornamental embankment, about one mile in length, affords an agreeable promenade on the northern side of the river.



Bedford Electric Light Station.—Map showing in Continuous Lines Route of Feeders and Site of Sub-stations, and in Dotted Lines the Position of the Distributing Mains.

At the commencement of the century the population comprised 4,000 persons, and at present the number of inhabitants reaches approximately 25,000 souls, the area of the borough being some 2,200 acres. The various schools, which it will be unnecessary to particularly specify, are open to boys and girls whose parents, or other legal guardians, are resident in the town. Among the public buildings may be mentioned the Shire Hall, the Corn Exchange, and the Assembly Rooms. The High-street Bridge—one end or the commencement of which is shown on the accompanying plan, was erected over the Ouse in 1813, on the site of the old bridge, which is reported to have supported the gaol where John Bunyan, of "Pilgrim's Progress" fame, was imprisoned.

Preliminary Steps in Electric Lighting.

A few years ago when many local authorities applied to the Board of Trade for provisional orders to supply the electric light, it was considered by the Bedford Corporation that they should also obtain parliamentary powers for this purpose. As a result a provisional order was granted in August, 1890, but the Corporation did not for some years take advantage of the powers thereby conferred upon them. In fact, it seemed at one time as if the provisional order would lapse. Not having taken any definite action in the matter, the Bedford Electric Lighting Company came upon the scene. But to this many of the inhabitants objected. Still the Corporation hesitated, and the company pressed for parliamentary powers. Meetings of the ratepayers were held, and a committee was appointed to prevent, if possible, the provisional order from lapsing into the hands of the company. The matter did not terminate there, and the dispute as to who should supply the electric light in the town was carried to the Board of Trade. It may be as well to recall some of the remarks made by Sir Courtenay Boyle in reply to the deputations to the Board of Trade on the subject in March last. Sir Courtenay Boyle then said:

"The Corporation have had an electric lighting order since August 4, 1890, and not done anything under that order at present, except to give to the difficulties of the situation their careful consideration. The time must come when consideration is not sufficient, and some definite action must be taken, and it seems as if the time has now arrived when, in the interests of a large section of the rate payers of Bedford, some definite steps should be taken. If the Corporation will act upon their order, and will undertake to do something to show that they really intend to carry out their powers, the Board of Trade will be very loth to interfere with those powers. If the Corporation will, as soon as they can, pass the necessary resolution to supply electricity within the compulsory area proposed in the company's order, their assent will not be dispensed with and their order will stand, but if they will not so resolve, their consent will be dispensed with, and an order will be granted to a company. The ratepayers' interests

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will be safeguarded, because the Corporation's order will not be at once revoked. The compulsory area will be open to reconsideration, so that if the company get the advantages for which they contend they shall be liable to supply at once, or within the compulsory time, a rather more extended area than has been suggested. Something has been said about the position of the company. I have nothing whatever before me to lead me to infer that the company will not be able to satisfy the Board of Trade as to their ability. If the company do not satisfy the Board of Trade within six months as to their ability to carry out their powers in the compulsory area within the limited time, or if they do not conform to the terms as to the compulsory area, their order will be revoked. There is now an opportunity given to the Corporation to decide aye or no whether they will do something or agree together on doing nothing. If they do something their powers will stand, but if they do nothing they will forfeit their powers."

A few days subsequently the Board of Trade intimated to the Bedford Corporation that they would allow the latter six months for the carrying out of the order in the compulsory area proposed by the company. Being thus put on their mettle, the Corporation decided in April last, although not unanimously, to proceed with the work.

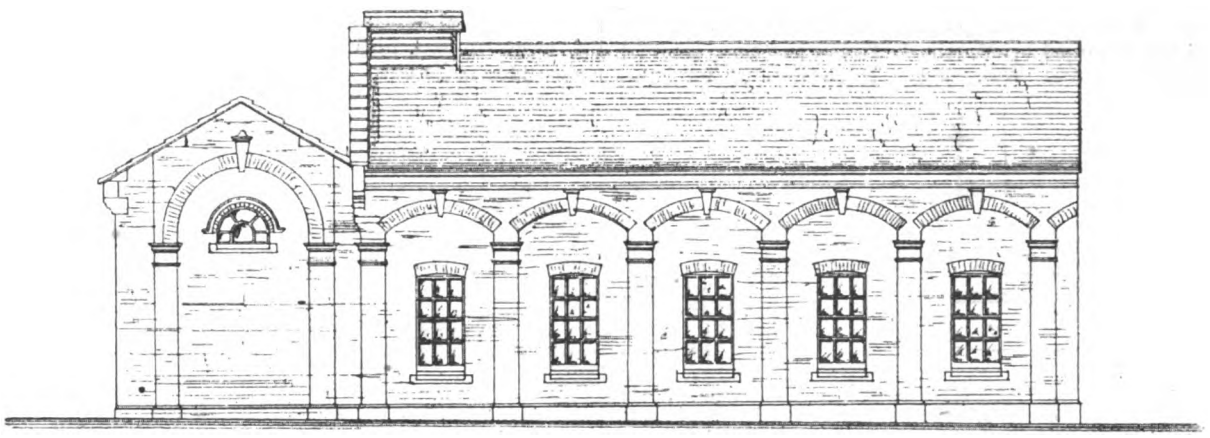
ELECTRIC LIGHTING COMMITTEE.
GEORGE WELLS, J.P., Mayor (chairman).
ALDERMEN:
ASTELL. | YOUNG.
COUNCILLORS:

BLAYDES.	JARVIS.
BURRIDGE.	RICHARDS.
CARTER.	SHELTON.
HARRISON.	SHARPIN.
G. HOWARD.	SPENCER.
J. H. HOWARD.	TAYLOR.

The Electric Lighting Committee (whose names are given above) called in Mr. Francis H. Medhurst, B.Sc., M.I.E.E., of 13, Victoria-street, Westminster, S.W., to advise them on the subject.

The Adopted System.

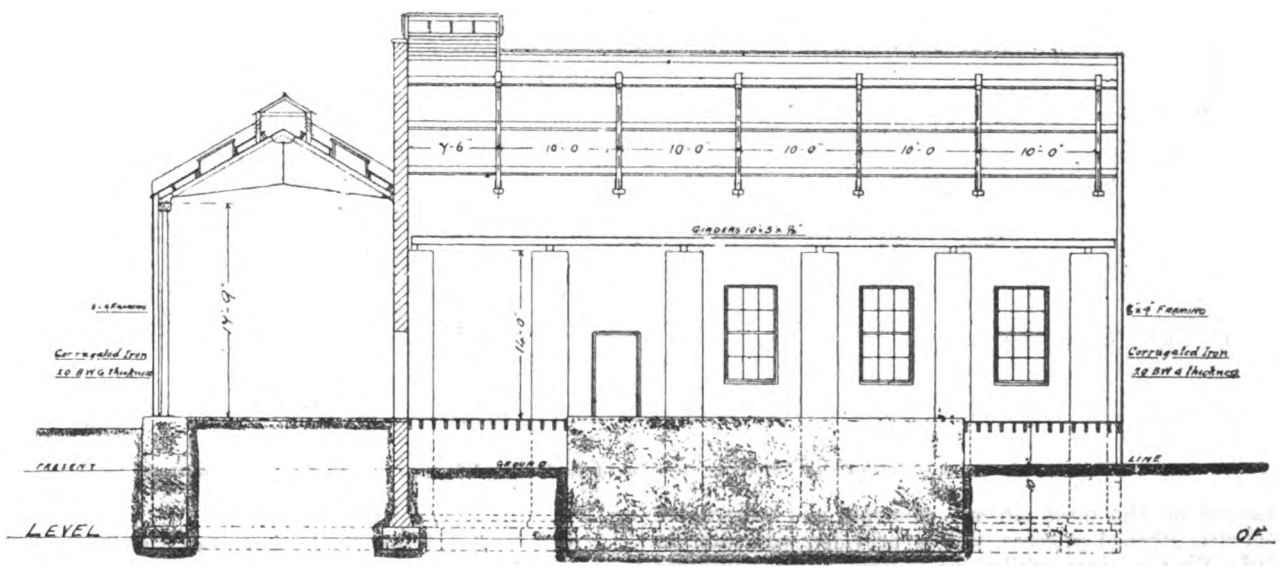
After having taken into consideration the straggling nature of the town and the sites available for the erection of the station, Mr. Medhurst suggested the laying down of a high-pressure alternating-current system of generation, with distribution to consumers from sub-stations at low pressure on the three-wire method. Having adopted this recommendation, the Corporation instructed Mr. Medhurst to prepare plans and specifications for the work. This was done and tenders were invited, the following being accepted:



Bedford Electric Light Station.—Elevation of Buildings from Prebend-street.

Buildings, T. Coleman	£1,565
Plant, Johnson and Phillips	5,200
Mains and transformers, Telegraph Manufacturing Company	2,271
Crane, Grafton and Co.	85
Total	£9,121

As the cost of the buildings may be considered to be low, it is well to explain that this contract did not include the foundations, which were made by the Corporation.



LONGITUDINAL SECTION OF ENGINE HOUSE

Bedford Electric Light Station.—Longitudinal Section of Boiler and Engine House.

The construction and equipment of the station have been rapidly carried out. As shown on the plan, the generating station has been built in Prebend-street, on land belonging to the Corporation, about 1,200 yards from the distributing centre in the town. There is ample space available for extending the buildings from either end, so as to provide for future extensions of the plant. The general arrangement of the station is indicated on the plan of the boiler and engine houses, whilst an external view of the station is given in the front elevation from Prebend-street.

The Boiler-House.

As shown in plan and section, the boiler-house is equipped with two Babcock and Wilcox water-tube boilers, each of

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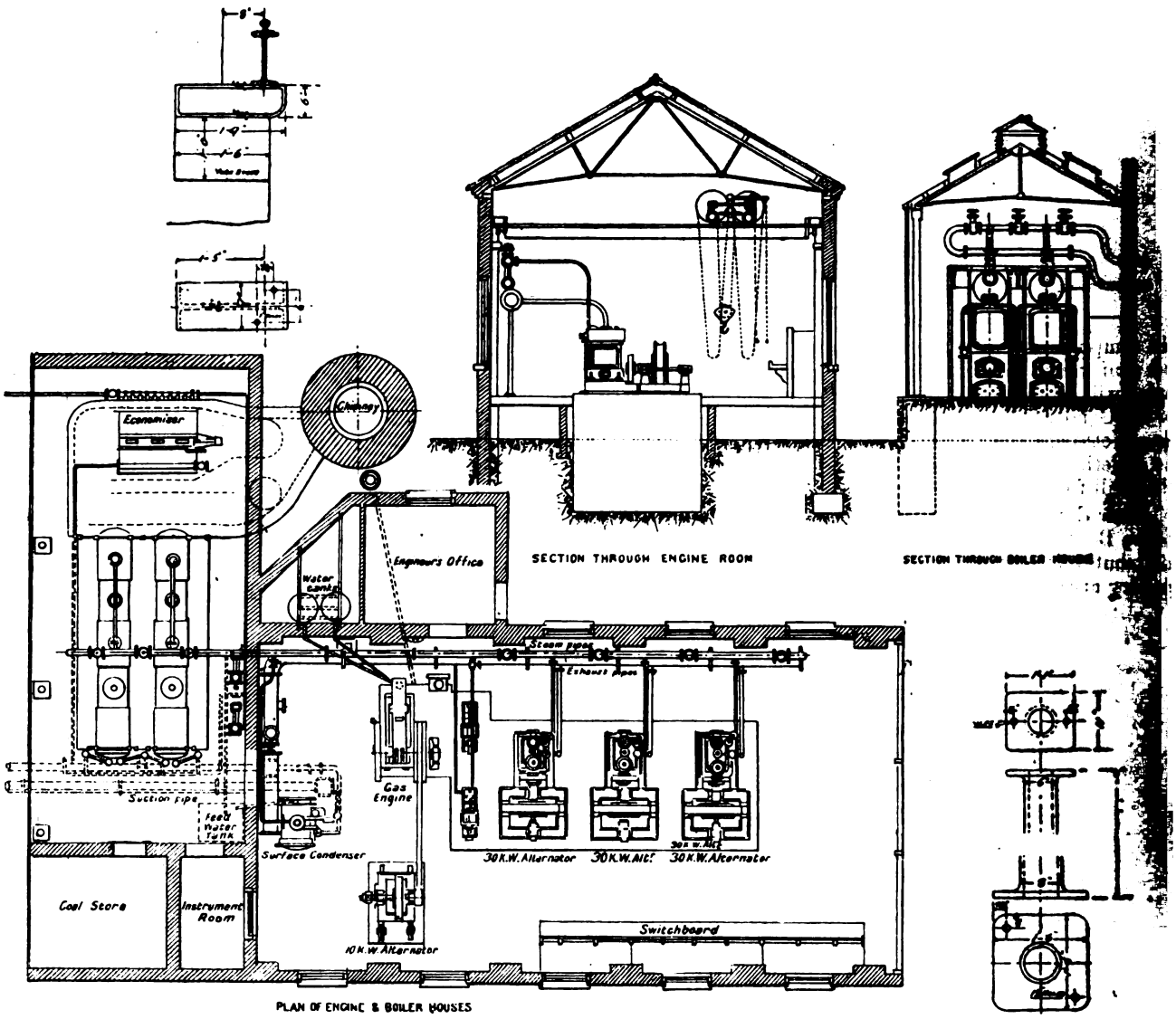
which is capable of evaporating 2,500lb. of water per hour, at a pressure of 130lb., with the feed water at 60deg. F. There is nothing new to say of these boilers, which are provided with a double feed service and with Hopkinson's fittings throughout. The feed pumps, of which there are two, are of the Worthington duplex type, each capable of delivering 1,500 gallons of water per hour, and made by the Worthington Pumping Engine Company, of Queen Victoria-street, London, E.C. A Green's economiser is arranged in the main flue, and a galvanised iron feed-water tank is sunk in the floor of the boiler-house, as shown.

The escaping gases from the boilers are utilised to heat the feed water by being passed through the economiser, which was supplied by Messrs. E. Green and Son, Limited, of Manchester and Wakefield. It consists of 96 tubes edge of the Ouse. From this tank a pipe is carried to each pump, either of which can be made to feed direct into the boilers, or force the water round the economiser tubes and thence into the boilers at a much higher temperature.

The steam main, which has been constructed on the ring system, is of steel, 6in. in diameter, with the flanges and branches welded on solid, and is carried through the boiler-house wall into the engine-room. The branch pipes connecting each boiler to the steam main, and the branches from the latter to each engine, are of copper, as are also the bends. The main pipe for the exhaust steam is of cast iron, 14in. in diameter. The exhaust steam from the engines is either taken to the surface condenser, or is allowed to pass into the atmosphere through a vertical pipe 22ft. in height.



Bedford Electric Light Station.—Plan showing General Arrangement of the Plant and Sections through Engine and Boiler Houses.

arranged on the most modern principle, and constructed from strengthened patterns, and is provided with internal lids for the top boxes, whilst the bottom branch pipes are fitted with access caps, thus enabling the tubes and bottom boxes to be readily cleaned internally. The motive power for driving the scraper gearing is afforded by a small high-pressure steam-engine bracketed to the end of the gearing frame, the scrapers thus traversing the pipes continuously from end to end, and preserving a clean heating surface. The sections of pipes were tested to a pressure of 350lb. per square inch, and in the aggregate the economiser contains 960ft. of heating surface.

It may not be uninteresting if we follow the working of the plant in the boiler-house. The feed-water tank is supplied with water both from the town mains and with the hot water coming from the condenser, to which reference will be subsequently made. By means of a valve the circulating water from the condenser can either be passed into the feed tank or into the discharge-pipe laid down to the

The Engines.

It will be seen from the general plan that the engine-room contains three main steam-engines, which are coupled direct to the alternators. These engines, which, together with the exciter engines and condensing plant, were made by Messrs. G. E. Belliss and Co., Limited, of Ledsam-street Works, Birmingham, are double-acting high-speed compound single eccentric engines of the company's E.C./5 standard pattern, running at a speed of 360 revolutions a minute. The high and low pressure cylinders of each engine are 8in. and 14in. in diameter respectively, the length of the piston stroke being 6in. The working parts of the engines, which are enclosed for the purpose of effective lubrication, are readily accessible through a door at the back of the casing.

A noteworthy feature in connection with these engines is the valve arrangement and the method of lubrication. Both the high and low pressure slide valves are placed in the same valve chest and are worked by the same eccentric.

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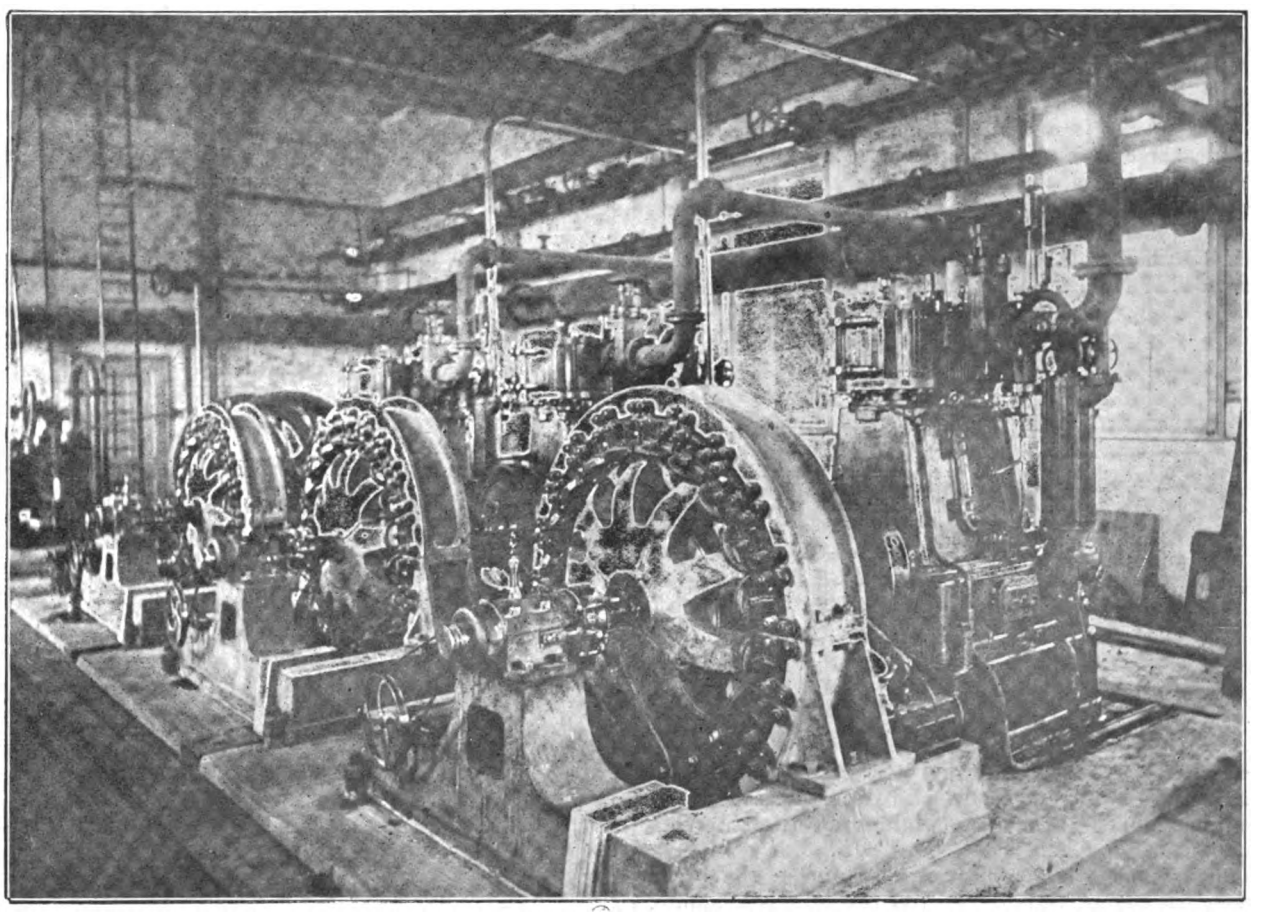
The cranks are set opposite to each other, and steam is admitted simultaneously to the top end of one cylinder and to the bottom of the other. As the reciprocating parts are thus balanced, a high speed is rendered possible without setting up undue vibration. This is specially noticeable at Bedford, where more vibration seems to be caused by the gas-engine than by the whole of the steam-engines. As far as the method of lubrication is concerned, the oil is applied to all the engine bearings under pressure from a system of pipes in connection with a tank which is placed at a level of about 20ft. above the engine-house floor. The oil escaping from the bearings drains into the lower part of the crank-chamber and thence into a sump placed below the level of the engine-room floor, whence it is pumped by a small duplex pumping engine back to the tank. Thus the oil is being constantly circulated, and is kept clear of dirt by special filtering arrangements arranged in the high-level tank.

station work. The circulating water is drawn from a well built in the Ouse, which adjoins the generating station, and is twice passed through the condenser tubes. There is a lift of 12ft. from the river level to the condenser base, and the water has to be forced through an additional height of 4ft. in the condenser.

A line of cast-iron suction and discharge pipes has been laid from the condenser to the river—a distance of about 260ft. These pipes have an internal diameter of 8in. The end of the suction pipe which dips into the well is fitted with a perforated suction box. The boiler blow-off pipes and all drains from the steam-traps, etc., in the engine-room are connected to the main discharge-pipe. A cast-iron pipe for the drainage of the economiser is also carried down to the river.

The water drawn from the well by the circulating-pump is passed twice through the tubes—the steam playing outside them. The condensed steam is then either allowed



Bedford Electric Light Station.—Internal View showing Line of Alternators and Engines.

In addition to the three main engines, there are two engines for driving the exciting dynamos. These are also of the enclosed double-acting type, but differ from the others in so far that they have single cylinders 4½in. diameter by 3in. stroke, and run at a speed of 650 revolutions per minute.

The Condensing Plant.

As shown on the general plan, the main exhaust-pipe delivers into a surface condenser, of which drawings are annexed. The condensing plant, which has been supplied by Messrs. Belliss and Co., comprises an independent surface condenser with air and circulating pumps fitted to it. The condenser has tube plates of rolled brass and brass tubes, which are secured to the former by means of screwed glands and tape packings. It has a total cooling surface of 400 square feet, is capable of condensing 4,000lb. of steam per hour, and will maintain a vacuum of 14lb. per square inch in the exhaust-pipes. The air and circulating pumps are both double acting, and are driven direct from the steam-cylinders by a prolongation of the piston rods. The arrangement is simple and compact, and presents many features of advantage for central-

to pass down the discharge-pipe, or, as already mentioned, it is caused to enter, by means of a valve, the hot-well or feed-water tank in the boiler-house. The condensed steam is not used for boiler feed purposes on account of the admixture of oil gathered in the engines.

The Alternators and Exciters.

In coming to consider the alternators, we have to record the interesting fact of the adoption of the new type of machine designed by Mr. Gisbert Kapp, and introduced by Messrs. Johnson and Phillips a few months ago. These alternators have revolving fields and stationary armatures. A plan, elevation, and end view of one of the alternators coupled direct to its corresponding engine are annexed. One of the principal features of this type of machine is the fact that the winding of the field magnets consists of a single coil; the magnets, which are of cast steel, are claw-shaped, and the faces of the pole-pieces are arranged parallel with the shaft. As will be seen from the internal view of the station, the exciting coil is placed on the shaft between the magnets. The coils of the armature are wound over cores formed of charcoal iron stampings, each coil being separately wound, and all the coils are connected in

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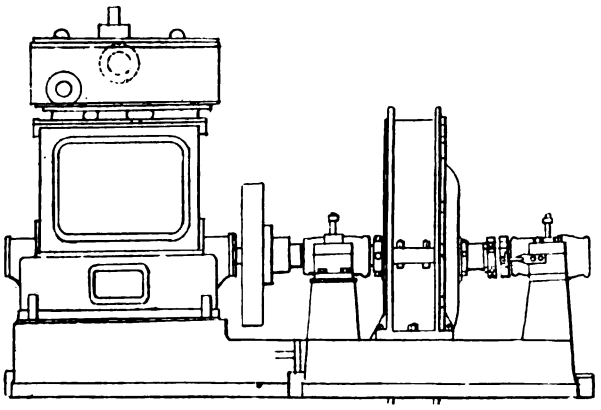
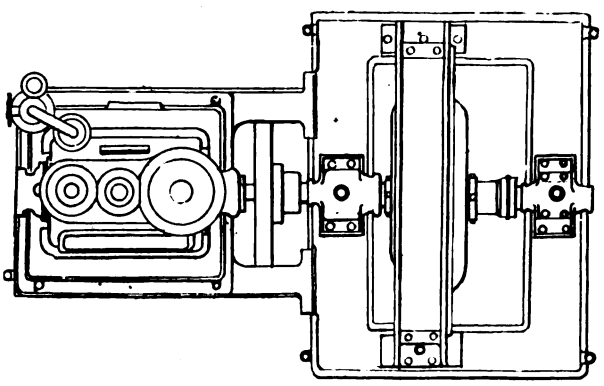
series when put into position. It is possible to remove, if necessary, any armature coil that may have become defective, and substitute another in a few minutes. One of the main advantages of this type of alternator is the fact that it can be short-circuited without any fear of being damaged.



Bedford Electric Light Station.—Elevation of Direct-Coupled Belliss Engine and Kapp Alternator.

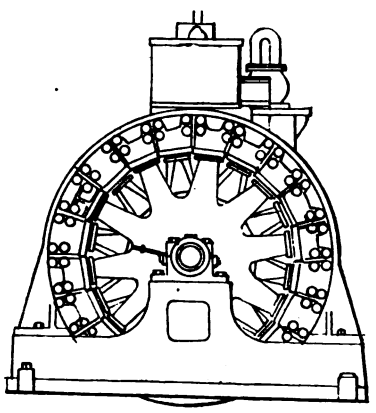
As will be seen from the plan, there are four alternators. Of these, three have each a capacity of 30 kilowatts, the current being 15 amperes at 2,100 volts. These machines are provided with an automatic system of sight-feed lubrication for the bearings. For this purpose a small pump, driven by a belt from an extension of the armature shaft, is provided. The method is entirely automatic, and works well.



Bedford Electric Light Station.—Plan of Belliss Engine and Kapp Alternator.

The exciters for the three large alternators are of Messrs. Johnson and Phillips's type, driven by separate engines, as already mentioned. They are two in number, each giving 66 amperes at 60 volts.

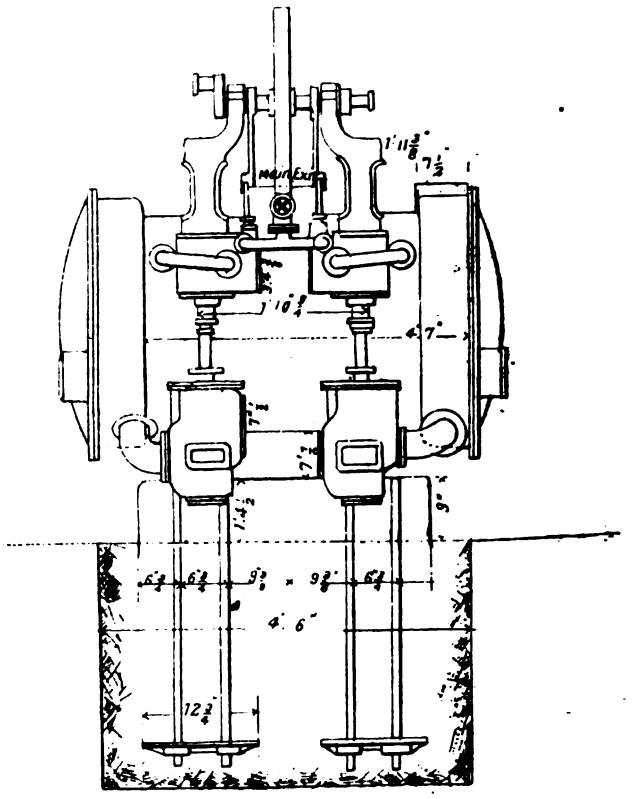
With a view to economical working during the day, a Crossley gas-engine, running at 180 revolutions a minute, has been erected for driving the fourth alternator. The engine is of 20 b.h.p., and is fitted with a double flywheel.



Bedford Electric Light Station.—End Elevation of Kapp Alternator and Belliss Engine.

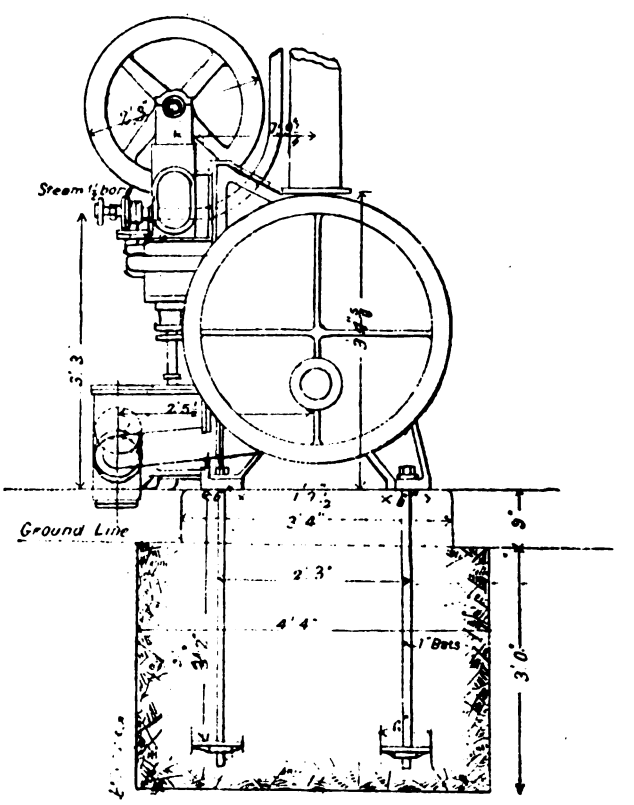
One of the flywheels is grooved to take five cotton ropes, and is provided with an outside bearing and pedestal, so as to prevent any undue strain on the journal. An automatic starting device is employed to set the engine to work. This engine actuates, by means of the five ropes, a 10-kilowatt Kapp alternator of the same type as those previously referred to. The small exciter for this machine is coupled direct to a prolongation of the armature shaft.

The engine-room is equipped with an overhead traveller made by Messrs. Grafton and Co., of Bedford. It has a



Bedford Electric Light Station.—Elevation of Condensing Plant.

capacity of six tons and a span of 29ft. The crab has two main side frames and two cross transomes, and between the cheeks is contained the whole of



Bedford Electric Light Station.—End View of Condensing Plant.

the gearing. This comprises single, double, and treble purchase—the treble purchase being obtained by means of snatch block and return chain. There are four ratchets and an automatic self-sustaining brake, by means of which the load can be held or lowered with ease and safety. The

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cross traversing motion is also actuated by means of hand hauling chains from below, and it gears direct by means of spur gearing on to one of the axles of the crab.

The Switchboard Arrangements.

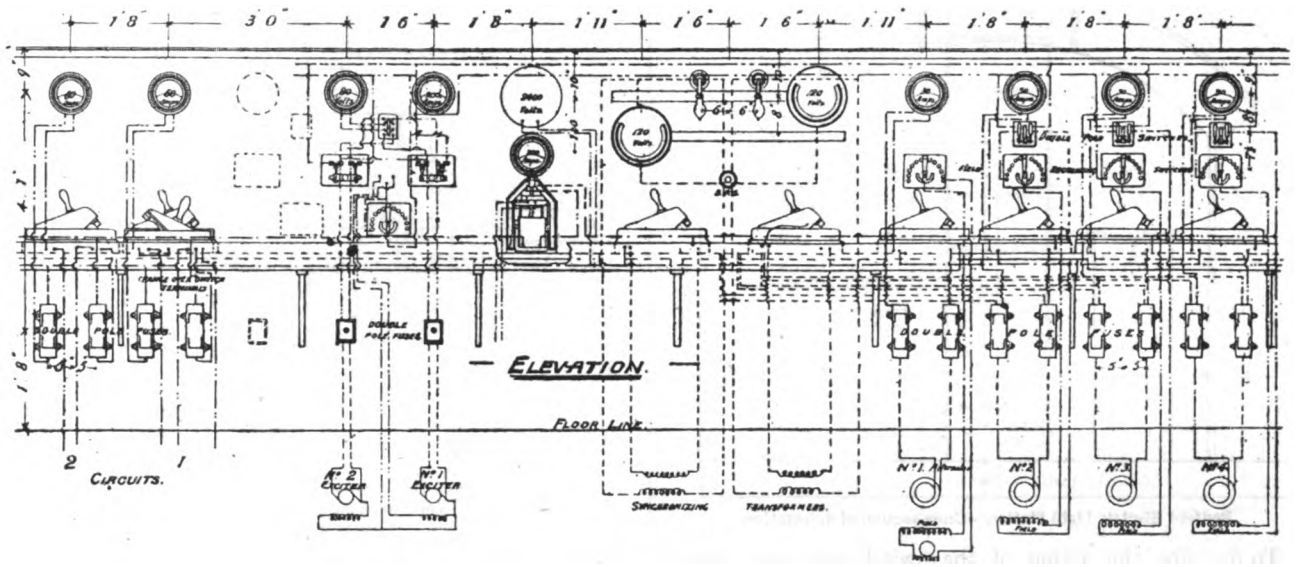
In describing the switchboard, of which a plan and elevation are subjoined, it may be as well to deal with it stage by stage, leaving the gas-engine alternator for the moment out of consideration. Briefly, each alternator is provided on the board with an ammeter, main switch, exciter switch and rheostat, and double-pole fuse; and each exciter with a double-pole switch and a common ammeter and voltmeter and rheostat.

Let us first deal with one alternator, say No. 4. The two leads from this machine are conveyed under the floor of the engine and dynamo room to separate fuses. Both leads are then taken through the main switch; next one is connected to the omnibus bar through the ammeter, whilst the other lead is directly connected to the second omnibus bar. An electrostatic voltmeter and a Mengarini watt-meter are arranged in the circuit. A lead is also taken from each main fuse to the terminals on the synchronising board, where by means of a plug and a switch the alternator is connected to the synchroniser, the primary leads being connected to the primaries of the transformers.

The synchroniser consists of two transformers with an incandescent lamp and a Cardew voltmeter in the secondary circuit of each, and having a double-pole switch to connect the secondaries. The same arrangement is followed in the case of the other two alternators.

The leads from the two exciters are taken to the board through fuses and switches, a third wire being provided for the exciter field. The current then passes through a voltmeter and ammeter on to omnibus bars, from which it is taken to the double-pole field switches and rheostats on the alternator part of the board, where the excitation of the alternator fields is regulated by the latter.

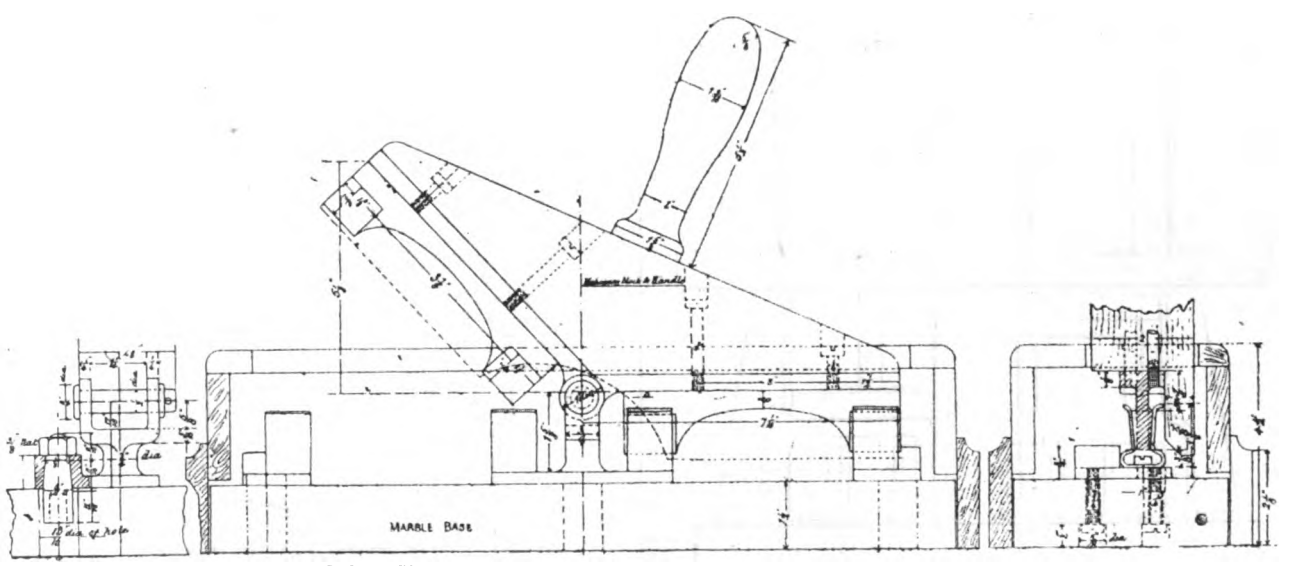
The current from the alternator omnibus bars is led through fuses to two change-over switches, where the feeder circuits, in each of which an ammeter is placed, are arranged, as shown, on the left-hand side of the board.



Bedford Electric Light Station.—Elevation of Switchboard, showing the Connections.

The object of these switches, which have been designed by Mr. Medhurst and Mr. Hope-Johnstone, is to automatically change over at the sub-station from the five-unit transformer to the 30-unit converter, and *vice versâ*. A view of the switch is given.

It will be seen from the illustration, which shows the arrangement of the automatic change-over switch at the sub-station, that mercury-cups are fixed on a slate base, and bridging contact pieces are provided on insulating slabs of ebonite. There are three bridging-pieces connecting three pairs of mercury-cups, and three bridging-pieces which connect three other pairs of mercury-cups. Above the mercury-cups two solenoids are fixed, and their iron cores are attached to the ebonite slabs by brass connecting-pieces. The top ends of the covers are each attached to a rocking pulley by means of a short piece of flat link chain. The pulley carries the contact springs of two small switches, one in the circuit of each solenoid winding. Stops are provided to arrest the pulley when the contact-pieces have been lifted out of the mercury-cups by the action of either solenoid. A segment-shaped piece of metal is arranged which moves freely on the spindle of the pulley, and when in the position shown



Bedford Electric Light Station.—Changing-over Switch at Generating Station.

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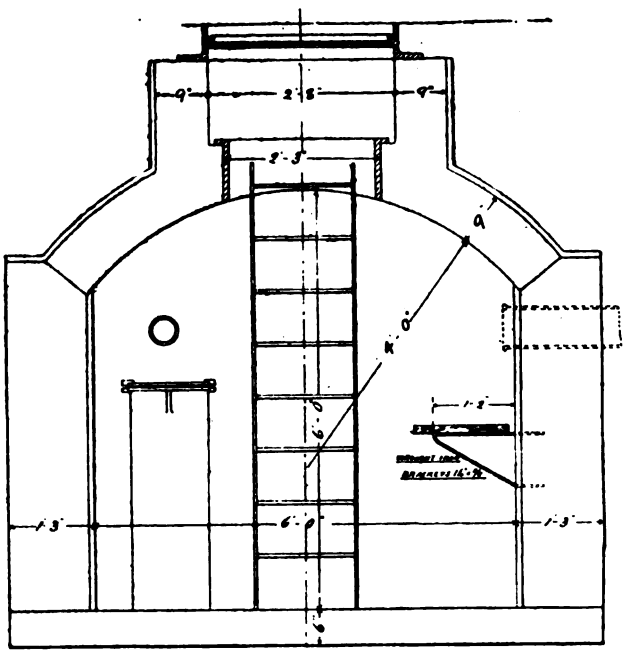
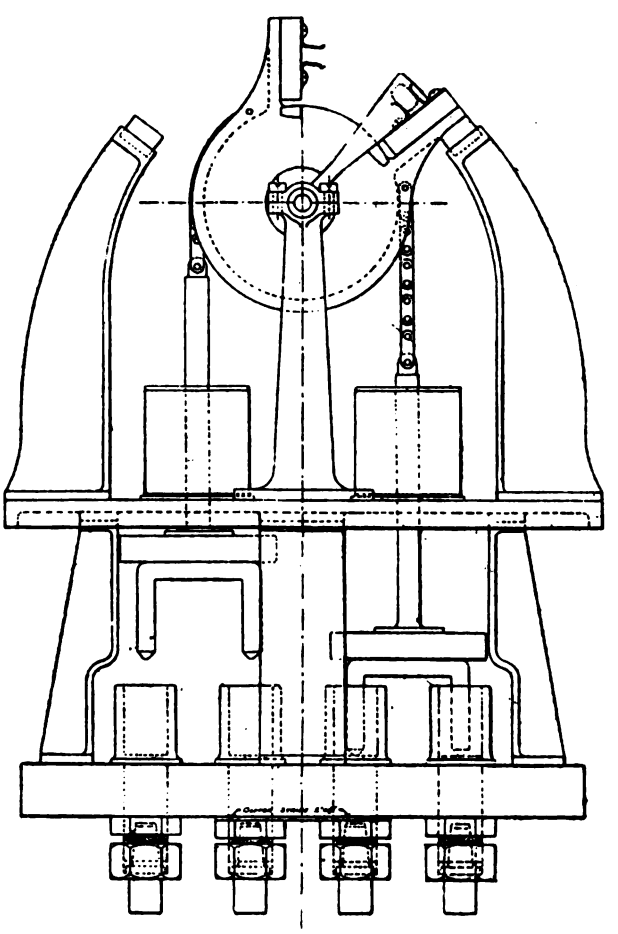
makes contact with the springs on the left, and thus completes the circuit of the solenoid to the left. Supports are provided to also form guides to keep the bridging contact-pieces in their proper position.



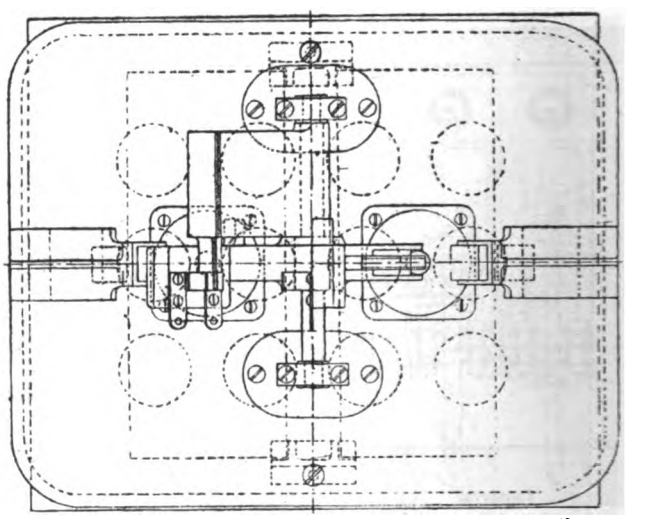
Bedford Electric Light Station.—Cross-section of Sub-station.

To describe the action of the switch, we will assume that the three mercury-cups to the left are connected to the three secondary terminals of the large transformer, and that the three cups to the right are connected to the three secondary terminals of the small transformer. The three



Bedford Electric Light Station.—Elevation of Automatic Change-over Switch at Sub-station.

cups second from the left and the three cups next to them will be connected to the three-wire secondary mains; the left-hand solenoid winding is connected as a shunt across the 100-volt terminals of the large transformer, and the right-hand solenoid winding is connected as a shunt across the 100-volt terminals of the small transformer. Then, in the position in which the switch is shown, the small transformer is connected to the secondary distributing mains, and the moving segment has completed the circuit of the left solenoid. There is, however, no current in this solenoid, because the large transformer is disconnected from the main omnibus bar in the central station. Directly the attendant in the generating station moves the changing switch, thus taking the load off the



Bedford Electric Light Station.—Plan of Connections of Automatic Change-over Switch.

small transformer and putting it on the large transformer, then the left solenoid is excited and attracts its core, thus

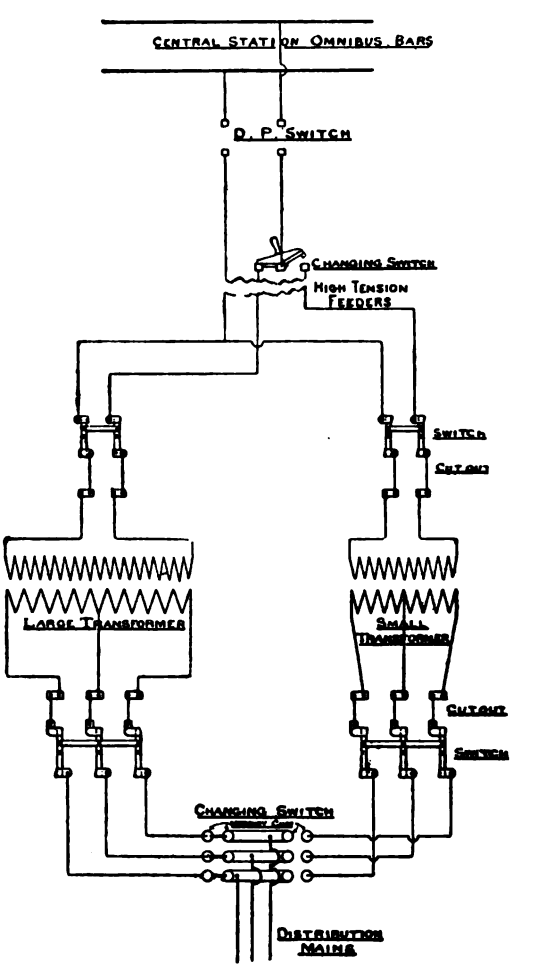


DIAGRAM OF CONNECTIONS TO TRANSFORMERS

Bedford Electric Light Station.

lowering the bridging-pieces into the two left-hand mercury-cups, and at the same time lifting the bridging-pieces out of those on the right. This breaks the circuit of the small transformer and connects the large transformer to the distributing mains. The pulley will now be arrested by a

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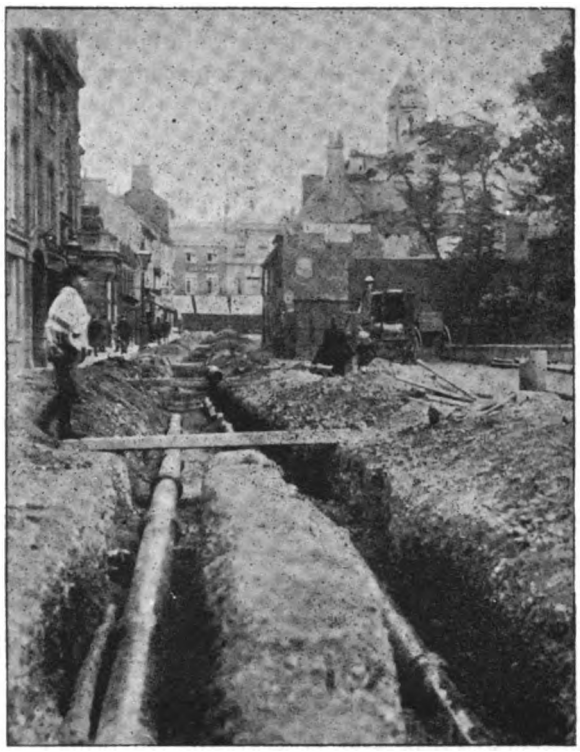
stop, and the segment will be carried over by its impetus and make contact with the springs on the right, so that the circuit of the left solenoid is broken immediately it has done its work, and the circuit of that on the right is completed ready to operate the switch when it is required. From the above description it is obvious that the solenoids are only momentarily excited, so that the watts wasted in actuating the apparatus are absolutely negligible.

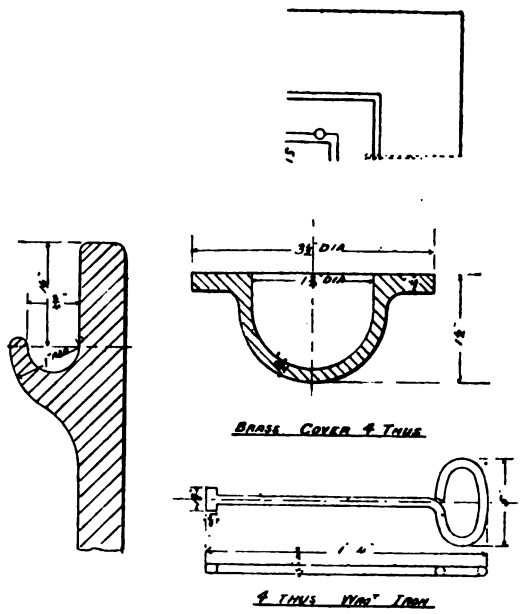


Bedford Electric Light Station.—Laying the Pipes and Cables.

The Distributing System.

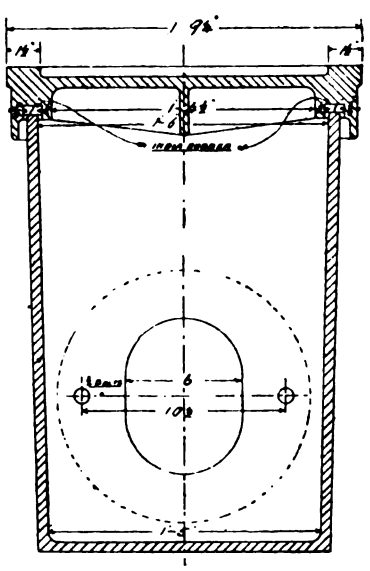
As will be observed from the map showing the line of mains, the distribution is effected from two transformer sub-stations, with a three-wire low-pressure network. The sub-stations are built underground, one being at the Bunyan Statue, and the other at St. Paul's-square, as shown. The former contains a 30-unit Parsons transformer, and the latter one of 30 units and one of five units for dealing with light loads. The high-pressure feeders are $^{19}/_{17}$ single cables for the large transformers, and one $^{7}/_{18}$ cable for the five-unit, one of the $^{19}/_{17}$ cables being used as a common return. The large transformers are fed by separate feeders, and are about 1,200 yards distant from the generating station. The transformation is from 2,000 to 210 volts.

The cables are all rubber insulated, and are drawn into lead-jointed cast-iron spigot and socket pipes, the high-pressure mains being drawn into 6in. pipes where they all run together, and into 4in. pipes where they diverge to their respective sub-stations. The three-wire low-pressure system consists of three single cables, at present all $^{19}/_{12}$'s, which are drawn into 6in. pipes in the principal streets, thus permitting additional cables to be drawn in to supplement the two outside conductors, and in the side streets the cables are drawn into 4in. pipes. Cast-iron drawing-in boxes are laid about every 50 yards for the high-pressure pipes, and about every 25 yards for the low-pressure, the latter being also used for service connections. The service pipes are of 2in. wrought iron, screwed into the sides of the boxes.

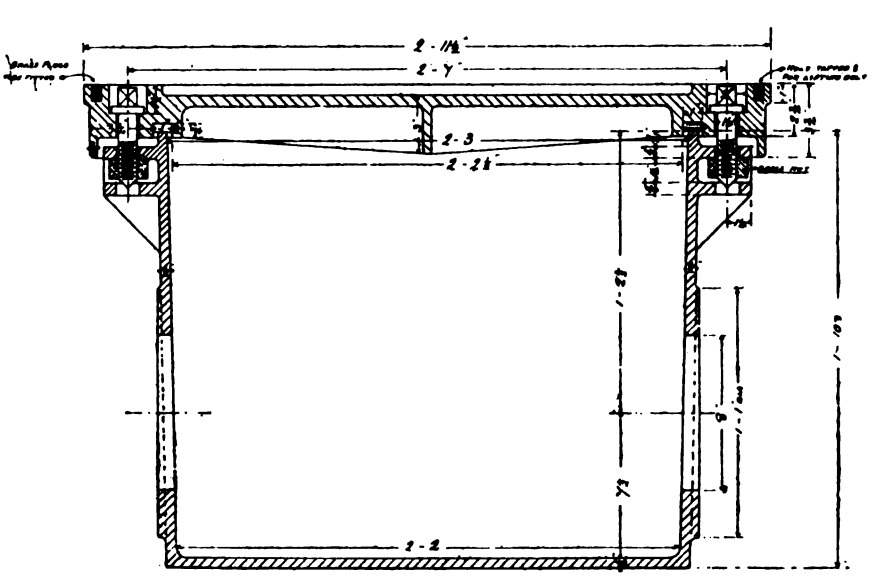


Bedford Electric Light Station.—Details of Drawing-in Box.

The pipes and boxes are constructed and laid with the object of having them not only watertight, but also air-tight, by means of lead joints in the pipes and rubber joints between the pipes and boxes and between the boxes and lids, the latter being well tightened down with bolts. This arrangement is detailed in the illustrations. It is proposed to instal a suction air-pump at the generating station, and to connect it with the network of pipes. This is a feature much to be commended, and there is no doubt that this arrangement will overcome the difficulty of explosions of gas and air.



Bedford Electric Light Station.—Cross-Section of Drawing-in Box.



Bedford Electric Light Station.—Longitudinal Section of Drawing-in Box

(Continued on page 636.)

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Vol. XIII. of new series of "THE ELECTRICAL ENGINEER" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

ELECTRIC COOKING.

What is the value of a pioneer to any industry? We doubt few, if any, of those who come into any industry after the pioneer work is done realise the money value to them of the work of the pioneers. A demand for something is created, and the demand is supplied through a long series of years, not always by those who created the demand, but often by those who had no part in the troublous times, and who reap the reward without deigning to thank those who did the work. The history of electric heating and electric cooking ought to place in the forefront of those who have educated the public, and shown the industry what can be done in this direction, the names of Mr. Dowsing and the firm of Crompton and Co. It is to them, if this branch of the industry succeeds, that success is due. The history of the development in England is, briefly, that the Carpenter system of heating made its appearance here about the time of the Crystal Palace Exhibition. At first it was in the hands of the General Electric Company—at least, it was first exhibited at their stand—then Messrs. Crompton devoted a room to it, and Mr. Dowsing lectured to the visitors. Subsequently Messrs. Crompton took the matter up in a still better business manner, opened a branch establishment under the management of Mr. Dowsing, since when, through evil and through good repute, that gentleman has been persistently and consistently advocating the claims of electricity as a heating servant. Mr. Crompton is down to give a paper at the Society of Arts on the subject. We are inclined to the opinion that an extension of business in the direction of electric heating and cooking utensils means reform in other directions. At first sight it would seem improbable that any connection could exist between such cooking apparatus and architectural designs, but we think a little explanation will show that such connection will, if it does not, exist. Before, however, calling attention to this phase of the subject, we may touch on another. Why should electricity be used for heating purposes as different from cooking purposes? The open grate is a privilege that Englishmen will not readily give up, but it is the open grate, whatever be its advantages, that causes most of the dirt about a room. The dirt and smoke from coal are a nuisance, carpets and furniture cannot easily be kept clean, and because of this there is a daily expenditure of money, an expenditure which must as certainly be reckoned as part of the cost of heating our houses as is the cost of the coal itself. Unfortunately, these indirect expenses are seldom calculated. Few ever think that a new carpet has to be provided a year sooner because of open fires. The smoke troubles we will not discuss. They are only felt to be real sometimes to a Londoner, perhaps, when he revels in a London fog. The indirect cost of burning coal in an open grate is very large, and those who suggest the introduction of any other form of heating rooms should not forget it. It is to this that the architect must pay attention, and, it may be, must in the near future make his designs to include, not heating by

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means of open grates, but by electrical means. In a vast number of cases heating cannot be treated separately from cooking, hence the combined value for these purposes must be insisted upon. First and foremost, then, comes the question of cleanliness. This has been touched upon above, but cleanliness for cooking purposes is an all-important property, and should be one to commend itself to users of any apparatus. Gas-stoves have been brought to great perfection, and are admirable adjuncts to the kitchen, but gas cannot compare with electricity for cleanliness. Another property of electricity that should appeal to the cook in favour of electricity is the ease and certainty with which the temperature can be regulated. No other form of heating lends itself so well to such regulation. The necessity of a constant temperature is well known to cooks, and hitherto their only method of even approximately getting what they want has been to produce too great heat and then dissipate a portion of it as well as they could. That means a great waste and an increased expenditure. With electricity everything could be regulated to the utmost nicety. Enough has been said, however, to show that this particular phase of the industry will not be allowed to go back for want of convincing arguments. On the contrary, everything seems to favour its more rapid development as central stations become commoner and current is more easily obtained.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ELECTRIC COOKING OF INSTITUTION DINNER.

SIR,—It may interest your readers to know that we supplied seven large electric ovens, four hot-plates, and other electrical apparatus for cooking the above dinner. We had some difficulty at first in convincing the *chef* that cooking could actually be carried out by electricity, and he was so incredulous that he demanded a trial beforehand. Of course, he was soon convinced of the practicability of the matter, and in the end he cooked 16 saddles of mutton, 30 brace of game, and numerous small dishes. Several other dinners served at the same place were also partly cooked by electricity, for the result was so good that the *chef* did all he could that evening by the aid of our apparatus. As a proof that the apparatus gave him perfect satisfaction, the *chef* has written us as follows: "I beg to inform you that as a practical cook of many years' standing, I felt rather doubtful of cooking being done by electricity; but after having used your roasting stoves and other apparatus, I am not only convinced but astonished to see how well joints can be roasted, and in a shorter time than by gas or in front of a range."

We give the above so that members who were unable to see the actual cooking operations carried out may know how the food was prepared, and with what successful results.—Yours, etc., CROMPTON AND CO., LIMITED.

London, S.W., November 27, 1894.

THE DEVIL AND THE DOG.

SIR,—The yellow dog is barking up the wrong tree. It doesn't know the difference between "coal bill" and "coal pile"; and when the wicked printer man goes and confuses them of malice aforethought, the poor bilious-looking jaundiced animal also gets muddled and can't tell "tother from which." Therein he is less clever than the learned pig, who *did* know his letters—but that is another tail, and a curly one. Seriously, however, Mr. Editor, you should feel highly flattered when out of the many pages of letterpress which yourself and contributors send out every week to an admiring crowd of genuine subscribers, an envious and jealous critic is only able to detect a few misprints, dropped letters, and other small villainies—perhaps even a piece of bad grammar, but whisper it low! *If* he were able to find out mistakes of theory and fact, or instances of wilful attempts to mislead the *sometimes* uninformed town councillor, then we should all have to hide our diminished heads, and, like Brer Fox, "lay low and say nuffin"; but things being as they are, don't you know, why all I can say, "Aren't we jolly clever?" Oh! by the way, have you seen that little extract from the just published issue of a monthly technical journal? This is what the editor says: "We have no particular desire to see the technical Press in general undertake the systematic criticism of its competitors. An effort in this direction made by one of the electrical papers, if it serves no other purpose, is useful perhaps as a warning of what might be expected should the average journal assume the office of critic." I couldn't beat that if I tried: so no more from—Yours, etc., P. D.

[The above is from a gentleman who is not unknown as a writer upon electrical subjects, who has made himself an acknowledged position as a specialist on certain phases of electrical work, and hence we can hardly refuse to let him have his say. The so-called criticisms of our contemporary do not concern us. No one takes them as the utterances of independent authority, or as coming from a source which inspires respect. For education they are valueless, for power impotent, and useful only to show the utter inanition of the dregs of technical literature.—ED. *E. E.*]

THE ELECTRICITY WORKS AT BEDFORD.

(Concluded from page 633.)

The low-pressure mains between the two sub-stations are only connected together through suitable fuse-boxes, and as far as possible T-joints have been avoided in the low-pressure mains near the sub-stations by running separate cables from the terminal and fuse boards therein to the various main streets. The high-pressure cables have an insulation resistance of 5,000 megohms and the low-pressure 1,500 megohms per mile. Both high and low tension cables, and also the service wires, are double braided, and finally taped and compounded. All the transformers, switches, and earthing devices and terminal boards in the sub-stations are in separate iron watertight cases. The original contract was for about 2,400 yards of pipes, but this has been increased to 3,800 yards, and all completed within the original contract time.

The whole of the work outside the central station was entrusted to the Telegraph Manufacturing Company, Limited, of Helsby, near Warrington, who have with their own staff, under the superintendence of their engineer, Mr. A. Whalley, installed everything, laid the pipes and boxes, pulled in and jointed cables and services, and also fixed and connected the sub-station apparatus. Everything (excepting the transformers and cast ironwork, which they supplied) was manufactured by the Telegraph Manufacturing Company, including cables, jointing tools, and the necessary testing instruments.

Private and Public Lighting.

It will no doubt have been understood that the generating plant has a capacity of supplying 2,000 10-c.p. lamps simultaneously alight; but this is insufficient to meet the demand. This will be gathered when we mention the interesting fact that even at the present time, when the electricity works are on the point of being set in operation, there are 2,500 10-c.p. lamps already wired, whilst the work of wiring for 500 additional lamps is being proceeded with. This is a very satisfactory commencement, and in order to deal with the increased requirements it has been decided to instal another steam alternator of a capacity of 90 units, and a third 30-unit transformer.

The consumers, who are mostly tradespeople in the centre of the town, will be supplied with electrical energy at 6d. per unit. This compares favourably with the price of gas,

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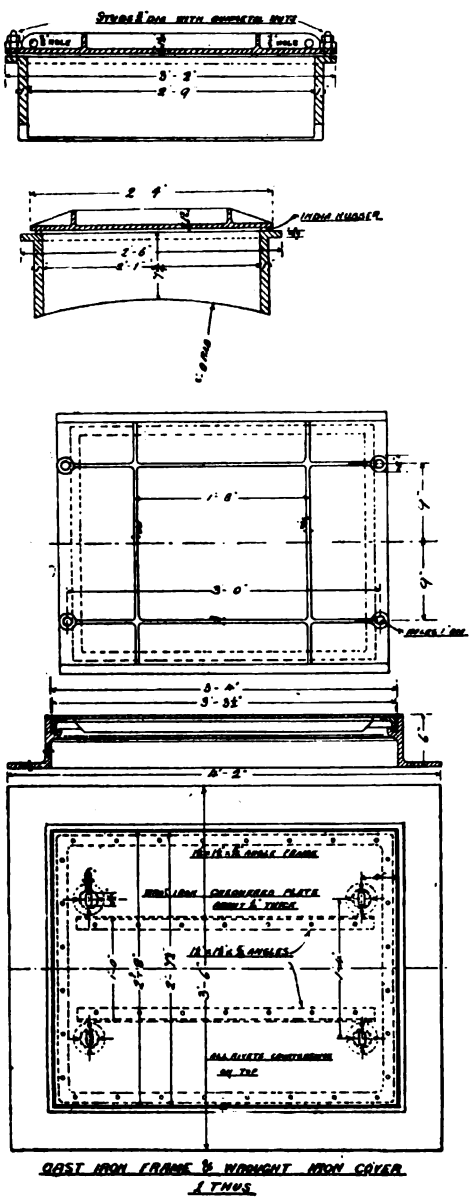
which is provided by a company at the rate of 3s. 3d. per thousand, and we should not be surprised to hear of further extensions of the electrical plant at no distant date.



Bedford Electric Light Station.—Details of Frame and Cover of Drawing-in Box.

So far the Corporation, with the exception of deciding upon street-lighting experiments with two incandescent lamps, have done nothing in the matter of public lighting. A few arc lamps judiciously erected in the principal thoroughfares would do much to improve the illumination of the main streets, and no doubt when the electricity works have been in operation for some time the Corporation will be induced to erect arc lamps, or, at any rate, incandescent lamps of high candle-power. As a matter of course, the substitution of electric for gas lamps would transfer a portion of the present outlay on public gas lighting to the revenue of the electricity works, a point which is worth the consideration of the Corporation.

Conclusion.

In bringing this description to a close, we must compliment the Corporation of Bedford upon having established municipal electricity works. Not only so, but our congratulations are due to Mr. Medhurst, the consulting engineer, for the able manner in which the works have been designed and brought to their present successful position. Our thanks are also due to Mr. W. J. Hope-Johnstone, the clerk of works for the plant (who will probably remain at Bedford as the electrical engineer in charge), for his kind assistance in the preparation of this article. Mr. C. Esson, has superintended the installing of the electrical plant on behalf of Messrs. Johnson and Phillips; Mr. H. G. Bone, the erection of the engines and condenser for Messrs. Belliss and Co.; and Mr. J. Hull, the construction of the buildings for Mr. T. Coleman, of Bedford. The undertaking has our best wishes for its success both electrically and commercially.

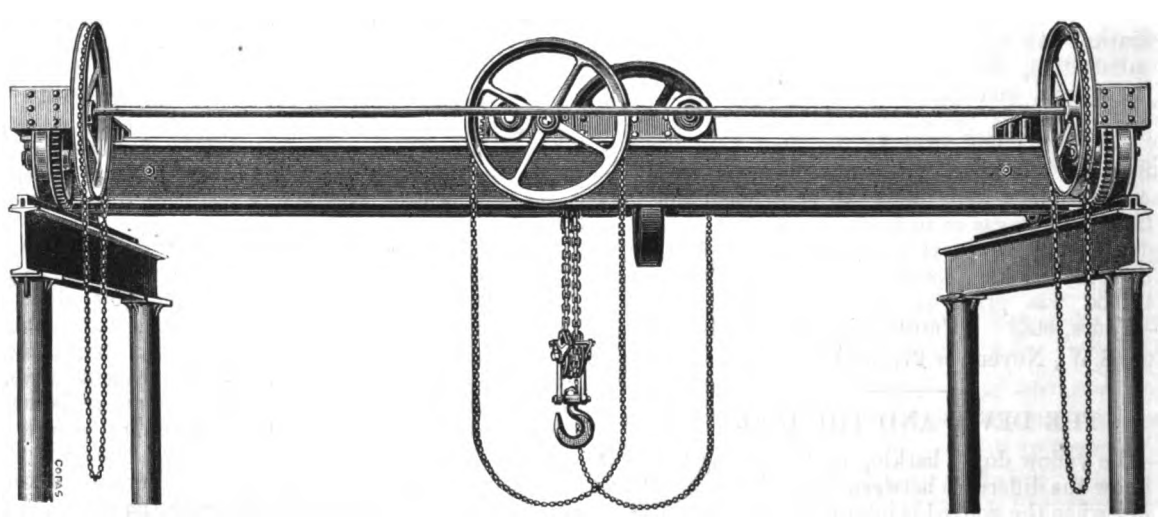
REGULATIONS OF SUPPLY OF CURRENT BY THE BEDFORD CORPORATION.

Conductors.—Each conductor used through an installation shall be of such a sectional area that the current in it shall not exceed 800 amperes per square inch. The section of the conductors shall also be so proportioned that the fall of pressure between the points of connection with the Corporation service wires and the lamps furthest therefrom shall not exceed two volts. Every conductor must be stranded.

Insulation.—The insulating covering of all fixed conductors shall consist of at least one coating of pure india-rubber, one coating of vulcanised indiarubber, braided and compounded to preserve the insulation from mechanical injury; and the above coatings shall be of such thickness that the insulation resistance shall not be less than 600 megohms per mile. This condition need not be adhered to in the case of flexible conductors joined up to the installation through a removable plug fuse, or ceiling rose, but the insulation of these flexible conductors should be of as good quality as possible.

Insulation Tests.—The Corporation reserve to themselves the right of refusing to connect up to their mains installations which have not the following minimum insulation resistances: for 25 lamps, two megohms; for 50 lamps, 1 megohm; for 100 lamps, ·5 megohm; for 150 lamps, ·4 megohm. The insulation will be measured with the lamps removed, but all fuses in place and switches turned on.

Protection for Conductors.—All conductors, where practicable, shall be closed in strong casings of well-seasoned



Bedford Electric Light Station.—Overhead Traveller.

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wood, the fillet dividing the two conductors being not less than ½in. in width in the smallest-sized casings used, and increased in proportion for larger casings. The lids to the casings shall be screwed down along the outside edges, and not to the central fillet, and in fixing the casings no nails or screws shall be driven through the central fillet. Wherever practicable the casings shall be run upon the surface. Where it is necessary to sink them into plaster walls, the casings must be covered with one coating of oil paint outside and a coating of shellac varnish inside.

Metal Tubes.—The conductors are not to be run in metal tubes. To pass conductors through walls porcelain tubes are recommended. Under no conditions whatever are staples to be used for the fastening down of conductors.

FITTINGS IN CONNECTION WITH INSTALLATIONS.

Switches.—The metal parts of all switches are to be mounted upon non-combustible bases, such as porcelain, the cover being of the same material preferably, or of metal. The switch is to be so designed as to have a "quick-make and quick-break" action, and the metal parts preferably so arranged that screwheads, etc., do not come through to the bottom of the base. Should they do do, the holes must be filled up with plaster of Paris well shellaced, or some equivalent material.

Fuses.—Fuses must be of good design, and similar in general construction to the switches before mentioned. A fuse should be placed on both the positive and negative wire for every branch circuit that is intended to carry more than five lights. All flexible connections must be fitted with a fuse.

Ceiling Roses.—Ceiling roses should be of the same general construction as switches and fuses, and must be fitted with a safety fuse.

Gas Fittings.—Gas fittings are not to be used for the support of incandescent lamps as well as gas.

Arrangement of Circuits.—The "trunk" system of wiring a building is not to be recommended. "The division board" system is always considered preferable, and may, at the Corporation engineer's option, be insisted on.

Apparatus.—Any apparatus not used for ordinary lighting purposes, such as motors, regulating switches, resistance or retarding coils, must be specially approved by the Corporation's engineer.

Connecting.—The Corporation only undertakes to connect up to the house so far as to bring their service wires into a position to be agreed upon. The consumer must run his conductors from the point of termination of the service wires, giving the Corporation facilities for introducing the meter in a position to be approved by the Corporation. The consumer must supply the two main secondary fuses to be inserted as near the Corporation's service mains as practicable, and also a double-pole switch of suitable construction next to the safety junctions.

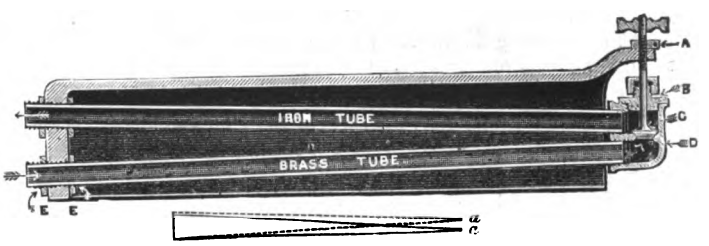
Testing.—The Corporation may refuse to connect up any house before the installation has been tested and inspected by them, and at any date after the house is connected up the Corporation may at once cut off the supply of electricity to it if the installation becomes defective and unsafe. When a consumer makes addition to the number of lights previously installed, the addition must be inspected and passed by the Corporation's engineer before it is connected to the older installation.

General.—The consumers must follow the rules of the fire insurance offices in which they are insured in addition to these rules.

Lamps.—The Corporation are prepared to supply lamps at the rate of 1s. 6d. per lamp (unfrosted) of 8, 10, 16, 25, or 32 candle-power, and at the rate of 2s. 6d. for lamps of 50 c.p., and 5s. for lamps of 100 c.p. This is done for the consumer's own benefit, inasmuch as the market is at present flooded with cheap and inefficient lamps using current very lavishly, and lasting but a very short time. The result is that in order to effect an apparent saving of 6d. per lamp in the first cost, the consumer has his electric light bill increased by from 2s. 6d. to 4s. per annum for every lamp installed. The Corporation will not give a supply of energy to any premises unless they are satisfied that the electric lines, lamps, fittings, and apparatus therein are in good order and condition.

GEIPEL'S STEAM-TRAP.

It has been found that for the high steam pressures now increasingly adopted steam-traps of the old types are not well adapted for this purpose, and the result is that trouble and loss of steam have arisen from their use. This fact was emphasised by Prof. Kennedy, who, in his presidential address to the Institution of Mechanical Engineers, stated that steam-traps required more looking after than all the rest of the machinery combined. This is due to the increased strain on the working parts and joints owing to the high pressure, and to the higher temperature of the steam. Steam-traps may be divided, broadly, into two classes—the one being operated by gravity, the other by expansion and contraction due to changes of temperature. In the former class the working parts are enclosed in a vessel generally made of cast iron, whilst in the latter class the parts need not be so enclosed. This distinction is obviously in favour of the expansion trap, for not only does the case involve the removal of a cover and the remaking of a joint each time the trap is inspected, but the continual oxidation of the levers and spindles, etc., used for opening and closing the valves causes rapid wear, and necessitates continual readjustment. The difficulty with the expansion trap has been due hitherto to the relative smallness of the motion set up in the linear expansion of the metal used, as well as in the positive nature of that motion. This has resulted in the cutting of the valve face and consequent leakage through the valve; for when the trap has been set for use with steam at a particular pressure, and the valve arranged to close with "live" steam at that pressure, it is apparent that should the pressure be increased inadvertently there is increased expansion, to which something must give way.



It is claimed for the steam-trap illustrated, which has been devised by Mr. W. Geipel, that it obviates both these defects. In the first place, the particular form in which the expansion parts are arranged—viz., that of an isosceles triangle—causes a considerable motion to be imparted to the apex for very small changes in the length of these parts; and, in the second place, there is a certain amount of elasticity in the pipes which there is not in the case of the direct thrust generally adopted in these traps. The method adopted by Mr. Geipel in practically applying this trap is shown in the illustration. The lower or brass pipe is connected to the steam-pipe, the upper iron pipe forming the discharge. These two pipes form the two sides of the isosceles triangle above mentioned, the valve seat being at the apex. The valve spindle is fixed to the frame of the trap. When cold the brass pipe is contracted, the apex is drawn down to the position marked *a* so that the valve is fully open, and the water is discharged. As soon as steam enters the brass pipe, the latter expands and raises the apex to the position marked *a*, when the valve is closed. In order that the valve may be set to blow off at any pressure desired, a screw adjustment is provided. In addition to this, when it is desired to blow through, the valve may be opened by hand, and, so that it shall not require resetting after blowing through, there is a lock-nut, A, on the spindle. The valve may be readily examined by unscrewing the top, B. This is a desideratum, as it is a common occurrence for the valves in all steam-traps to become choked with sediment, or to require attention otherwise. The form of the trap is compact, and therefore is very suitable for fixing on the bed-plates of engines. It is also claimed for the trap that it is specially suitable for marine engines, where its use should involve a considerable saving of labour and attention, as well as effecting economy in steam by opening and closing the drain-valves at the proper time. The makers of this steam-trap are the Shillingford Works Company, of 12, London-street, E.C., who state that they have already supplied a number of these traps in different works.

New Publication.—A new fortnightly paper has been issued in Berlin under the title of the *Zeitschrift für Beleuchtungswesen*, which, as the name indicates, deals with questions of illumination. The editor is Dr. H. Lux, whose name is certainly appropriate.

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PRACTICAL NOTES ON DYNAMO CALCULATION.*

BY ALFRED E. WIENER.

(Continued from page 393.)

The approximate thicknesses for the various kinds of belts are:

Single belts ..... $h_b = \frac{3}{16}$ in.
Light double belts ..... " $= \frac{9}{32}$ in.
Heavy double belts ..... " $= \frac{11}{32}$ in.
Three-ply belt ..... " $= \frac{7}{16}$ in.

Inserting these figures in (84), the width of the belt is obtained:

$$\text{Single belts} \ldots\ldots b_b = \frac{\cdot 2}{\frac{3}{16}} \times \frac{W}{S_b} = 1\cdot 1 \times \frac{W}{S_b} \quad . \quad (85)$$

$$\text{Light double belts} \ldots b_b = \frac{\cdot 2}{\frac{9}{32}} \times \frac{W}{S_b} = \cdot 7 \times \frac{W}{S_b} \quad . \quad (86)$$

$$\text{Heavy double belts} \ldots b_b = \frac{\cdot 2}{\frac{11}{32}} \times \frac{W}{S_b} = \cdot 6 \times \frac{W}{S_b} \quad . \quad (87)$$

$$\text{Three-ply belts} \ldots\ldots b_b = \frac{\cdot 2}{\frac{7}{16}} \times \frac{W}{S_b} = \cdot 45 \times \frac{W}{S_b} \quad . \quad (88)$$

Single belts are used for all smaller sizes up to 100 kilowatts output, light double belts up to 200 kilowatts, heavy doubles up to 400 kilowatts, and three-ply belts for capacities from 400 kilowatts up.

Based upon the above formulæ, the author has prepared the following Table XLVI., from which the belt dimensions for various outputs and for different belt speeds can readily be taken:

TABLE XLVI.—Sizes of Belts for Dynamos.

Capacity of dynamo in kilowatts.		Thickness of belt, inch.	Width of belt. Belt speed, in feet per minute — 2,000	2,500	3,000	3,500	4,000	4,500	5,000	5,500	6,000
			in.	in.	in.	in.	in.	in.	in.	in.	in.
1	Single belt	3-16	·6	·5	·4	—	—	—	—	—	—
2		3-16	1·1	·9	·7	—	—	—	—	—	—
3		3-16	1·7	1·3	1·1	1·0	·8	—	—	—	—
5		3-16	2·75	2·2	1·8	1·6	1·4	—	—	—	—
7·5		3-16	4·1	3·3	2·75	2·4	2·1	—	—	—	—
10		3-16	5·5	4·4	3·7	3·1	2·75	2·5	2·2	—	—
15		3-16	8·25	6·6	5·5	4·7	4·1	3·7	3·3	—	—
20		3-16	11·0	8·8	7·3	6·3	5·5	4·9	4·4	—	—
25		3-16	—	—	9·2	7·9	6·9	6·1	5·5	—	—
30		3-16	—	—	11·0	9·5	8·25	7·3	6·6	—	—
40		3-16	—	—	14·7	12·6	11·0	9·8	8·8	—	—
50		3-16	—	—	18·3	15·75	13·75	12·25	11·0	10	9·2
60		3-16	—	—	22·0	18·9	16·5	14·7	13·2	12	11·0
75		3-16	—	—	27·5	23·5	20·5	18·5	16·5	15	13·75
100		3-16	—	—	—	—	27·5	24·5	22	20	18·5
150	Double belt.	9-32	—	—	—	—	26·2	23·5	21	19	17·5
200		11-32	—	—	—	—	30·0	26·75	24	21·8	20
250		11-32	—	—	—	—	37·5	33·5	30	27·5	25
300		11-32	—	—	—	—	45·	40	36	32·75	30
400	3-ply	7-16	—	—	—	—	45	40	36	32·75	30
500		7-16	—	—	—	—	56·5	50	45	41	37

The width of the belt being thus determined, the breadth of the pulley rim is found by adding from ½in. to 2in., according to the width of the belt.

PART II.—CALCULATION OF MAGNETIC FLUX.

1.—USEFUL AND TOTAL MAGNETIC FLUX.

31. *Magnetic Field—Lines of Magnetic Force—Magnetic Flux, Field Intensity.*—The surrounding of a magnetic body, as far as the magnetic effects of the latter extend, is called its "magnetic field."

According to the modern theory of magnetism, magnetic attractions and repulsions are assumed to take place along certain lines, called "lines of magnetic force"; the magnetic field of a magnet, therefore, is the region traversed by the magnetic lines of force emanating from its poles.

The lines of magnetic force are assumed to pass out from the north pole and back again into the magnet at its south pole; their direction, therefore, indicates the polarity of the magnetic field.

The total number of lines of magnetic force in any magnetic field is termed its "magnetic flow," or "magnetic flux," and is measured in webers; a field of 1,000,000 webers, or one megaweber, for example, is one containing 1,000,000 lines of force.

The intensity of the magnetism at any point within the region of magnetic influence of a magnet, or the field intensity of a magnet, is expressed by the number of these magnetic lines of force per unit of field area at that point, measured perpendicularly to their direction.

The unit of field intensity is one line of magnetic force per square centimetre of field area, and has received the name of gauss.

A magnet pole of unit strength is that which exerts unit force upon a second unit pole, placed at unit distance from the former. The lines of force of a single pole, concentrated in one point, are straight lines emanating from this point to all directions—*i.e.*, radii of a sphere. The surface of a sphere of one centimetre radius is 4π square centimetres; a pole of unit strength, therefore, has a magnetic flux of 4π absolute or C.G.S. lines of magnetic force, or 4π webers.

The number of C.G.S. lines of force, or the number of webers expressing the strength of a certain magnetic field, must consequently be divided by 4π, or by 12·5664, in order to give that same field strength in absolute units of magnetism—*i.e.*, in unit poles.

A magnetic field of unit intensity also exists at the centre of curvature of an arc of a circle whose radius is one centimetre and whose length is one centimetre, when a current of one absolute electromagnetic unit of intensity, or of 10 practical electromagnetic units—that is, of 10 amperes—flows through this arc. Therefore, the unit of magnetic flux—*i.e.*, one C.G.S. line of force, or one weber—is equal to $\frac{10}{4\pi}$ practical electromagnetic units, or one practical electromagnetic unit $= \frac{4\pi}{10}$ webers.

32. *Useful Flux of Dynamo.*—The total number of lines of force cutting the armature conductors is called the "useful flux" of the dynamo.

According to the definition given in Chapter 1 we have:

$$\text{Volts} = \frac{\text{Number of C.G.S. lines cut per second}}{10^8} \quad . \quad (89)$$

Let now Φ = total number of useful lines, or useful flux, in webers;

K = number of conductors all around pole-facing circumference of armature;

$K = m \times n$, for ring armatures;

$K = 2 \times m \times n$, for drum armatures and for drum-wound ring armatures;

(where m = number of commutator divisions;

n = number of turns per commutator division;

$m \times n$ = total number of convolutions of armature, see Chapter 11).

N = speed in revolutions per minute; and

b = number of bifurcations of current in armature—*i.e.*, number of pairs of armature portions connected in parallel, see Chapters 26 and 27;

then

One conductor in one revolution cuts 2Φ lines of force, for the Φ lines emanating from all the north poles, after passing the armature core, return to the south poles, hence pass twice across the air-gaps, and, in consequence, are cut twice in each revolution by every armature conductor.

The armature makes $\frac{N}{60}$ revolutions in one second, hence

One conductor in one second cuts $2\Phi \times \frac{N}{60}$ lines.

Each one of the $2b$ parallel armature portions contain

* From the *Electrical World* (New York).

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$\frac{K}{2b}$ conductors connected in series; in each of these $2b$ armature circuits, therefore,

$\frac{K}{2b}$ conductors in one second cut $2\Phi \times \frac{N}{60} \times \frac{K}{2b}$ lines.

But, according to the law of the divided circuit, the E.M.F. generated in one of the parallel branches is the output voltage of the machine; the E.M.F. generated by any armature consequently, by virtue of (89), is

$$E = \frac{\Phi \times K \times N}{b \times 60 \times 10^8} \text{ volts} \quad . \quad . \quad . \quad . \quad (90)$$

and from this we obtain the number of useful lines required to produce an E.M.F. of E volts, thus:

$$\Phi = \frac{6 \times b \times E \times 10^9}{K \times N} \quad . \quad . \quad . \quad . \quad . \quad (91)$$

For dynamos with but one pair of parallel circuits in the armature—*i.e.*, for bipolar machines and for multipolar dynamos with series connections—we have $b = 1$ (see *b*, Chapter 26), and the useful flux for this special case is

$$\Phi = \frac{6 \times E \times 10^9}{K \times N} \quad . \quad . \quad . \quad . \quad . \quad (92)$$

This is the formula usually given in text-books for the useful flux of a dynamo.

(To be continued.)

CITY AND GUILDS OF LONDON INSTITUTE.

LECTURE XII.—GENERAL DESCRIPTIVE KNOWLEDGE OF MAGNETS AND ELECTROMAGNETS. — BEST METHOD OF WINDING ELECTROMAGNET COILS FOR VARIOUS SERVICES.

(Specially contributed.)

Direction of Current and Polarity of Core.—Our definition of a magnet said that, freely suspended, the magnet would take up a position such that its ends would point north and south. I mentioned that the magnetic north pole was not quite coincident with the geographical north pole. The former varies its position between certain limits, while the latter is constant. That end of a magnet which points to the north we, however, call the north-seeking pole of the magnet, or more frequently, because it is shorter, the north pole simply. The opposite end is similarly called the south seeking pole, or, more shortly, the south pole. In many cases, and especially with permanent magnets, the north-seeking pole is marked by means of a notch in the steel or is coloured red, and hence has been called the marked pole. The reason why some people prefer to call the north pointing or seeking pole the marked pole, is because the pole which points towards the north in a magnet is really the south pole of the magnet. However, we need not trouble about this for the present. It is enough if we all agree to call that pole which points towards the north the north pole, and stick to it. Now you may ask how to wind a core, and the proper direction for the current to go through the coils so as to obtain a north pole.

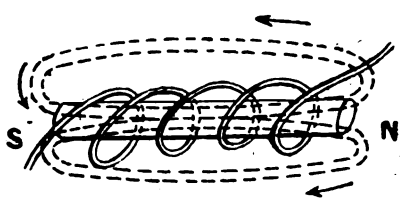

FIG. 1.

Suppose, then, I take a piece of iron, Fig. 1, and hold it so that I face one end. I also take a piece of insulated wire and commence to wind at the farther end. I wind, as you see, towards the right hand. If, now, still facing the end of the core, I send a current through the coil such that it goes from the coil at the top of the core *towards the left hand*—that is, in a direction *opposite* the direction of the hands of a watch—then I shall face a north pole. If, however, I face a pole the current around which is in the same direction as the hands of a watch, then I am facing a south pole.

The lines of force come from the magnet towards you when facing a north pole, and go away from you when facing a south pole. In other words, when the magnetic circuit is partly of iron or other magnetic material and partly of air, the lines of force are supposed to leave the metal at its north pole and enter at its south pole.

It is upon properties belonging to these lines of force that the industrial value of magnetism depends. It is of the utmost importance, then, that the lines of force should be in such positions as to allow the easy utilisation of the properties required. Unfortunately, lines of force are not always easily harnessed.

Density of Lines of Force.—I have explained that if I have a complete ring of soft iron, and generate lines of force by means of a current through the coil on this ring, almost the whole of the lines are within the iron ring. A few escape, but practically all are enclosed. If Fig. 2 represents

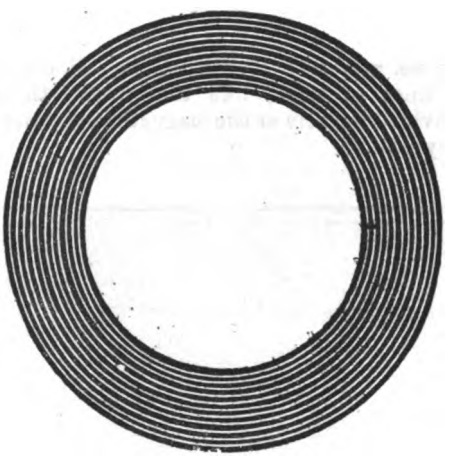

FIG. 2.

such a ring round which all the lines circulate, then the density of the lines is the same throughout the ring—that is, the same number of lines pass through any one section of the ring as pass through another. In this case it is very easy to get an expression for density. Thus let the section of the iron be circular, then the area of the section is

$$A = r^2 \pi.$$

where A = area of section, r = radius, and π = 3·1416, the ratio of the diameter to the circumference of a circle.

Further, let

d = density of lines per square inch;

N = total number of lines;

then $$d = \frac{N}{r^2 \pi};$$

or, density per square inch $= \frac{\text{total number}}{\text{area of section in sq. ins.}}$.

But now suppose the ring is not complete, but that the path of the lines or the magnetic circuit includes an air-gap or air-gaps, as Fig. 3. The lines, instead of going straight across through an air-space whose sectional area is the same as that of the iron, go through an air-space whose sectional area is greater than that of the iron, so that the density of lines per square inch over the greater area is less than in the case before discussed. If the coils acting, or rather the amperes, and the coils acting are as before, the total number of lines will be less if the air-space is an additional resistance to the iron. The number of lines will only be the same when the acting force and the magnetic resistance of the circuit are constant. If the air-gap is very very small compared with the sectional area of iron, the lines will go almost straight across; but if the length of air-gap is long, the lines bulge out largely. Fig. 4 shows

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the lines as indicated by iron filings across an air-gap. You see a large number go almost straight across, but also a large number bulge out and increase the sectional area of the field very considerably.

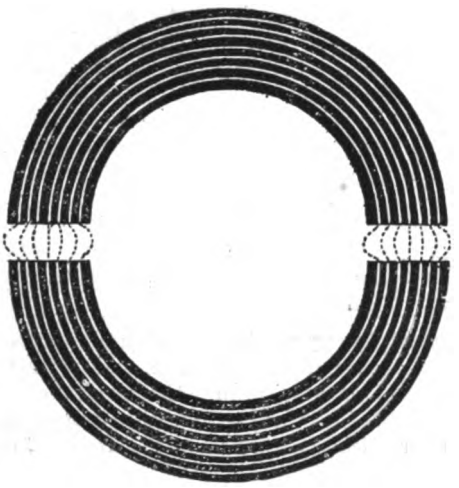

FIG. 3.

I think we may take it without fear of error that the magnetic lines of force, like the current through conductors, divide inversely as the magnetic resistances through which they pass.

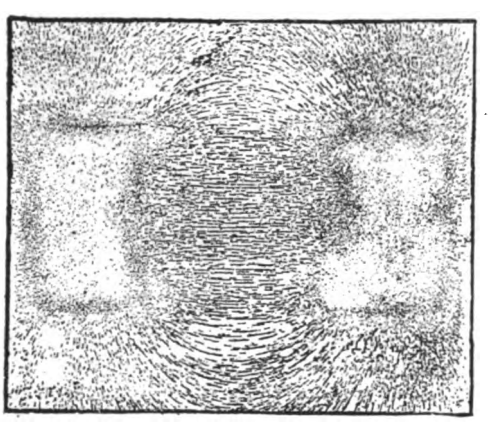

FIG. 4.

Directive Properties of Lines of Force.—Although we have no earthly knowledge as to what causes or constitutes a line of force, it is possible to talk and write about it, and from observed phenomena endow it with properties so as to make a good working hypothesis for the study of magnetism. Let us then assume that the magnetic line of force—that is, the cause—gives us as a result a circuit of matter. Go a little further, and talk about this result as if it was the final point to investigate. A circuit of iron filings is a circuit of tangible matter. But the circuit is there whether the iron filings are or not, and we may therefore assume that in the invisible circuit something tangible takes the place of the filings. This something may be oxygen atoms or molecules, nitrogen atoms or molecules, these being the gases which go principally to make the air-space, or the circuit may consist of air impurities, or adulterations of air, or, further, it may consist of that hypothetical matter called ether. Now, I am fully convinced in my own mind that of whatever any individual line circuit may be composed it is something tangible, and therefore I proceed to endow the line with the property of occupying space. This may seem an unimportant property, but it is not so, as if it exists no two lines can occupy the same space. If, therefore, we have one line or lines existing in a given space, and attempt to put another line or lines in that space, we must, so to speak, push aside the firstcomers, or distort the original contour of the circuit. Now, to push aside or to distort the contour means the expenditure of force. In other words, the existing lines resist being moved or having their shape disturbed. To this resistance we have given the name of *repulsion*. It is owing to this property of resistance or repulsion that when one north pole is brought into the neighbourhood of another, it seems to be pushed away. This push, or repulsion, can be measured. Later on we shall see why a south pole brought near a north pole is not pushed away, but, on the contrary, is pulled towards it. These phenomena give rise to the statement that like poles repel, unlike poles attract.

Continuing the view just expressed, let us imagine two sets of lines of force brought into the same space. But first of all, if the view expressed is correct, we shall see that if any space is *completely filled* with lines of force, it will be absolutely impossible to force any more lines into that space; or as the space gets filled with lines, you will see at once that more and more power is required to force in more lines. Experiment shows this to be correct, for though a small increase of force will at first increase the lines through a piece of iron almost in proportion to the force employed, when the iron begins to get full of lines, or is saturated with them, a very large increase of the producing force fails to send many more lines through. The space, then, into which I tried to bring these two sets of lines is far from being saturated. These sets of lines will only cease to act upon each other when the lines are parallel; hence one magnet, with its bevy of lines, when brought into the field of another magnet will try to take up a position, and will take up that position if free to move, so that its lines are parallel to those of the field into which it is brought.

Now, the earth is supposed to be a huge magnet, and it therefore has its lines of force; hence the reason why any magnet we use, if free to move, takes up a position pointing north and south. It takes up that position because when the position is attained its lines are parallel to those of the earth.

PHYSICAL UNITS.

BY MAGNUS MACLEAN, M.A., F.R.S.E.

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(Continued from page 122.)

ELECTROMAGNETIC SYSTEM OF UNITS.

§ 55. In the electromagnetic system all the units are derived from the definition of magnetic pole given in § 48. From the experiments of Oersted and of Ampère we are led to regard a linear conductor carrying a current as producing a magnetic field. If the linear conductor be bent into a circle of unit radius, then unit magnetic pole placed at the centre is acted on by unit force per unit length of the conductor when unit current is flowing in it. The total force acting on the unit pole is therefore 2π units. If Γ be the symbol used to represent current, then

$$[\Gamma] = [F\,L\,m^{-1}];$$

$$= [L\,M\,T^{-2} \times L \times L^{-\frac{3}{2}} M^{-\frac{1}{2}}\,T\,\mu^{-\frac{1}{2}}];$$

$$= [L^{\frac{1}{2}}\,M^{\frac{1}{2}}\,T^{-1}\,\mu^{-\frac{1}{2}}].$$

If we have, as in a practical experiment we would have, a magnet of length l and strength of pole m suspended at the centre of a coil of radius r, large in comparison to l, and if n be the number of turns in the coil, and θ the angle between the plane of the coil and the axis of the magnet, the moment G tending to turn the magnet when a current Γ is in the coil, is

$$G = \Gamma \times m\,l \times 2\pi\,n\,r \times \frac{1}{r^2} \cos\theta;$$

$$\therefore [G] = [\Gamma\,m];$$

$$[\Gamma] = [G\,m^{-1}] = [F\,L\,m^{-1}],$$

which is the same as above.

Let us suppose the coil to be fixed so that its plane is vertical and in the magnetic meridian, that the intensity of

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the magnetic field at the magnet is H; then when the deflection of the magnet due to the current Γ in the coil is θ, the moment G tending to bring the magnet back to its original position is

$$G = m\,l\,H \sin\theta.$$

Equating these two expressions for G we get

$$\Gamma = \frac{r}{2\pi n} H \tan\theta.$$

$$\therefore [\Gamma] = [L\,H] = [L \times L^{\frac{1}{2}} M^{\frac{1}{2}} T^{-1} \mu^{-\frac{1}{2}}] = [L^{\frac{1}{2}} M^{\frac{1}{2}} T^{-1} \mu^{-\frac{1}{2}}].$$

§ 56. The quantity of electricity Q is equal to the product of the current into the time during which it lasts.

$$[Q] = [\Gamma\,T] = [L^{\frac{1}{2}} M^{\frac{1}{2}} \mu^{-\frac{1}{2}}].$$

§ 57. The work done in urging a quantity Q of electricity through a difference of potential V is, as in § 43, = Q V.

$$\therefore [V] = [W\,Q^{-1}] = [L^2 M T^{-2} \times L^{-\frac{1}{2}} M^{-\frac{1}{2}} \mu^{\frac{1}{2}}] = [L^{\frac{3}{2}} M^{\frac{1}{2}} T^{-2} \mu^{\frac{1}{2}}].$$

§ 58. The capacity of a conductor is, as defined in § 44, the quotient obtained by dividing the quantity of electricity with which it is charged by the potential which this charge produces in it. Hence

$$[C] = [Q\,V^{-1}];$$
$$= [L^{\frac{1}{2}} M^{\frac{1}{2}} \mu^{-\frac{1}{2}} \times L^{-\frac{3}{2}} M^{-\frac{1}{2}} T^2 \mu^{-\frac{1}{2}}];$$
$$= [L^{-1} T^2 \mu^{-1}].$$

§ 59. The dimensions of a resistance are

$$[R] = [V\,\Gamma^{-1}];$$
$$= [L^{\frac{3}{2}} M^{\frac{1}{2}} T^{-2} \mu^{\frac{1}{2}} \times L^{-\frac{1}{2}} M^{-\frac{1}{2}} T \mu^{\frac{1}{2}}];$$
$$= [L\,T^{-1} \mu].$$

§ 60. The coefficient of self-induction of a circuit, in a medium of constant permeability, is the ratio of the counter E.M.F. of the circuit to the rate of variation of the current producing it. In symbols

$$L_1 = e \div \frac{d\Gamma}{dt}$$

where L_1 is the cofficient of self-induction,

$$\therefore [L_1] = [L^{\frac{3}{2}} M^{\frac{1}{2}} T^{-2} \mu^{\frac{1}{2}} \div L^{\frac{1}{2}} M^{\frac{1}{2}} T^{-1} \mu^{-\frac{1}{2}} \times T^{-1}] = [L\,\mu].$$

If M_1 be the coefficient of mutual induction between two circuits, then the counter E.M.F. e^1, in one circuit, due to a current Γ in the other circuit, is $e^1 = M_1 \frac{d\Gamma}{dt}$,

$$\therefore [M_1] = [L\,\mu].$$

§ 61. These electromagnetic quantities may now be put into a tabulated form for convenience of reference:

Name.	Symbol.	Relation to other quantities.	Dimensions in L M T μ.
Current	Γ	Length × magnetic force	$L^{\frac{1}{2}} M^{\frac{1}{2}} T^{-1} \mu^{-\frac{1}{2}}$
Quantity	Q	current × time	$L^{\frac{1}{2}} M^{\frac{1}{2}} \mu^{-\frac{1}{2}}$
Potential	V	work ÷ quantity	$L^{\frac{3}{2}} M^{\frac{1}{2}} T^{-2} \mu^{\frac{1}{2}}$
Electromotive-force	E	work ÷ quantity	$L^{\frac{3}{2}} M^{\frac{1}{2}} T^{-2} \mu^{\frac{1}{2}}$
Capacity	C	quantity ÷ potential	$L^{-1} T^2 \mu^{-1}$
Resistance	R	Electromotive force ÷ current	$L\,T^{-1} \mu$
Self-induction.	L_1	Electromotive force / rate of variation of current	$L\,\mu$
Mutual induction	M_1	Electromotive force / rate of variation of current	$L\,\mu$

§ 62. The dimensions of these electromagnetic quantities have been obtained by starting with the dimensional formula of unit quantity of magnetism, and from it deriving that of unit current. Similarly we might start with the dimensional formula of unit current in electrostatics, and from it derive the dimensional formula of unit quantity of magnetism, and hence of all other magnetic and electromagnetic quantities. For, as in § 55,

$$[m] = [F \cdot L\,\Gamma^{-1}];$$
$$= [L\,M\,T^{-2} \times L \times L^{-\frac{3}{2}} M^{-\frac{1}{2}} T^2 K^{-\frac{1}{2}}];$$
$$= [L^{\frac{1}{2}} M^{\frac{1}{2}} K^{-\frac{1}{2}}].$$

The rest of the quantities need not be worked out in detail. They are all given in the tables below. The reader is also referred to the following papers for further information on this subject: "On the Different Systems of Measures for Electric and Magnetic Quantities," by Prof. R. Clausius (*Phil. Mag.*, June, 1882, p. 381); "On the Dimensions of a Magnetic Pole in the Electrostatic System of Units," by Prof. J. D. Everett (*Phil. Mag.*, May, 1882, p. 376, and June, 1882, p. 431); also articles on the same subject by J. J. Thomson and Prof. J. Larmor in *Phil. Mag.*, June, 1882, pp. 427 and 429; "Remarks on Absolute Systems of Physical Units," by A. F. Sundell (*Phil. Mag.*, August, 1882, p. 81); "On the Dimensions of a Unit of Magnetism in the Electrostatic System of Measures," by R. Clausius (*Phil. Mag.*, August, 1882, p. 124), also J. J. Thomson (*Phil. Mag.*, September, 1882, p. 225), and Oliver J. Lodge, D.Sc. (*Phil. Mag.*, November, 1882, p. 357); "On Systems of Absolute Measures for Electric and Magnetic Quantities," by Prof. H. Helmholtz (*Phil. Mag.*, December, 1882, p. 430).

§ 63. Table of dimensions of electric and magnetic quantities:

Name.	Symbol.	L M T K.	L M T μ.
Quantity of electricity	q Q	$L^{\frac{3}{2}} M^{\frac{1}{2}} T^{-1} K^{\frac{1}{2}}$	$L^{\frac{1}{2}} M^{\frac{1}{2}} \mu^{-\frac{1}{2}}$
Current	γ Γ	$L^{\frac{3}{2}} M^{\frac{1}{2}} T^{-2} K^{\frac{1}{2}}$	$L^{\frac{1}{2}} M^{\frac{1}{2}} T^{-1} \mu^{-\frac{1}{2}}$
Magnetic potential	V	"	"
Surface density	σ	$L^{-\frac{1}{2}} M^{\frac{1}{2}} T^{-1} K^{\frac{1}{2}}$	$L^{-\frac{3}{2}} M^{\frac{1}{2}} \mu^{-\frac{1}{2}}$
Electric displacement	σ	$L^{-\frac{1}{2}} M^{\frac{1}{2}} T^{-1} K^{\frac{1}{2}}$	$L^{-\frac{3}{2}} M^{\frac{1}{2}} \mu^{-\frac{1}{2}}$
Magnetic surface density	σ^1	$L^{-\frac{3}{2}} M^{\frac{1}{2}} K^{-\frac{1}{2}}$	$L^{-\frac{1}{2}} M^{\frac{1}{2}} T^{-1} \mu^{\frac{1}{2}}$
Electric potential	v V	$L^{\frac{1}{2}} M^{\frac{1}{2}} T^{-1} K^{-\frac{1}{2}}$	$L^{\frac{3}{2}} M^{\frac{1}{2}} T^{-2} \mu^{\frac{1}{2}}$
Total electromotive force	e E	$L^{\frac{1}{2}} M^{\frac{1}{2}} T^{-1} K^{-\frac{1}{2}}$	$L^{\frac{3}{2}} M^{\frac{1}{2}} T^{-2} \mu^{\frac{1}{2}}$
Quantity of magnetism.	m	$L^{\frac{1}{2}} M^{\frac{1}{2}} K^{-\frac{1}{2}}$	$L^{\frac{3}{2}} M^{\frac{1}{2}} T^{-1} \mu^{\frac{1}{2}}$
Magnetic pole	m	$L^{\frac{1}{2}} M^{\frac{1}{2}} K^{-\frac{1}{2}}$	$L^{\frac{3}{2}} M^{\frac{1}{2}} T^{-1} \mu^{\frac{1}{2}}$
Intensity of magnetic field.	H	$L^{\frac{1}{2}} M^{\frac{1}{2}} T^{-2} K^{-\frac{1}{2}}$	$L^{-\frac{1}{2}} M^{\frac{1}{2}} T^{-1} \mu^{-\frac{1}{2}}$
Magnetic force	H	$L^{\frac{1}{2}} M^{\frac{1}{2}} T^{-2} K^{-\frac{1}{2}}$	$L^{-\frac{1}{2}} M^{\frac{1}{2}} T^{-1} \mu^{-\frac{1}{2}}$
Magnetic moment	M	$L^{\frac{3}{2}} M^{\frac{1}{2}} K^{-\frac{1}{2}}$	$L^{\frac{5}{2}} M^{\frac{1}{2}} T^{-1} \mu^{\frac{1}{2}}$
Intensity of magnetisation	I	$L^{-\frac{3}{2}} M^{\frac{1}{2}} K^{-\frac{1}{2}}$	$L^{-\frac{1}{2}} M^{\frac{1}{2}} T^{-1} \mu^{\frac{1}{2}}$
Magnetic induction	B	$L^{-\frac{3}{2}} M^{\frac{1}{2}} K^{-\frac{1}{2}}$	$L^{-\frac{1}{2}} M^{\frac{1}{2}} T^{-1} \mu^{\frac{1}{2}}$
Intensity of electric field	f	$L^{-\frac{1}{2}} M^{\frac{1}{2}} T^{-1} K^{-\frac{1}{2}}$	$L^{\frac{1}{2}} M^{\frac{1}{2}} T^{-2} \mu^{\frac{1}{2}}$
Specific inductive capacity	K	K	$L^{-2} T^2 \mu^{-1}$
Capacity	c C	L K	$L^{-1} T^2 \mu^{-1}$
Resistance	r R	$L^{-1} T K^{-1}$	$L\,T^{-1} \mu$
Magnetic permeability	μ	$L^{-2} T^2 K^{-1}$	μ
Magnetic susceptibility	κ	$L^{-2} T^2 K^{-1}$	μ
Self-induction	L_1	$L^{-1} T^2 K^{-1}$	$L\,\mu$
Mutual induction	M_1	$L^{-1} T^2 K^{-1}$	$L\,\mu$

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§ 64. It will be noticed from these expressions (1) that mass appears always under a square root and does not appear in any of the expressions involving K and μ to integral powers; (2) that the ratio of the dimensions in terms of K to the dimensions in terms of μ is a power of $L T^{-1} K^{\frac{1}{2}} \mu^{\frac{1}{2}}$. Hence, if we suppose that every electric and magnetic quantity has definite dimensions in terms of length, mass, and time, $K^{\frac{1}{2}} \mu^{\frac{1}{2}}$ must be of the dimensions of a slowness or the inverse of a velocity, and "the two systems become identical as regards dimensions, and differ only by a numerical coefficient just as centimetres and kilometres do." [See "On the Suppressed Dimensions of Physical Quantities," by A. W. Rücker, M.A., F.R.S., *Proceedings* of the Physical Society of London, vol. 10, p. 37; and "On the Dimensions of Electromagnetic Units," by Prof. G. F. Fitzgerald, F.R.S, same volume, p. 95.]

§ 65. By supposing the dimensions of K and μ to be zero, the ordinary electrostatic and electromagnetic systems of units are obtained. The quantities generally used in the two systems are given in the following table:

Name.	Symbol.	Dimensions in electrostatic system.	Symbol.	Dimensions in electromagnetic system.	Ratio.
Quantity...	q	$L^{\frac{3}{2}} M^{\frac{1}{2}} T^{-1}$	Q	$L^{\frac{1}{2}} M^{\frac{1}{2}}$	$\frac{q}{Q} = L T^{-1} = v$
Current...	γ	$L^{\frac{3}{2}} M^{\frac{1}{2}} T^{-2}$	Γ	$L^{\frac{1}{2}} M^{\frac{1}{2}} T^{-1}$	$\frac{\gamma}{\Gamma} = L T^{-1} = v$
Potential..	v	$L^{\frac{1}{2}} M^{\frac{1}{2}} T^{-1}$	V	$L^{\frac{3}{2}} M^{\frac{1}{2}} T^{-2}$	$\frac{v}{V} = L^{-1} T = \frac{1}{v}$
Capacity...	c	L	C	$L^{-1} T^2$	$\frac{c}{C} = L^2 T^{-2} = v^2$
Resistance	r	$L^{-1} T$	R	$L T^{-1}$	$\frac{r}{R} = L^{-2} T^2 = \frac{1}{v^2}$

One electromagnetic unit of quantity $= v$ electrostatic units.

" " " " current $= v$ " "

" " " " potential $= \frac{1}{v}$ " "

" " " " capacity $= v^2$ " "

" " " " resistance $= \frac{1}{v^2}$ " "

where v (determined by experiments to be referred to subsequently) is a velocity of 3^{10} centimetres per second, or 300,000 kilometres per second.

WHAT IS ELECTRICITY?—VII.

BY SYDNEY F. WALKER.

REFLECTION OF ELECTRICAL WAVES.

Readers of my previous articles upon this subject will remember that the view I have ventured to put forward as to the nature of electricity is that it is simply a mode of motion, just as heat, light, and sound are, but at a different rate, and possibly in a different manner, to either of those forces. I have already pointed out the close similarity that exists between the different forces named and electricity, in the fact that conduction takes place in all of them under very much the same laws; that the presence of any one of them, electricity included, in any body increases the apparent size of that body; and that all, though necessarily in different degrees and with different substances, possess the property of altering the chemical constituency of compound bodies.

Seeing that the different forces represent different forms and rates of motion, we should necessarily expect that there would be diversities in the similarities of their resultant action, and, further, we should expect that some properties would be peculiar to one or more rates of motion, to one or more of the forces, but not common to all. The more features of similarity, however, that we find between a force supposed to be outside the group and those known to be inside, the stronger does the argument become that the outsider is really one of the group. If, therefore, we can show that electricity or electric waves are reflected and refracted as heat and light rays are, we shall have a strong argument in favour of my contention that electricity is a mode of motion, like the other physical forces.

As students of electrical literature are aware, the late Prof. Hertz went a very long way towards proving this, and he actually succeeded in obtaining reflection of electromagnetic waves. What Prof. Hertz actually proved was, that if in the path of a series of electromagnetic waves created by an induction coil an object be placed capable of reflecting those waves, just as mirrors reflect waves of light or heat, the actual phenomena of reflection were obtained. My object in drawing attention to this is the hope that some of those who have the time and the appliances at their disposal will carry on Prof. Hertz's experiments to their logical conclusion, and prove or disprove my supposition that an electrically-charged body is sending waves into space, just as a luminous, a heated, or a sounding body does, and that these waves may be caused to reflect and possibly also to refract.

In order to pursue this investigation with advantage it may be well to enquire what we mean by reflection, since it will be evident that a substance that reflects one of the physical forces may not reflect another. To follow the theory I ventured to put forward in one of the earlier articles, the rate of motion already existing in any particular body on which a ray impinges may be such as to combine readily and fully with the motion brought by the ray when the latter is, say, a ray of heat, while it may not be able to combine with a ray of electricity, supposing such to exist. In the case of the reflection of light rays, we see this selective property exercised all around us. Thus, a substance we know as black has the property of absorbing and, on the theory enunciated above, of combining with the whole of the motion brought by the impinging ray. A substance we know as red is only able to absorb a portion of the motion, reflecting the remainder out again, and giving us the phenomena of colour. A substance that is white, as we know, absorbs very little of the motion brought by an impinging ray, reflecting nearly the whole of it; while, again, bright polished substances, such as mercury, silver, and to a lesser degree copper, and other coloured metals have the property, not only of reflecting a mass of light rays, but of reflecting every ray brought to them in the exact inverse order in which they arrive.

To reflect electric rays, then, we require to find a substance that does not readily absorb a charge of electricity, or, in other words, one which, while it is a poor conductor, has also a small electrostatic capacity. An experiment I think that should prove successful might be made with a large hollow metal sphere charged to a very high potential, and the neighbourhood explored with a sheet of ebonite and a light pith ball. If waves of electricity are given out by the highly-charged sphere, just as waves of sound are given out, say, by a tuning-fork, evidence of them would be found and of their reflection. Possibly a careful consideration of some of the phenomena of electrostatic induction may lead to the conclusion that this also is only a form of reflection.

PHYSICAL SOCIETY.

At the ordinary general meeting, held on 23rd inst., Prof. Rücker, F.R.S., president, in the chair, **Mr. Womack** read a paper on "**A Modification of the Ballistic Galvanometer Method of Determining the Electromagnetic Capacity of a Condenser.**" The condenser is placed in parallel with one arm, S, of a Wheatstone's bridge arrangement of non-inductive resistances. A balance for steady currents having been obtained, the condenser is placed in circuit, and the throw on depressing the battery key determined. The condenser is then thrown out of circuit, and the proportionality of the arms of the bridge disturbed by changing the value of S to $S + dS$. The steady deflection due to this change

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is then read. From these two readings and the known value of S and dS the capacity is immediately determined. In practice, readings of deflection may be taken with equal positive and negative values of dS. To avoid changes of E.M.F. of the battery, the author finds it best to use a reversing key in the battery circuit, and to observe the throw on reversing the current instead of on simply breaking it. One advantage of the method is that there is no need to know the galvanometer or battery resistance, and the author points out that it may be of service in the simultaneous determination of the resistance and of the joint capacity and inductance of a submarine cable, or of a telephone or telegraph line.

Prof. Perry asked what were the advantages of the method as compared with the Rayleigh-Sumpner method.

Mr. Blakesley thought that the correction for damping in the ballistic part of the experiment might be avoided if in the second part the disturbance of balance due to the increment, dS were measured by half the first throw of the needle on making the galvanometer circuit, instead of by the steady deflection. He doubted whether reversing the current in the battery circuit would have just twice the effect of simply breaking the circuit.

In reply, **Mr. Womack** said he had not tried the method of reading suggested Mr. Blakesley, but with regard to the reversing of the battery circuit, that was found to give in practice as nearly as possible twice the deflection which resulted from simply breaking.

A paper by **Prof. S. P. Thompson** and **Mr. Miles Walker** on "**Mirrors of Magnetism**," was read by Prof. Thompson. It was pointed out that, corresponding to the theory of electric images produced by insulated conductors, there is a theory of magnetic images produced by bodies of infinite magnetic permeability. A magnet pole in the latter theory is the analogue of an electric charge in the former, and a body of infinite magnetic permeability is the analogue of an insulated conductor (which is electrostatically indistinguishable from a body of infinite dielectric capacity). Experiments were made to determine how far the magnetic images due to thick sheets of iron recorded with those deduced by theory for the case of infinite permeability. The image of a north pole in an infinite plane sheet should consist of a south pole of the same strength at a point coinciding with the optical image of the north pole, together with an equal north pole distributed uniformly over the surface of the infinite sheet, as a free electrical charge would be, and so exerting no finite action. Working at distances of a few inches in front of the surface, a sheet of iron a few feet in length and breadth and a couple of inches thick was found to realise the theoretical conditions with very tolerable exactness. In a coil of wire placed on one side of the sheet a current was started or stopped, and the electromotive impulse produced in a subsidiary exploring coil was detected by means of a ballistic galvanometer. That the effect of the actual mirror was equivalent to that of the theoretical image was verified by substituting for the iron a coil equal and similar to the first, and coinciding with its optical image. Sending the same primary current as before round the two coils (with due regard to its direction in the second coil), hardly any appreciable difference in the secondary impulse was observed. This was found to hold good whether the original primary coil had its axis perpendicular or oblique to the plane of the magnetic mirror. Some observations on spherical sheets were also recorded, but in this case the conclusions were less simple.

The paper was followed by a discussion, in which **Mr. Boys**, **Prof. Perry**, **Prof. Ayrton**, **Dr. Burton**, **Mr. W. Bailey**, and **Prof. Carey Foster** took part.

Prof. Ayrton exhibited a "**Student's Apparatus for Verifying Ohm's Law**," designed by himself and Mr. Mather. The current flowing through a circuit is to be measured (not necessarily in terms of any defined unit) by means of a galvanometer, while the potential difference between two fixed points is measured by means of an idiostatic electrometer. Within small limits of experimental error the current and potential difference are found to vary in the same proportion, but the electrometer and its manner of use constituted the chief interest of the paper. The fixed and moving parts (inductors and needle) are alike cylindrical in form (the term being understood in its most unrestricted sense) and the generating lines are vertical. There is a vertical axis of symmetry, such that the disposition of these cylindrical parts would remain unchanged if the instrument were rotated through 180deg. about the axis. The needle is hung by a very thin phosphor-bronze strip, and to obtain a reading when it differs in potential from the inductors by an amount which we have to measure, it is brought back to its ordinary zero position by turning a torsion-head to which the upper end of the suspending strip is fixed. The potential difference is then proportional to the square root of the angle through which the torsion-head has been turned, but the E.M.F. of a moderate battery of accumulators can be read with very fair accuracy. The authors have bestowed great care on the design of the needle, so that for a given potential difference the turning moment divided by the moment of inertia may be as great as possible. The whole instrument is protected from external inductive influence by having the inner surface of its glass case coated with a transparent conducting varnish, which Prof. Ayrton has described elsewhere.

Prof. Ayrton, also showed an idiostatic electrometer whose needle, instead of being suspended, was pivoted on an axle. The instrument is rapid and nearly dead-beat in action, and gives a scale-reading of about 3in. for an E.M F. of 100 volts.

Prof. S. P. Thompson expressed great admiration for the instruments exhibited, but denied that the law which they served to prove was Ohm's law at all, and this led to some discussion as to what Ohm's law really is.

Prof. Ayrton briefly replied.

THE RECENT EXPLOSION IN THE CITY.

In our last issue we reported the proceedings of the Board of Trade enquiry into the circumstances connected with the explosion which occurred in the City on the 10th inst. as far as it had been carried. The enquiry was resumed by Major Cardew on Friday last at Winchester House. Mr. R. W. Wallace (instructed by Messrs. Ashurst, Morris Crisp, and Co.) appeared for the City of London Electric Lighting Company, Limited; Mr. Russell Griffiths, for the Aldermen and City Commissioner of Police; and Mr. Baylis for the City Commissioners of Sewers.

Mr. T. G. Chesterman, M R.C.V.S., said that he made a *post-mortem* examination of the mare killed by the accident on the evening of the 10th inst., at the request of Mr. Boutland, its owner. He found nothing whatever to cause death. There was no appearance of congestion, and all the internal organs were perfectly healthy. He discovered no wounds, and he could not say, as the result of his examination, what the animal died from.

Major Cardew: Was there anything to indicate the passage of a current through the tissues of the body?

Witness: Nothing; and there were no signs of asphyxia. If he had not been told that the mare died from a shock, he should have been unable to account for its death.

Mr. H. Smith, foreman of cable mains to the City of London Electric Lighting Company, said he superintended the laying of the main from the Watling-street cable. The pipes were already in, and they had only to draw through the main, which was laid in lengths and connected together at junction-boxes. He was not present when the connections at the junction-boxes were made, that work being the duty of the jointing foreman. The main was in about 15 separate lengths from Watling-street to Bankside, the generating station, and each length was labelled. Replying to **Mr. Griffiths**, witness said it was his duty to see the mains left properly at each junction-box, and he did so in the present case. He satisfied himself that the right label was attached to each separate length of main. In answer to **Mr. Wallace**, witness stated that the labels, some of which were of linen and others of paper, were securely fastened with iron wire. Men going into the junction-boxes, however, might accidentally tear them off. He noticed that the tubes were crossed at some places, but that could not always be avoided.

Mr. Parrott, jointing foreman, said he superintended the jointing up of the Watling-street main. Each length was labelled, and the men jointed them up accordingly. Before any jointer got into a box to make the necessary connections he examined the labels, which were still there. He also examined each joint after it was made. Since the accident occurred he had traced the cable quite through, and had found that it was crossed with the Milk-street cable between the box in Maiden-lane and the box outside Edison and Swan's shop on the west side of Queen-street. In reply to **Major Cardew**, witness stated that when he jointed up the cables the labels were wrongly attached. Somebody must have made a mistake in putting the labels on. This was the only instance they had had of the kind. Replying to **Mr. Griffiths**, witness said the mistake must have been made in the labelling. When he traced out the cable on the day after the accident there were four or five men with him. The first examination in the junction-boxes of the cables was also made on that day. Nobody connected with the laying of the cable was with him when the inspection was made. He was positive that, according to the labels, the cables were properly connected. On the 13th the second engineer (Mr. Bates) examined the boxes at Thames-street and Queen-street, and saw the labels.

Mr. A. Cook, superintendent of cable-laying and of the transformer stations, said he gave the order for the jointing of the Watling-street cable to be performed, but he did not examine the labels before the work was proceeded with. He had been connected with electrical work for 12 years, and knew how to test a cable for continuity. Such a test would have revealed the existence of the fault. He was not present at the Watling-street station when the switching on of the new main took place, he having been occupied at Worcester Wharf in paying the men.

Major Cardew: Were you aware that the main was to be made alive?

Mr. Cook: Not of the exact time.

Major Cardew: But I suppose if you had so instructed the men it would have been deferred until you could have attended?

Mr. Cook: Well, we intended making it alive earlier in the morning, but they were not quite ready at Bankside. The foreman was left with instructions at Watling-street to make it alive on a signal from Bankside.

Major Cardew: Did you look into the arrangements for switching the main on?

Witness: Yes; they were the same as those on previous occasions for making a main alive. In answer to **Mr. Griffiths**, witness said he asked Mr. Peard, engineer of the testing department, whether he had tested the Watling-street main, and he replied he had made a rough test, and he then asked him if it were good enough to be put on, and he said yes. A note was here produced, written by Mr. Parrott to Mr. Peard, as follows: "Can Watling-street main be put in pillar? Wanted to be at work by 11 a.m." Mr. Peard's reply was: "The cable is good, but the final test has not yet been taken. Can go in pillar." The meaning of the phrase, "can go in pillar," was that the main was in a fit condition to be made alive.

Mr. Oliver Peard, electrical engineer in charge of the testing department, said the first he knew officially of a new main was on receiving a notification from the cable-jointing department, on a special form, that it was ready to be tested; and until he returned

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a signed certificate as to the result of the testing to be made by him he was not responsible for any use made of the main. That was well understood. If a main were wanted in a hurry he would be informed of the fact, and would thereupon make a rough test to discover any fault in the insulation. The cable was then put into terminals provided for it at each end. The meaning of his words, "can go in pillar," was simply that the cable was ready for the final test, and not that it could be made alive. It ought not to be made alive until he returned his certificate guaranteeing that it was sound. In addition to the insulation test a pressure test was made, and subsequently the electrostatic capacity and the copper resistance of the main were taken. This series of tests occupied uncertain periods, but he had never made them under two days; and during that time, as far as he knew, the main being tested was never used.

Major Cardew: Mr. Cook told us that he asked you if the main were good enough to be put on, and that you said "yes."

Mr. Peard: That is not true. My reply was simply that I had made a rough test for insulation resistance, and that it was fairly good.

Major Cardew: You were aware the main was to be brought into work that day?

Mr. Peard: I did not think Mr. Cook would make a high-tension main of that importance alive when he knew that only a rough test had been made.

Major Cardew: Have you ever previously known a cable to be put to work before you had completed your tests?

Mr. Peard said he had not. There had never, so far as he knew, been any fault of insulation on the Benetfink main before.

Mr. Joseph M'Mahon, foreman of the transformer department, said he switched on the new main at Watling-street station on the 10th inst. Mr. A. Cook telephoned to the effect that he was to proceed to Watling-street station and wait for word from Bankside to switch on. He thought the main had been already charged. When he switched on he noticed after about a minute a kick in the lights. His orders had always been that the pressure should be on at Bankside first, and that the switching on should take place afterwards.

Mr. J. P. Buck, superintendent of conduits, and **Mr. F. H. Jackson**, engineer in charge of the generating station, having given formal evidence, the enquiry terminated.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Madrid.—Tenders are invited by December 8 by the Spanish Government for the construction of a telephone system at Santa Cruz, Teneriffe. Tenders are to be sent to the Ministère d'Outre Mer, Madrid.

Coventry.—The Corporation invite tenders from manufacturers for electricity meters. Particulars may be obtained on and after Friday, November 30, at the office of Mr. Robert Hammond, the consulting electrical engineer, Ormond House, Great Trinity-lane, London, E.C. Tenders to be delivered to Mr. Lewis Beard, town clerk, by Wednesday, December 12.

Enniscorthy (Ireland).—Tenders are invited for providing the Enniscorthy District Lunatic Asylum with internal telephonic communication, about 13 stations being required. Tenders will be considered by the Board on December 12, and should be sent, addressed to the chairman, so as to reach the asylum by 6 p.m. on December 11. Furthers particulars can be obtained from the resident medical superintendent.

Blyth.—The Cowpen District Local Board (Blyth, Northumberland) invite tenders for the efficient lighting, by electricity or otherwise, of the lighting area within their district for a period of seven or ten years respectively, commencing from August 15, 1895. A plan of the district can be seen and further information obtained at the Surveyor's Office, Commercial-buildings, Waterloo, Blyth. Tenders, endorsed "Lighting," to be sent to Mr. Robt. T. Guthrie, clerk to the Board, not later than December 20.

London, N.— Tenders are invited for the supply of new and the purchase of old stores for 12 months from January 1, for the Great Northern Railway Company. A list of the contracts, and separate forms of tender for each contract, may be obtained on application to Mr. Martin, stores superintendent, Doncaster, by whom every information will be furnished. The stores must be in every case equal in quality to the company's sealed samples and patterns, which will be exhibited in the Stores Department, Doncaster, where they may be inspected, on application to the stores superintendent, from now until December 7 between 10 a.m. and 4 p.m., and the contractors are requested to call and examine them before tendering. N.B.—The patterns of telegraph and electric lighting material will be exhibited at the Telegraph Stores, Retford. The company's samples and patterns cannot be sent to contractors for inspection. Tenders, addressed to the Stores Committee, marked on the outside with a description of the stores tendered for, must be sent to the company's offices, at King's Cross, in the envelopes specially provided, so as to be received by 10 a.m. on December 8. Mr. William Latta, secretary.

RESULTS OF TENDERS.

London, W.C.—Thirty-four tenders were received for the Salisbury Estate electric lighting, the totals for the whole job varying from £5,437 to £8,473. The lowest tender was from Messrs. B. Verity and Sons, who offered a combination of Edwin Danks's dry-back boilers and Parsons turbines, and made stronger guarantees than any other tenderer in reference to the absence of vibration. The contract has accordingly been allotted to them.

St. Pancras.—The Vestry have received the following tenders for supplying and laying armoured cable mains:

W. T. Henley's Telegraph Works Company, Limited (accepted)	£17,104 16 3
Callender's Bitumen, Telegraph, and Waterproof Company, Limited	17,817 16 7
Alternative tender	17,760 6 7
Siemens Bros. and Co., Limited	18,581 7 9
Fowler-Waring Cables Company, Limited	18,645 13 4
British Insulated Wire Company, Limited	18,848 19 3
India Rubber, Gutta Percha, and Telegraph Works Company, Limited	23,650 19 5
Alternative tender	21,713 13 8
W. T. Glover and Co.,	25,767 7 8
Alternative tender	22,331 3 2

For the extension of the underground sub-station, the tenders were:

J. Steed (accepted)	£208 16 9
J. O. Richardson	226 12 5
C. W. Killingback and Co.	244 7 5
J. Mowlem and Co.	284 0 10

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—For the past week the receipts were £3,415.

Glasgow.—A new Conservative club was opened yesterday (Thursday) in Bothwell-street. It is lighted electrically.

Burton.—Mr. Codrington, R.E., has held an enquiry into the application of the Town Council to borrow £53,000 for various purposes, including electric lighting.

Newcastle.—The foundation-stone was laid yesterday (Thursday) of the new John Knox Presbyterian Church in Elswick-road. It is intended to light it electrically.

Brazilian Submarine Telegraph Company. — An interim dividend of 3s. per share has been declared by the Board for the quarter ended September 30, payable on December 21.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 25th inst. amounted to £913, as compared with £580 in the corresponding week of last year.

Sale.—The Brighton and Hove Electric Light Company, Limited, announce for sale the whole of the plant, machinery, and stock at Brighton. Particulars will be found in our advertisement columns.

Aberdare.—A meeting of the promoters of the proposed company to provide for the electric lighting of Aberdare has been held at the Boot Hotel, and arrangements were made for the formation of the company.

Croydon.—Councillor Dr. Hobson has suggested to the Croydon County Council that incandescent gas lamps should be used in streets which would "in all probability not be benefited by the proposed electric light."

Leamington.—Alderman R. Eardley Wilmot, who has presented a report on the last year's work at the pump-room, pointed out that among the improvements decided upon last March was a new electric light installation.

Ayr.—The Town Council have unanimously agreed to remit to a committee, with powers, the completion of the purchase for £1,000 of a site in Mill-street, abutting on the river, as the central station for the electric light.

Olympia.—The London County Council have approved of plans for alterations on the ground level of the large hall at Olympia, provided the four divisions in the palace be enclosed and be lighted with the electric light.

Worcester.—The new Electricity Committee of the Town Council comprises the Mayor, the Deputy-Mayor, Aldermen Hill, Ernest Day, and W. Holland, Councillors Cock, W. Caldicott, H. Day, Chaplin, and Millington.

International Trade Exhibition, Limited.—This Company has been registered, with a capital of £2,000 in £1 shares, to establish and carry on the business of exhibition promoters, restaurateurs, advertisement contractors, and caterers.

Hampstead —The Metropolitan Asylums Board have approved of the draft agreement with the Vestry of Hampstead for the supply for three years certain of electrical energy to the North-Western Hospital at 4d. per Board of Trade unit.

Home Telephone Company, Limited.—The creditors of the above-named Company are required, on or before December 14 next, to send in their names and addresses, and the particulars of their debts or claims, to Mr. E. A. Horne, 85, Queen Victoria-street, London, E.C., the liquidator of the Company.

City and South London Railway.—The receipts of the Company for the week ended November 25 were £957, against £897 for the corresponding week of 1893, or an increase of £60. The total receipts for the current period of the present half-year amount to £18,648, as against £17,370 in the corresponding period of 1893, an increase of £1,278.

Islington.—The Vestry have received a deputation from the Islington Board of the Independent Labour party with reference to the provision of work for the unemployed during the ensuing

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winter, and in connection with the installation of the electric light in the parish. The Works Committee are to present a report on the subject.

Newcastle.—A meeting of Newcastle City Lighting Committee was held on Tuesday, when Mr. J. Barker Ellis was re-elected chairman, and Mr. W. J. Matthewson, vice-chairman. It was proposed by Mr. T. Waller, and carried, that two new electric lamps be erected, one at the bottom of Picton-place and the other at the east end of Byker Bridge.

Williamson Electrical and Engineering Company, Limited.—Notice is given that a general meeting of the members of the above-named Company will be held at Temple-chambers, 33, Brazennose-street, Manchester, on December 17, for the purpose of having an account laid before them showing the manner in which the winding up has been conducted.

Granada Railway Company, Limited.—This Company has been registered with a capital of £300,000 to construct, equip, and maintain railways, light railways, tramways, wire, electric, pneumatic, water, or other powers, telegraph and telephone lines and works, and any means of communication, connection, and propulsion in the kingdom of Spain or elsewhere.

Bournemouth.—The trustees of the Punshon Memorial Wesleyan Church are considering a scheme for lighting the church by electricity. The Town Council have received a letter from the Secretary of the Board of Trade stating that the promoters of the Poole and Bournemouth Tramways Company have been granted an extension of time till August 4, 1895.

Dundee.—The Gas Committee of Dundee Town Council have received an application from Messrs. Jaffe Bros., jute merchants, to have their establishment in Seagate illuminated with electric light. The engineer reported that the mains would require to be extended in Seagate to give effect to the request, and this he estimated would involve an expenditure of £135. It was agreed that the request should be granted.

Chiswick.—The surveyor to the Local Board has submitted plans of the extra ground required at the electric lighting station, the area being 72ft. On the proposal of Mr. Hunt it was decided to allow the use of this ground for the works. In reply to a letter from the Board, Messrs. Bourne and Grant wrote stating that the work should be pushed on with all expedition after the Board had decided to allow them the necessary land.

Electric and General Investment Company, Limited.—We are informed that the directors have declared an interim dividend on the capital paid up on the ordinary shares of the Company at the rate of 10 per cent. per annum for the six months ending November 30, 1894, the dividend to be payable on and after December 20 next. The transfer books of the company will be closed from December 6 to December 20 inclusive.

Conversion of Firm.—Messrs. Nalder and Harrison inform us that they have formed their business into a limited company, trading under the name of The Nalder and Harrison Construction Syndicate, Limited, in order to increase the capital sufficiently to cope with the large amount of work they have now in hand. The business will be carried on under the same management, and the shares are being privately subscribed for by the directors and their friends.

An Interesting Model.—Mr. John G. Masson, stamp and die cutter, South Constitution-street, Aberdeen, who has gained many prizes for expert workmanship, has just completed an exceedingly ingenious model which he intends to enter for competition for a prize of £20 offered by a popular London weekly. The subject of the model is "The Village Smithy." The model is lighted by electricity. A small battery gives a light of 1½ c.p. The battery is sufficient to give light for nine hours.

London.—Messrs. Rashleigh Phipps and Co. have received the contract for the electric lighting of Mr. Frank Wyatt's new house in Queen's-gardens, and also for Mr. J. A. Mitchell's new restaurant in Princes-street, and the offices of the National Assurance Company of Ireland in Nicholas-lane. They have also just completed the lighting of the Wimpole Hotel, Wimpole-street, and Limmer's Hotel, George-street, Hanover-square, and are very busy with electric lighting several private houses, etc., in the West-end.

Cassel Gold Extracting Company.—The directors have resolved to pay a dividend of 5 per cent. in cash, together with one share each in the African Gold Recovery Company, Limited, and the Australian Gold Recovery Company, Limited, for every 20 fully-paid shares held in the Cassel Company, and one share in the New Zealand Crown Mines Company for every 40 fully-paid shares held in the Cassel Company, all free of income tax; two of the third issue of Cassel shares, with 10s. each paid, to be counted as one fully-paid share.

Brighton.—On the proceedings of the Lighting Committee at a meeting of the Town Council, Councillor Wishart complained of the prolonged obstruction of Church-street by excavations for electric lighting purposes. Councillor Stafford promised that the work should be pushed forward as rapidly as possible. Replying to Councillor Daniel, Councillor Stafford said the committee could not see their way to give additional light in Meeting House-lane, as the two lamps there were 90ft. apart, whereas the regulation distance was 150ft.

Wolverhampton.—Alderman Gibbons at a meeting of the Town Council presented a complaint with regard to the taking up of the footway in narrow streets on market days to place the electric light in shops. He thought the work should be done with less inconvenience to pedestrians. The Mayor said the obstruction which had been caused should not occur again. The following have been appointed members of the Lighting Committee of the Town Council: the Mayor, Aldermen Dickenson, Jackson, and S. T. Mander; Councillors Allen, Craddock, Ironmonger, Jenks, Johnson, McBean, Pinson, Shepherd, and J. J. Tate.

Litigation.—In the Chancery Division on Friday last, before Mr. Justice North, the Electrical Power Storage Company, Limited, and the Electric Construction Company, Limited, were plaintiffs in an action against the Chloride Electrical Storage Syndicate, Messrs. Mather and Platt, and Mr. John Hopkinson. Sir Richard Webster moved to restrain an alleged infringement of what he called the great patent for secondary batteries. The patent, which had been extensively used, was now 13½ years old, and would expire in May next, so that time was of the essence of the matter. The defendants not being ready with their affidavits, the motion was ordered to stand over till Thursday next week.

Manchester.—The City Council have been considering the question of the gas management, and incidentally Mr. Alderman Higginbottom, deputy-chairman of the Gas Committee, pointed out that four years ago the Gas Committee suffered under one great disadvantage. They then had to face the introduction of the electric light into Manchester. That suggested a formidable rival to gas, and the committee were afraid of launching out and spending a large capital in improvement when their revenue seemed likely to diminish. The experience of London and other places showed there was no ground for fear, and so of late the committee had spent large sums in extending and remodelling their works.

Municipal Installations.—Blackpool's electric lighting system has, says the *Blackpool Gazette*, received a lot of attention from other corporate bodies who are desirous of lighting up their respective towns by similar means. There may have been a lack of foresight in making the local installation, but this is compensated for in other directions, I take it. Anyway, there is little doubt that peregrinating deputations, picking up information and having an enjoyable pleasure tour at the expense of the ratepayers, are generally very favourably impressed with what they see at Blackpool. The Mayor of Harrogate, the ex-Mayor (Alderman Fortune), and other members of the Harrogate Town Council have visited us, and were conducted over the works in West Caroline-street by Mr. Hesketh. At night all the lights upon the Promenade were turned on for the benefit of the deputation, who afterwards foregathered with local councillors at the Winter Gardens and Opera House.

Wigan.—Notice has been given by the Wigan and Districts Tramways Company, Limited, of an application for a provisional order for the construction of new tramways in the districts of the Hindley and Ince-in-Makerfield Local Boards and the borough of Wigan. It is provided that the company may use horse, steam, mechanical, or electric power. The clause runs: "To empower the tramways company and their lessees to work the intended tramways by electricity, steam, or any other motive power, and partly by one power and partly by another, and to authorise the tramways company and their lessees to erect, place, make, and maintain works, engines, machinery, dynamos, and apparatus for the production, storage, and supply of electricity or other power, and to lay down and construct mains, wires, pipes, conductors, apparatus, and things necessary or proper for the transmission of electricity or other power, and the working of the intended tramways, or any of them, by electricity or other power."

Harrow.—The Governors of Harrow School have intimated to the Harrow Local Board their willingness to favourably consider a proposal for lighting the school chapel, library, and other school buildings, provided they had full estimate of the cost. The Board's engineer offered to estimate at 5 per cent. if the work was carried out, and 2½ per cent. if it was not carried out. The headmaster of the school would not pledge himself to this expense, so the Board decided to ask 10 good firms for tenders. Eight were sent in, and the committee having charge of the matter sent up two of those tenders to the Board for consideration. These were from the Brush Company and from Messrs. Crompton. The Board accepted Messrs. Crompton's provisionally, and it was announced it amounted to £8,762 for plant, etc., and £1,686 for maintenance, as against the engineer's estimate of £9,300 and £2,092. The Board expressed themselves exceedingly satisfied, the estimate of the accepted firm being so close to that of their electrical engineer.

Luton.—The following resolution has been passed by the Town Council: "That application be made to the Board of Trade on or before December 21, 1894, for a provisional order empowering the Mayor, Aldermen, and Burgesses of the borough of Luton to supply electricity for public and private purposes within the said borough, in accordance with the provisions of the Electric Lighting Acts, 1882 and 1888, and the rules made by the Board of Trade relative thereto under the said Acts; and the town clerk and parliamentary agents are hereby authorised to give all notices and do all other acts and things necessary and legal to complete and finally obtain the said provisional order; and, further, that the memorial to the said Board of Trade, so soon as prepared, be sealed with the common seal of the Town Council, and duly signed by the Mayor and town clerk." Considerable discussion took place on the proposed compulsory area, and it was ultimately decided that the area be George-street, Market-hill, Park-square, Cheapside, King-street, Upper George-street, Wellington-street to Stuart-street, and Bute-street.

Llandudno.—Messrs. Dickenson and Co., Darlaston, have written to the Improvement Commissioners enclosing plans of an electric tramway they propose to construct along the shore of the Conway Bay from Deganwy to Llandudno. The Deganwy Estate Company have approved the scheme, and the promoters

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sought the approval of the Board. Mr. Elias Jones moved, and Mr. Bevan seconded, that the plans be referred to committee. Mr. Jones (Cedars) moved that the Board approve the principle of the scheme that day, without committing themselves to details. The scheme would develop the erection of residential property on the Conway shore, and ought to have commenced years ago. People would be able to come from Deganwy shopping to Llandudno in a quarter of an hour. Surely Llandudno tradesmen would not object to that. Mr. J. Owen seconded. Mr. Elias Jones saw no reason for such a great hurry. They were not opposed to the scheme, but it should be reported upon first. Several members thought it would facilitate matters if the principle of the scheme were approved that day, and eventually the amendment of Mr. Jones (Cedars) was carried by the casting vote of the chairman.

Westminster Electric Supply Corporation, Limited.—An extraordinary general meeting of this Company was held on Wednesday at the office, Eccleston-place, Belgravia, Mr. J. H Powell presiding, in the absence of Lord Suffield (chairman of the Company). The Chairman formally moved resolutions to the effect that out of the newly-created share capital of £100,000, £40,000 in 8,000 shares of £5 each be forthwith issued at a premium of £1 per share, and in the first instance be allotted to shareholders on the register on the 14th inst., in the approximate ratio of one to every completed eight shares then held; that the amounts due on the shares be payable as follows: £1 (premium) on January 3, 1895, £2 on January 15, 1895, and £3 on July 1, 1895, the new shares to rank for dividend (on amount of capital paid) from January 1 next; and that the balance of 12,000 shares be retained until such time as the Board deem it desirable to issue them. Mr. E. Boulnois, M P., seconded the resolutions, which, after a complaint from Mr. Tooth that the shares were not offered to the shareholders at par, were agreed to unanimously.

The Rhondda.—At the fortnightly meeting of the Rhondda Local Board the clerk read letters he had received from various colliery companies in respect to the proposed scheme to light the valleys by electricity. Messrs. Cory Bros., Cardiff, stated they had no supply of electricity to spare at the Gelli colliery, but at the Pentre collieries they could afford to supply the Board with 50-c.p. lights. As they were not accustomed to supply electricity to outsiders, it would be difficult for them to furnish terms. The company were prepared to give further consideration to the scheme. If the Sanitary Authority would grant a license for supplying the district generally, the company might be disposed to consider a scheme for laying down an additional installation to light the streets as well as the houses. Messrs. D. Davis and Sons, Ferndale, replied that they would give the scheme their consideration, and would forward their views to the Board in a few days. The Glamorgan Coal Company, Llwynypia, enquired whether the Sanitary Authority desired them to lay down cables, and what number of lights were necessary. After receiving full particulars of the scheme the company would be able to give a definite reply.

Leigh.—The Local Board have held a meeting, at which the chairman said that application had to be made to the Local Government Board for a provisional order for the extension of the gas-works during the month of November. Application had also to be made to the Board of Trade for a provisional order to supply electricity in the Local Board district within the month of November. All the details with respect to the introduction of the electric light would have to be fully considered hereafter. At the present time they had merely to pass a formal resolution to apply to the Board of Trade for a provisional order. The Gas Visiting Committee had been to Nelson, Lancaster, Morecambe, and Blackpool, and had also made enquiries elsewhere, and they were of opinion that the time had now arrived when the electric light ought to be supplied to Leigh; and they had reason to believe that there would be an adequate demand to justify them in introducing it to Leigh. He then formally moved, and Mr. R. Guest seconded, the following resolution which was carried unanimously: "That the report, dated November 13, 1894, of the Gas Visiting Committee, now produced and read, having reference to the supply of electric lighting within the Leigh urban sanitary district, be approved and adopted, and that the clerk be authorised to make application to the Board of Trade for a provisional order to supply electricity within the Leigh urban sanitary district under provisions of the Electric Lighting Acts, 1882 and 1890."

Dover.—It has been reported by the town clerk that the electric light company had paid their account for August, but the accounts for September and October were outstanding. The Chairman remarked that he thought the company should pay more promptly, the gas company would not want such long credit. Notice was received from the electric light company of their intention to continue their mains as far as Buckland Church, it having been decided to adopt the light in that church. A letter was read from Mr. Lawson, the engineer to the company, suggesting that as men expecting the work of fixing street lamps and laying mains were in the town, the light of the streets by electricity should be continued to the Town Hall. A memorial very extensively signed was also received from the inhabitants of Biggin and Cannon-street making a similar request. Councillor Finnis expressed his opinion that they ought to wait until the street was widened before going into the matter. The Chairman said he could not see that there was any objection to light Cannon-street. Councillor Barnes moved that the matter should stand over for a week. Councillor G. Mowll said he did not see how the Town Ward Lighting Committee could report until, the street was widened, as to the lamps required. Alderman Peake said that the complaint as to the street being badly lighted did not originate from any fault on the part of the gas company, but because the Council had not expended enough to light the street properly. They were open to compete with the electric light company so far as light was concerned. The matter was allowed to stand over for a week.

Edinburgh.—The Lord Provost has stated in a speech to the Town Council that the scheme for lighting the city by electricity would soon be completed, and he thought the Council was very much indebted to the convener of the sub-committee for the energy he had shown in carrying out the mandate of the Council. He trusted that the citizens would take kindly to the new light and become good customers of the town. In his opinion the introduction of the electric light would not affect in any degree the consumption of gas, provided, of course, the Gas Commissioners charged a popular price for it. There was plenty of scope for gas, not only as a heating agent, but also as a motive power. Messrs Mackenzie and Cranston gave notice of a motion to remit to the Lord Provost's Committee to consider and report as to whether it is desirable at this stage to arrange for laying down electric light high-tension cables from the station to Nicolson-street for the purpose of supplying domestic lighting through transformers. The Town Council have resolved, on the motion of Bailie Anderson, seconded by Mr. Hunter, to remit to the Lord Provost's Committee to consider and report as to which mode of tramway traction the Council should adopt in view of a change, wholly or partially, to mechanical power. The Electric Light Committee of the Edinburgh Town Council have agreed to supply electric current for the lighting of the M'Ewan Hall and the Medical School, New University, and also to give a supply to large business premises, called the Globe Mart, at the top of the Canongate. The supply is granted on the usual terms, that a certain amount of current is taken for three years. These buildings are outside the compulsory area.

Cardiff.—A special meeting of the Lighting and Electrical Committee of the Cardiff Corporation was held on Friday last at the Town Hall, Cardiff, the Mayor (Alderman Carey) presiding, for the purpose of making a primary selection of candidates for the post of electrical foreman at the Cardiff electric lighting works, the salary of which is £3 per week. The candidates selected to appear before the committee were Philip Peter, St. John's, Worcester; Thomas J. Archer, Chelmsford; and Charles H. Yeaman, Victoria-street, Westminster. Messrs. Leaf and Co. are now engaged fitting the new Aberdare Hall for the electric light. Mr. Harpur, the borough engineer, has told an interviewer that although meters for private consumers had been ordered some months ago, they have not yet been supplied. In consequence of this, a new scale of charges has been drawn up which it is intended shall remain in force until such time as meters can be obtained. The new scale is as follows:

Per lamp per annum. s.	d.	C.P. lamp.
15	0	8
22	6	16
34	0	25
45	0	32
66	0	50
113	6	100
227	0	200
340	6	300
		Watt arc lamp.
100	0	250
200	0	500

In lieu of a rate of payment of 6d. per Board of Trade unit as agreed in the requisition. For private residents and offices the charge will be one-third less.

Snowdon.—It was originally intended that the ceremony of cutting the first sod of the Snowdon electric railway would take place on Dec. 5. Owing to unforeseen circumstances this function has been postponed until December 15. The following letter has appeared in the *Times*: "Sir,—If I am not boring you about a matter which has already occupied much of your space, I should like, failing a better man's pen, to deal very briefly with the *altera pars*. Having known the Snowdonian district for 30 years, I am well aware how much the attractiveness of the great mountain could be increased by giving the 'old man in a hurry,' the middle-aged one, and the young facilities for ascending to heights sublime without the laborious walk of five miles from base to summit. No pedestrian would be robbed of his walk by the making of a funicular or other railway, and only one side of the giant hill would be disfigured. In all cases of this kind it is 'Arry who is dreaded, and he only is thought of; there are, however, many scholars and men of business and others with scant holidays who would make the ascent if only Snowdon were treated like Vesuvius, the Rigi, and Pilatus; and I feel confident that neither a cultured man like Canon Rawnsley nor more homely lovers of grand scenery need fear anything from the multiplication of excursionists, male and female, learned and ignorant, serious and frivolous. I made the ascent years ago on foot without a guide, being then what a Welshman called a good 'pedestinarian,' and I should like the glories of the mountain to be enjoyed by those whose holidays and breath are alike short. These latter look to wheels to help them, and I trust that the wheels will be forthcoming ere long.—Very truly yours, R. St. J. Corbet, St. Mary's-place, Shrewsbury."

South Staffordshire Tramways Company.—Justice Williams has had before him the petition of Smallman and others for a winding-up order in the matter of the South Staffordshire Tramways Company. Mr. Parker, for the petitioner, said the Company

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did not dispute, but asked for an adjournment. The assets were in the hands of a receiver and manager appointed by Justice Kekewich, and the action was coming for trial before Justice Kekewich in Chancery. His Lordship asked what was there to try? Mr. Parker replied that the point had been taken, and Justice Kekewich was now of opinion that he had not jurisdiction to appoint a manager, but only to appoint a receiver in this as a going concern. In that case the Company would be able to pay off these creditors, who were trade creditors. Mr. Stuart Smith, for the Company, and Mr. Levitt, Q.C., for the largest creditor, the Electric Construction Company, agreed to an adjournment. His Lordship said the case must stand over for a week. The case of Marshall *v.* the South Staffordshire Tramways Company, Limited, has been before Mr. Justice Kekewich in the Chancery Division, on the motion for judgment. Plaintiffs, who are the holders of debentures, asked for a declaration that mortgage debentures issued by the Company and its predecessors in title, and now outstanding, constitute the first charge on all the undertaking and property of the Company for an account of which is due and owing to plaintiffs—viz., principal, interest, and costs; and also to have a receiver and manager of defendant Company's undertaking included in the said debentures. At the conclusion of the arguments of counsel his Lordship held that the plaintiffs had no ground whatever for asking for a manager, and the only thing they were entitled to was the appointment of a receiver to make proper enquiries.

Bristol.—The chairman of the St. George's Local Board has informed the Board that a private company was seeking powers to light the parish by electricity, and he submitted to them whether they ought not to obtain such power, and then they would be in a position to use it if required. They ought not to give themselves to a private corporation without defending themselves to some extent. It was agreed to leave the matter to the new body to be dealt with. There was a large attendance at the meeting of the Electrical Committee of the Town Council on Saturday, all the members being present with the exception of Alderman Proctor Baker—viz., the Mayor, Alderman Pethick (high sheriff), Messrs. Bastow, Board, Hill, Hughes, Lloyd, Pearson, Pembery, Tryon, and Wills. The secretary having read the formal appointment of the committee, the Mayor proposed, and Mr. Charles Wills seconded, that Mr. George Pearson be appointed chairman for the ensuing year, and the motion was carried unanimously. On the motion of Mr. Pearson, Mr. Stephen Tryon was appointed deputy-chairman. The chairman, deputy-chairman, Alderman Pethick, and Mr. Hughes were appointed a sub-committee for finance for the ensuing year. The secretary reported the result of the circular letters to the occupiers of premises in St. Stephen-street, and the committee determined not to make the extension at present. Applications for a short extension along Percival-road, Clifton, were considered, and the committee determined to make the extension on the usual agreements, guaranteeing a minimum consumption, being entered into. Applications for an extension to Pembroke-road were considered and declined. An application for an extension to Victoria-square, Clifton, was reported, and the secretary was directed to send a circular letter to the residents of the west side of the square, with the view of ascertaining the amount of support the undertaking would receive in the event of an extension being made.

Asylum Lighting.—Messrs. Ernest Scott and Mountain, Limited, Newcastle-on-Tyne, send us particulars of the electric lighting installation carried out by them at New Craig House, Morningside, Edinburgh, to the order of the Managers of the Royal Edinburgh Asylum for the Insane. There are two steel Lancashire boilers, each 25ft. long by 7ft. 6in. in diameter, of a working pressure of 140lb. per square inch. These supply steam to four compound horizontal steam-engines, each capable of developing 60 h.p., for driving four dynamos — one engine being a spare. The engines are each fitted with cylinders of the following diameters: high pressure 8½in. diameter, and low pressure 14½in. The stroke is 16in. The engines are each constructed to run at a speed of 150 revolutions per minute. Four dynamos are provided of Messrs. Scott and Mountain's improved type, each machine being constructed to give an output of 240 amperes at 105 volts. The speed is approximately 700 revolutions per minute. The dynamos are belt driven. The installation is divided into 12 main circuits and a large number of sub-circuits. The whole of the cables used throughout the installation are highly insulated with vulcanised indiarubber, the minimum insulation resistance being 600 megohms per statute mile, but from careful tests taken by the consulting engineer, it has been found that the insulation of the whole of the building is extremely high; all cable is run in continuous wood casing, fitted with a moulded cover secured by brass screws. Great consideration has been given by the architect and consulting engineer to the class of switch most suitable for an installation of this kind, and the switches throughout are of a special type, the object being to prevent the patients interfering with them or switching on the lights. The switches in the main corridors, and in all positions where they could in any way be tampered with by the patients, are all of the sunk type, of solid brass, the face of the switch lying flush with the wall, and the switch can only be put on or off by a special key kept by the attendant. The whole of the work in connection with the lighting of the house has been carried out under Mr. W. A. Bryson, M.I.E.E., consulting electrical engineer, Glasgow, and Messrs. Sidney Mitchell and Wilson, architects, Edinburgh.

Coventry.—The General Works Committee of the Town Council have reported that in the agreement made April, 1893, between the Corporation and Mr. Graff Baker with respect to the equipment of the tramways, it was provided that if before September 30, 1893, the undertakers shall not have equipped the tramways upon the Thomson-Houston overhead system, the Corporation might require the tramways to be so equipped within three months from the date of such notice, and if after the expiration of such three months the tramways shall have not been so equipped, either party to the agreement might determine the same. No part of the tramways was equipped on September 30, 1893. After various postponements, the committee had received another letter stating that a gentleman interested in the matter was expected from New York, and asking that the matter may be again postponed until his return. The committee considered, however, that no more delay should take place, and recommended that notice be given to the proprietors of the tramways requiring the tramways to be equipped within three months. Alderman Marriott moved the adoption of the report, and said the whole subject had given the committee a vast amount of trouble and much anxiety. He thought every member must be pretty well satisfied that it was high time something was done to bring the matter to a conclusion one way or another. Either Coventry ought to have the tramways properly equipped and worked, or if that were not done, the rails should be removed. He was not one to advocate their removal—although in the first instance he was not a great advocate for tramways being laid—as the public had much appreciated them. It was the Council's duty to see that no more time was lost in getting them into proper order. Nearly two years had elapsed since the trams ceased to run, and sufficient time had been given to the owners. Time after time they had applied for extensions, and he thought nothing had been wanting on the part of the Corporation. The last communication made to them was that some gentleman was about to leave America. It was not said whether he was coming here or going to Australia, or what he intended to do. At any rate, it was high time the Council knew what all this was about, and he had great pleasure in proposing the adoption of the report. Alderman Singer seconded the adoption of the report, and it was carried unanimously. The corporate seal has been affixed to a mortgage of the general district fund for £300 at 3¼ per cent. for the electric light.

Ealing.—The Electric Lighting Committee of the Local Board have reported that a letter had been received from Mr. C. Shepheard, J.P., in which he stated that the electric lighting of his house in Grange-road had given great satisfaction. Messrs. Penny and Co. had written intimating their intention to wire five houses they were about to erect in Montpelier-road. Messrs. Bramwell and Harris, the engineers to the Board under the scheme, wrote that they were unable to ascertain with whom the fault lay that the work of laying the electric light mains in the Uxbridge-road towards the Acton boundary had been proceeded with in disregard of a resolution of the Board and of the instructions conveyed by them to the contractors in pursuance of that resolution. Mr. St. John thought that this letter was very unsatisfactory, and the Chairman expressed a similar opinion. The surveyor reported that, including applications from the Drayton Court Hotel and the three adjoining shops, and one from the High-street (which applications had just come to hand), the number of private 8-c.p. lamps applied for was 3,580, out of the 5,000 that at the inauguration of the scheme it was computed would be required by private residents; that number of lamps applied for was included in some 58 applications. Thirty-eight of these applications had been complied with by the connections being made; five other connections would be completed in the present week, and others, it was expected, would be finished in the course of the following week. The Surveyor added that he would be much mistaken if by March next the full number of 5,000 private lamps were not applied for, and the record in this matter for all England be thus broken. The Electric Lighting Committee, in their report, stated that the question of the extension of the mains for the purposes of private lighting had been considered by them, and was again deferred pending the signing of forms of application by the residents of the Mount Park district and tradesmen on the Haven Green-parade who had signed the memorial presented to the Board, and asking for the introduction of the light into that locality. Mr. Baker Hays urged that the Board should at an early period consider the question of extending the mains to, at any rate, the Haven Green-parade (for the accommodation of the shops there) and Woodville-road, if not beyond, into the Mount Park district. He pointed out that an increased private consumption of the light meant an additional revenue to the Board, with a consequent reduction of the cost of the street-lighting, and also of the rates; and whilst not formally moving on the present occasion any resolution on the subject, urged that the Board should take an early opportunity of letting the residents in the Mount Park district know that the Board had absolutely a definite intention of introducing the light into that district. When that intention was made known, Mr. Baker Hays asserted, signed agreements from residents to use the light would be readily and numerously obtained. Mr. Tidy thought that before proceeding to consider any extension of the electric area the Board should first have completed the works in the present area, as regarded repairs to the footpaths necessitated by the laying of the mains and the erection of the lamps that were not at present put up along the Uxbridge-road; there was, he said, plenty of work to do in connection with the present part of the scheme before any extension of the work was resorted to. Mr. Baker Hays responded that the matters to which Mr. Tidy had referred related to past history, and were matters of detail with the contractors; the proposed extension of the mains for the purposes of private lighting in other parts of the district was a matter of future work. The subject was not further pursued.

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PROVISIONAL PATENTS, 1894.

NOVEMBER 19.

22302. **Improvements in chairs for electric tramways, underground channel or conduit.** John Wilkinson, 27, Rawcliffe-street, South-shore, Blackpool.

22303. **Improvements in arc lamps.** Victor Henry Coates, Lagan Foundry, Belfast.

22325. **Improvements in safety and distributing fuses for electric light wire and for other purposes.** Ralph Gooch Tyler, 5, Crown-court, Cheapside, London.

22310. **Improvements in and relating to multipolar dynamo machines.** George Leonard Addenbrooke, 433, Strand, London.

22341. **Improvements in connection with the pickling of articles with the aid of electricity and apparatus therefor.** William Stepney Rawson and Woodhouse and Rawson United, Limited, 74, Coleman-street, London.

NOVEMBER 20.

22394. **Electric liquid level indicator.** William Blenheim, Station-road, Egham.

22403. **Improvements in and connected with steam-engines for driving dynamo-electric machines.** James Weir and James Gilmore Latta, 87, St. Vincent-street, Glasgow.

22453. **Improvements in the manufacture of insulated electric conductors and in the method of and apparatus for producing the same.** John Robinson, Norfolk House, Norfolk-street, London. (Complete specification.)

22458. **An improved electrically-propelled carriage.** Frank King, 47, Lincoln's-inn-fields, London.

22460. **Improvements in or connected with electrically-propelled vehicles for common roads.** Frank King, 47, Lincoln's-inn-fields, London.

22465. **Improvements in electrical switches.** William Thomas Burbey, 77, Chancery-lane, London.

NOVEMBER 21.

22486. **A sheet, card, or book, with alphabetical spaces or divisions containing names, numbers of telephone, and address of clients or customers, for telephone renters' use.** Sydney Buckthought, 53, Arcade-chambers, St. Mary's-gate, Manchester.

22517. **Improvements in commutator brushes for dynamo-electric machines.** William Begg, 62, St. Vincent-street, Glasgow.

22521. **Improvements in electric gas-lighters.** Axel Orling, 4, Corporation-street, Manchester.

22531. **Improvements in and connected with resistances and switches for electric circuits.** Michael Holroyd Smith, 55, Chancery-lane, London.

22547. **Improvements in electrodes applicable for use in electric accumulators and other electric apparatus.** Alexander Emil Hugo Honrichs, 191, Fleet-street, London. (The Firm of Hirschwald, Schäfer, and Heinemann, Germany.)

NOVEMBER 22.

22613. **Improvements in or relelating to the electro-chemical decomposition of solutions of salts.** James Charles Richardson, 19, Claremont-square, London. (Complete specification.)

22615. **Method of and apparatus for illumination by means of combustible gas with forced supply produced by electrical energy.** Louis Denayrouze, 28, Southampton-buildings, Chancery-lane, London.

NOVEMBER 23.

22700. **Improvements in accumulators.** Auguste Lesquoy, 70, Palace-chambers, Westminster.

22718. **Improvements in or relating to electric motors.** Alfred Julius Boult, 323, High Holborn, London. (Emmanuel Depoux, France.)

NOVEMBER 24.

22270. **Electrically-illuminated timepiece.** George Ashford, Montefiore, Caerleon-road, Newport, Mon.

22779. **Improvements in phonographs.** Joseph Oulton, 2, Market-street, Bradford.

22819. **Improvements in lock and block electric apparatus for railways.** Edward Tyer, 28, Southampton-buildings, Chancery-lane, London.

22821. **Improvements in conduits for electrical conductors and in the mode of making same.** James Tatham, 28, Southampton-buildings, Chancery-lane, London.

22824. **Short-circuiting device for stopping dental motors.** Francis Napier Denison, 4, South-street, Finsbury, London. (Complete specification.)

22826. **Improvements in the treatment of solutions of zinc chloride for the purification thereof for electrolytic purposes.** John Brock, Arthur Edward Waring, and Ferdinand Hurter, 47, Lincoln's-inn-fields, London.

22827. **Improvements in and relating to the treatment of solutions of chloride of zinc for the purification thereof for electrolytic purposes.** James Brock, Arthur Edward Waring, and Ferdinand Hurter, 47, Lincoln's-inn-fields, London.

22802. **Automatic electrical wonder.** William Frank White, 41, Meyrick-road, Clapham Junction, London.

22842. **Improvements in automatic circuit breakers for electric currents.** Jean Lorwa and Pierre Feys, 45, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1881.

129.* **Galvanic batteries.** Johnson. (Faure.) (Third edition.)

2272. **Storing electricity.** Swan. (Fifth edition.)

1889.

10933. **Electromoters.** Von Dolivo-Dobrowolsky and others. (Second edition.)

19555. **Electric induction.** Von Dolivo-Dobrowolsky and others. (Second edition.)

1890.

3082. **Incandescent electric lamps.** Langhans. (Second edition.)

5750. **Armatures for dynamo-electric machines, etc.** Crompton. (Fritsche.) (Second edition.)

8703. **Electric welding.** Thompson. (Coffin.) (Second edition.)

9861. **Electrical storage batteries.** Boult. (Tommasi and another.) (Second edition.)

14624. **Electrolytically making metallic articles.** Elmore. (Second edition.)

1893.

20698. **Electric cables.** Hardingham. (Felten and Guilleaume.)

21631. **Electrolytic apparatus.** Caldwell.

23074. **Electrical switches.** Theermann.

24889. **Phonographs, graphophones, etc.** Young.

24979. **Measuring and recording electric pressures and currents.** Baron Kelvin.

1894.

62. **Dynamo-electric machines.** Kingdon.

67. **Arc lamps.** Mensing.

646. **Voltaic batteries.** Walker and others.

14202. **Signalling by electric lamps.** Fitzpatrick. (Boughton Telephotos Company.)

15506. **Voltmeters, etc.** Brown.

17297. **Armatures for dynamo-electric machines.** Lake. (Eickemeyer.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	5	5⅛-6
Bournemouth Electric Company	—	—
Brush Company, Ordinary	3	2⅞-2⅞
—— Nom. Cum., 6 per cent. Pref.	2	2⅛-2¼
—— 4½ Debenture Stock	100	110-113
Charing Cross and Strand	5	4⅞-5⅛
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	12⅞-13⅛
—— 6 per cent. Cumulative Pref.	10	14⅞-15⅛
—— 5 per cent. Debenture Stock	115	131-133
City and South London Railway, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	122-124
—— 5 per cent. Pref. Shares	10	13⅞-14⅛
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2⅞-3⅛
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	96-100
Electric Construction, Limited	2	⅞-1
—— 6 per cent. Debentures	—	93-97
—— 7 per cent. Cumulative Pref.	2	1⅛-2
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1⅛-1⅛
Elmore's French Company	2	1-1⅛
Elmore's Wire Company	2	1-1⅛
Fowler-Waring Cables	5	⅛-1⅛
W. T. Henley's Telegraph Works, Ordinary	10	8-9
House-to-House Company, Ordinary	5	2⅛-2⅜
—— 7 per cent. Preference	5	6⅛-6⅜
India Rubber and Gutta Percha Works	10	25-26
—— 4½ per cent. Debentures	100	103-104
International Okonite, Ordinary	—	—
Kensington and Knightsbridge	5	4⅞-5⅛
—— 6 per cent. Pref.	—	6⅛-6⅜
Liverpool Electric Supply, Ordinary	5	7 1/16-7 3/16
—— Pref.	—	—
Liverpool Overhead Railway	10	7 15/16-8 1/16
—— Pref.	10	13-13½
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric	5	⅛-1⅛
Metropolitan Electric Supply	10	9⅛-10
—— 5 per cent. Reg. Debentures, 1-10,000 in Bonds of £10, £20, and £40	—	—
National Telephone, Ordinary	5	5-5⅛
—— 6 per cent. Cum. First Pref.	10	15-16
—— 6 per cent. Cum. Second Pref.	10	15-16
—— 5 per cent. Nom. Cum. Third Pref.	5	5⅛ 5⅜
—— 4½ per cent. Deb. Stock	—	110-113
Notting Hill Company	10	6⅞-7⅛
Oriental and Electric Company, £1 shares	1	1-1⅛
—— £5 Shares	—	6⅛-7⅛
—— £4½ shares	—	5⅛-6⅛
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7⅞-8
—— 7 per cent. Pref.	5	8⅛-9
Swan United	—	—
Telegraph Construction and Maintenance	12	41-43
—— 5 per cent. Bonds	100	106-109
Westminster Electric Supply, Ordinary	5	7-7⅛
Yorkshire House-to-House	4½	4⅛-4⅜

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NOTES.

Lecture.—Mr. E. Scott, chief draughtsman to the Electric Construction Corporation, has delivered a lecture on "Electricity" at Wolverhampton.

Night Watchmen's Check.—An electric system for controlling the rounds of night watchmen is described, together with illustrations, in *L'Electricien* of December 1.

Old News.—The *Globe* has just discovered that the Allgemeine Elektricitäts-Gesselschaft (*sic*) have brought out an electrically-lighted lifebuoy. We gave particulars of this months ago.

City and South London Railway.—This Company have raised their fares between the hours of 8 and 10 a.m. to 3½d. from Stockwell to the City. There is a good deal of grumbling at this advance of ½d.

Smithfield Club Show.—This year the Smithfield Club Show will open at the Agricultural Hall on December 10 and will close on the 14th. In the machinery department the number of exhibitors is larger than ever.

Antwerp Exhibition.—The London Chamber of Commerce has received a copy of the official list of all the awards made to exhibitors at the Antwerp Exhibition. This list may be inspected at the office of the Chamber.

Bedford Electricity Works.—We omitted to mention in our description of these works last week that the photograph showing an internal view of the station was taken by Messrs. E. Walker and Co., of Midland-road, Bedford.

Look Here!—Lord Sandhurst, at a quarterly general court of the governors of Middlesex Hospital, stated that the adoption of the electric light in the hospital had effected a saving of several hundred pounds in the course of the year.

Lime-street Telephone Exchange.—The National Telephone Company announce that any subscriber to the system can obtain permission to view the new Lime-street exchange by applying to Mr. A. Calder, metropolitan manager, 58 and 59, London-wall, E.C.

Society of Arts.—On Monday next, at 8 p.m., the third Cantor lecture on "Modern Developments in Explosives," by Prof. Vivian B. Lewes, will be delivered. On Wednesday, at 8 p.m., a paper will be read on the "Manufacture of Salt," by Mr. Thomas Ward."

Electric Traction in Dublin.—One of the *Daily News* young men has evidently been reading some of the back numbers of the *Electrical Engineer*, for he announced on Monday that the Dublin Southern Tramways Company have made arrangements to run their cars by electricity.

Mining and Mechanical Engineers.—The North of England Institute of Mining and Mechanical Engineers assembles in general meeting to-morrow (Saturday) in the Wood Memorial Hall, Newcastle. Mr. Alex. Siemens will present a paper on "The Cost of Electric Transmission of Power."

An Opportunity for Electric Traction.—As will be seen from our report of the meeting of the Tramways Company of France, the company have decided to substitute electric for horse traction at Rouen. The opportunity is one which should not be overlooked by English electrical firms.

Madras Electric Tramway Company.—Mr. J. E. O'Shaughnessy, a retired senior executive engineer of the P. W. D., Madras, and lately executive engineer of the Civil and Military Station Municipality, Bangalore, has been appointed chief engineer to the Madras Electric Tramway Company.

American Institute of Electrical Engineers.—The offices of the American Institute of Electrical Engineers have been removed to Rooms 1,009 and 1,010, Havemeyer Building, 26, Cortlandt-street, New York. The institute meetings will be held at 12, West Thirty-first-street, as hitherto.

Cooking by Electricity.—*L'Energie Electrique* of the 1st inst., in paying a tribute to the efforts put forth in London to obtain a day load for supply companies by the use of electric heating and cooking appliances, refers to the apparatus made by Messrs. Crompton and Co., of which it gives various illustrations.

Royal Statistical Society.—A paper has been read before this society on "The Eleventh United States Census" by the Hon. Robert P. Porter, superintendent of the eleventh census. At the conclusion of the lecture, Dr. Holleritt, by means of lantern slides, gave an account of his system of electrical tabulation.

Finsbury Polytechnic.—The sixth annual dinner of the clubs and societies of this institution will be held on Saturday, 15th inst., at the Three Nuns Hotel, Aldgate. The Archdeacon of London will preside, and Mr. F. W. Pixley will be in the vice-chair. Tickets can be obtained of the hon. secretaries, at the institution, Appold-street, E.C.

Registered Telegraphic Addresses.—The third and last supplement to the 1894 volume of "Sell's Directory of Registered Telegraphic Addresses," containing new registrations, cancellations, and alterations from June 1 to August 31 in the case of the Metropolis, and for May 15 to August 11 in the case of the provinces, is about to be sent out.

Electric Light Lanterns.—A supplemental list for 1894-95 of electric light and other lanterns has been issued by Mr. J. H. Steward, of 406, Strand, and 7, Gracechurch-street, E.C. Among the various specialities mentioned in the list are an electric triple lantern, one for institution or club work, an electric theatre light in substitution for the limelight, and a scenic projection lantern, together with accessories.

Northern Society of Electrical Engineers.—The annual general meeting will be held at the Palatine Hotel, Hunt's Bank, Manchester, on Monday, December 10, when the president, vice-presidents, officers, and council for 1895 will be elected. A paper will be read "On the Commercial Possibilities of Accumulators for Tramcar Traction considered as a Municipal Undertaking," by Mr. A. H. Gibbings, member.

New Books.—We have received the following new books: "An Introduction to the Theory of Electricity, with Numerous Examples," by Mr. Linnæus Cumming, M.A., fourth edition, with corrections and additions, published by Messrs. Macmillan and Co., price 8s. 6d.; and "The Electro-Platers' Handbook: A Practical Manual for Amateurs and Young Students in Electro-Metallurgy," by Mr. J. E. Bonney, second edition, published by Messrs. Whittaker and Co., price 3s.

The Proposed Pacific Cable.—To those who are interested in the projected Pacific cable, an article published in the *Journal Télégraphique* of November 25 will be of interest. The article, which is accompanied by a coloured map showing the different routes proposed for the cable, summarises the progress of the scheme since 1893 and the position of affairs at the present time, not excluding an extract from the report presented by Mr. Alex. Siemens to the recent inter-colonial conference on the subject at Ottawa.

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"Lightning."—Our contemporary has cut itself adrift from all respectable literature in its obvious lack of the commonest courtesies of life, and in its want of common decency, by indulging in personalities. We have no wish to graduate in the school of "Paul Pry" or *Town Talk*, and must therefore decline to enter the lists it so gracefully, in its own estimation, adorns. "There are critics who cannot swim, but who think it very clever to throw stones at swimmers." This sentence of Prof. Max. Muller might well be studied by many "knowing" people.

Institution of Civil Engineers.—On Tuesday next, at 8 p.m., an ordinary meeting will be held at which a paper will be read on "Colliery Surface Works" by Mr. Edw. B. Wain, A.M.I.C.E. On Friday next, at 8 p.m., at a students' meeting, a paper will be read on "Some Experiments on the Heat Losses to the Cylinder Walls of a Steam-engine" by Mr. S. Henry Barraclough, B.E., Stud.Inst.C.E., and Mr. Lionel S. Marks, B.Sc. Mr. Bryan Donkin, M.I.C.E., will take the chair.

Electric Traction in Egypt.—With reference to the note on this subject given in our issue of the 23rd ult., a telegram of Tuesday's date from Cairo states that the Cairo tramway concession to the Belgian Company was signed on that day. Lord Cromer has intimated to Mr. Fell that there is no chance of an amicable arrangement with the Egyptian Government, but the Government consents to acknowledge itself bound by Mr. Scott-Moncrieff's official letters as Under-Secretary. The hearing of Mr. Fell's case in the Appeal Court has been postponed.

Australian Cable Rates.—A Reuter's telegram from Wellington says: "The Victorian Government having announced its intention of withdrawing from the present inter-colonial arrangement regarding the cable subsidy, the Hon. J. G. Ward, the New Zealand Postmaster-General, has sent a reply to the Victorian authorities strongly deprecating the proposed withdrawal. He points out that it would compel the other colonies to follow Victoria's example, with the result that the high cable rates prevailing before the present agreement would be restored."

Transmission of Power.—The members of the Société des Ingénieurs Civils de France listened on the 16th ult. to a paper by M. G. Dumont dealing with investigations made by him, in conjunction with MM. G. Baignères and Lencauchez, on the electrical transmission of energy over long distances and on transmission by means of continuous currents. The paper, which was mainly of a historical nature, concluded by suggesting that electric transmission of power by means of overhead conductors should be preferably employed in organising the mechanical service of the exhibition to be held in Paris in 1900.

Removed from the Medical Register.—The General Medical Council on Saturday completed their enquiry into the conduct of Dr. Herbert Tibbits in connection with the "Medical Battery" Company and the establishment in Weymouth-street known as the "London Massage and Galvanic Hospital and West-end School of Massage and Electricity." The council decided to erase the name of Dr. Tibbits from the Medical Register. It is stated that erasure from the Medical Register carries with it inability to sue in a court of law for professional charges, or to sign valid medical certificates, and ineligibility for a number of public medical appointments.

New Mains in London.—The London County Council have sanctioned the laying of mains by the County of London and Brush Provincial Electric Lighting Company, under the County of London (North) Electric Lighting Order, 1892, in various streets in the northern and east central district; by the London Electric Supply Corporation in Blackfriars-road and Stamford-street, and in the Haymarket district; by the House-to-House Electric Light Supply Company in Old Brompton-road and neighbourhood; by the St. James's and Pall Mall Electric Light Company in King-street and Foubert's-place; and by the Westminster Electric Supply Corporation in Rochester-row and neighbourhood.

Institution of Electrical Engineers.—The annual general meeting will be held at 25, Great George-street, S.W., on Thursday next, the 13th inst. The annual report of the Council will be presented, and the election of Council and officers for the year 1895 will take place. Discussion will then be resumed on the following papers: "Electrical Steep-Grade Traction in Europe," by Mr. C. S. du Riche Preller, M.A., Ph.D., member; "Notes on Electric Tramways in the United States and Canada," by Mr. H. D. Wilkinson, member; and on "Electric Traction, with Special Reference to the Installation of Elevated Conductors," by Messrs. R. W. Blackwell, foreign member, and Philip Dawson, associate.

Electric Traction in Donegal.—Writing to the *Pall Mall Gazette*, "W. D. R." refers to an article published in that paper concerning the suggested construction of piers and harbours in county Donegal in preference to an expensive railway. He states that "if a railway be attempted I have often thought when glancing at the map, and when driving round the coast, that an electric carway (the electricity being generated by means of turbines on the innumerable streams) running along the coast road, would be the cheapest, both as to outlay and cost of working. It is, at any rate, a suggestion which should receive the attention of the Postmaster-General, as postal arrangements here are primitive in the extreme."

Applications for Provisional Orders.—In addition to the applications for electric lighting provisional orders to be made in the coming session of Parliament noted in our last issue, the following are announced: by the British Insulated Wire Company, Limited, of Prescot, to supply current in the townships and parishes of Prescot, Huyton, and Roby, Rainhill, Eccleston, and Whiston, all in the county of Lancaster; by the Municipal Electric Light and Power Corporation, 33, Old Broad-street, E.C., within the borough of Margate; by the Holloway Electricity Supply Company, Limited, 34, Victoria-street, Westminster, within the township of Great Crosby, Lancashire; and in Scotland for Montrose, Brechin, Motherwell, and Stirling.

Ealing Electricity Works.—The *Electrotechnische Zeitschrift*, in describing, in its issue of November 29, the electricity works at Ealing, assumes that the hot gases from the refuse destructor and fume cremator are only used for raising steam in the boiler or boilers for dealing with the day load, and that at night the gases are passed direct into the chimney, and the boilers fired with coal in the usual way. Whilst this course may be followed if desired, a reference to our description of the Ealing station will show that the works have been designed and have been operated so that one or two boilers may be fired with coal, and steam raised in the third by means of the hot gases, both operations proceeding simultaneously.

Ventilation of Conduits.—The recent explosions of gas and air in connection with junction-boxes, etc., of underground mains point very forcibly to the necessity for some effectual means of keeping gas out of the conduits, pipes, and boxes. One method which suggests itself is that of ventilation, but it seems doubtful whether pipes arranged in connection with the boxes will answer

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the purpose. A far preferable precaution, and one which, we believe, has already met with success, is to put down a blower or blowers and force *dry* air through the conduits. This system has been adopted with satisfactory results at Newcastle and Cambridge, and it is intended to introduce the method at the Bedford central station, which we described last week.

A Funny Man.—Alderman Pollack, in moving the adoption of the report of the Birmingham Corporation Gas Committee on Tuesday, is reported to have said that he ventured to say that this light (*i.e.*, gas) was infinitely superior to the electric light, while its cost was hardly one-third, probably not one-fourth, of that of electricity. He trusted that the conductors of all large institutions, and especially of those fostered by the Council, would think twice before satisfying the craze of electric lighting, when they had at their command a light equally good, if not superior, supplied from their own works at one-fourth the cost. Judging from the amount of repetition in this short but erroneous passage, the alderman himself is fitted to be on the Gas Committee.

Wayleaves.—A dispute has arisen between the French Government and the Paris Municipal Council out of the purchase of the telephones by the State. The Government telephone department claim the right to put their conductors inside the sewers, and the Municipality want to charge for the wayleave. The Government refuse to pay, and they point to a law of 1885 which declares they can use the sewers for the purposes of public utility, to which argument the Municipality reply that in purchasing the telephones the Government have embarked upon a commercial undertaking, and that they cannot claim privileges in connection with it to which the commercial company they have supplanted were not entitled. The matter is to be decided in the law courts.

Electric Lighting in France.—A central electric light station has been put into operation at Arques-la-Bataille in an old mill, where the waterwheel has been replaced by a Hercules turbine. A Postel Vinay continuous current dynamo is employed, which supplies current at a pressure of 110 volts, the distribution being effected by two overhead conductors.—At Clisson Mr. Rauold, of Landerneau, is carrying out an electric station, the water power of the Sévre being utilised. Two Hercules turbines, each of 15 h.p., drive two Brown dynamos delivering current at a pressure of 125 volts. A 40-h.p. steam-engine will be added in the spring.—La Talaudière, a village of 3,000 inhabitants, in the Loire, has been furnished with a central electric light station.

English Ingenuity.—A compliment to the resources of English electrical engineering is paid by the *Elektrotechnische Zeitschrift* of the 29th ult. Our contemporary refers to the economical advantages arising from the use of accumulators in direct-current central stations for dealing with the day load, but the difficulty is to effectually meet this requirement in alternating-current stations. As instances of how this obstacle has been overcome in some English stations, it is mentioned (1) that at Bristol a small gas-engine alternator is laid down; (2) that at Worcester turbine-alternators are used; and (3) that at Ealing the hot gases from the refuse destructor suffice to deal with the day load. Thus English engineers may congratulate themselves on their ingenuity in endeavouring to economically provide for the day load.

Electric Organ-Blowing.—Electric motors have been introduced into St. Paul's Church, Prince's-park, Liverpool, for blowing the organ. Current is obtained from the mains of the electric supply company in Belvedere-road. At the left-hand side of the organ is a switch by which the organist not only starts or stops the electric motors, two in number, but by which he can regulate their speed to suit the requirements of the music he is playing. There is also an automatic regulating arrangement which controls the speed of the motors in accordance with the wind required. The motors are connected by means of belts and crank-shafts to the feeders, which supply the wind to the organ. The arrangement is very compact. The electrical engineers who have supplied and fixed the electric motors and gearing are Messrs. Bergtheil and Young, of London.

Gas-Engine Competition.—The question as to the relative efficiencies of different types of gas-engines is occupying the attention of French periodicals and makers of such motors. In this connection it is probable that some interesting experiments with gas-engines will be conducted at an exhibition of gas-motors which is being organised by a committee appointed by the Société Technique de l'Industrie du Gaz, of 65, Rue de Provence, Paris, on the occasion of the congress which is to take place in Paris next June. It has been decided in principle that the exhibition will be restricted to small motors of not exceeding 10 h.p., that each exhibitor shall only display one engine of each type made by him, that only coal-gas motors will be admitted, and that experiments may be made with the engines by a special engineering commission.

Berlin-Vienna Telephone.—The Vienna Press, says a Vienna correspondent, were invited on Thursday last week to speak over the new line of telephone to Berlin, which was to be opened for general use on Saturday. The result was surprisingly good on the Vienna side, but less so, it is stated, on the other. The length of the line is 660 kilometres, of which 430 are in Austria, so that it is much less extensive than the present line between Bodenbach and Trieste of 1,100 kilometres. The minimum charge is to be three marks for three minutes. The cost of the line is about £10,000. The Austrian engineers began simultaneously to lay the lines in Lower Austria and in Bohemia on September 9, and finished before the end of the same month. The line has now been officially opened by a conversation between the Emperors William and Francis Joseph.

Transformer-Chambers.—An enquiry is to be held at the Board of Trade on the 13th inst. into the subject of transformer-chambers. The London County Council and other local authorities in the Metropolis have objected to the chambers being placed in the public streets, contending that they are a serious obstruction in the roadway and may possibly interfere with the laying of gas, water, and other pipes in the future, and, further, that they are a grave public danger. They have therefore urged the Board of Trade to compel electric lighting companies to place their transformer-chambers on private property. On the other hand, those connected with the electric lighting industry contend that there is no danger to the public in placing the chambers in the streets, and that they can be so constructed as not to form any serious obstacle to the future use of the streets for other necessary purposes.

Steam-Pipe Covering.—According to *Power*, a certain test of steam-pipe coverings leads to the conclusion that it costs 15·40dol. to run 100ft. of naked 2in. pipe at from 70lb. to 80lb. pressure for one year of 3,000 working hours, with coal at 2dol. per ton. With the least efficient of insulating coverings used in the test this loss could be reduced to 4dol., with the most efficient to 2·64dol. Striking as are these figures, they are probably below the cost of actual practice, for a steam-pipe is under pressure usually more than 10 hours a day, and 2dol. a ton is below the average cost of coal. Prof. Charles B. Gibson, in some tests for

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the Manufacturers' Mutual Insurance Company, some years since, reached the conclusion that with coal at 4dol. per ton and 3,000 working hours per year, the loss from a naked 2in. pipe was 64½ cents per linear foot—considerably more than Mr. Dickinson's test would show even with coal at 4dol. per ton. However, the lowest of the estimates shows the importance of covering the pipes.

African Telegraphy.—A Reuter's message from Blantyre (British Central Africa), dated October 16, says that great progress has lately been made with the construction of the telegraph line, and the most satisfactory co-operation has existed between the Portuguese and British authorities. Mr. Watson, the engineer employed by the African Transcontinental Company, has spanned the Zambesi at Tete, making use of an islet in the middle of the river for the support of the wire. The line has been completed between Blantyre and Tete, and also between Salisbury and Mazoe, 150 miles from Tete. A conference of agents-general and representatives in London of the South African Governments was held on Wednesday at the office of Sir Charles Mills, agent-general for the Cape of Good Hope. The countries represented were the Cape, Natal, Transvaal, Orange Free State, and several of the minor British possessions. The object of the discussion was to endeavour to obtain a reduction of the cable rates to the territories concerned.

Royal Institution.—The members of the Royal Institution held a monthly meeting on Monday, Sir James Crichton-Browne presiding. The following gentlemen were elected members: the Rev. J. O. Bevan, Messrs. H. T. Brown, F.R.S., H. S. Keating, G. Lindo, S. Morse, E. Steinkopff, G. J. Stoney, F.R.S., C. L. Tuckey, M.D., A. E. Western, C. Wightman, and G. W. Wolff, M.P. The special thanks of the members were returned to Mr. Ludwig Mond and Dr. William S. Playfair for donations towards the fund for the promotion of experimental research at low temperatures. Among the lecture arrangements announced were Prof. J. A. Fleming, F.R.S., six lectures, adapted to a juvenile auditory, on the "Work of an Electric Current," and the Right Hon. Lord Rayleigh, six lectures. The Friday evening meetings will commence on January 18, when Prof. Dewar will deliver a discourse on "Phosphorescence and Photographic Action at the Temperature of Boiling Liquid Air." Succeeding discourses will probably be given by, among others, Prof. A. Schuster, Prof. A. W. Rücker, Prof. Roberts-Austen, Prof. H. E. Armstrong, and the Right Hon. Lord Rayleigh.

Conduit Electric Tramways.—A paper asking the question as to whether there is a solution of the electric conduit railway problem was read recently by Mr. Joseph Sachs before the Electrical Society of New York. The author stated that the reasons for the non-success of such lines were that most of the projects were immature, that the inherent difficulties were great, and that the cost of construction was very large. On the other hand, he thought that the maintenance would seem to be less expensive than with the trolley. After describing a number of conduit systems, the author said that there was not much of a choice between them, as there had apparently been nothing practical evolved from the number described, except the plain open-slot conduit and continuous-wire system. This was the one in actual operation, and it had given satisfaction both at Budapest and at Blackpool, but he considered it was doubtful whether it could be made practicable in the United States, where the climatic and local conditions were different. The author was of opinion that we shall never get a conduit system which could be put in for £4,000 a mile, single track, and that it might be as high as £6,000 or £8,000 per mile single track. The system which is to be installed upon Lenox-avenue by the Metropolitan Traction Company was then described.

Luminescent Electric Lights.—Mr. H. Ebert recently contributed a paper of great interest to Wiedemann's *Annalen* on the production of light by high-frequency currents, in which results are indicated which are likely to prove of the utmost importance. The fundamental difference between the light and that associated with Tesla's name seems to be in an insistance upon the principle of resonance. He says that it is not necessary to use high tensions, since it has been found that intense light effects can be produced by the movement of exceedingly small quantities of electricity, provided only that the oscillations follow each other regularly and are persistent. The luminous substance of Ebert's "luminescent" lamp is said to be a small disc of compressed luminous paint. This is enclosed in an exhausted glass receiver, upon the external surface of which are glued two strips of tin-foil, to which the terminals of the circuit are attached. When the electric oscillations act upon these coatings active cathode rays are formed on the inner surface. These, though almost invisible themselves, produce a strong luminescent light upon the surface of the luminous paint. To determine the efficiency of the lamp, it was compared with the amyl acetate standard. Its candle-power was found to be about one-thirtieth of this, which is approximately equal to the standard candle. It was found that the energy actually expended in producing this light was only about one-millionth of a watt.

Government Telegraphy.—According to the *Daily Telegraph*, a proposal is under consideration at St. Martin's-le-Grand to celebrate in some becoming way the silver wedding of the State and the electric telegraph. "That union was effected on February 5, 1870, and the parties will therefore have reached the twenty-fifth year of a prosperous and profitable wedded life on February 5 next year. The occasion is one which merits to be marked with some festivity, for it signalises a date when stock can be taken of the immense progress made in the speedy transmission of messages nationally and internationally in 25 years. When the State took over the telegraphs, electricity as a means of communication was in its infancy. It has now reached a stage of considerable development, and promises in the future to attain a stature which no man may measure. Those who have never had the privilege of viewing the immense department of telegraphs at St. Martin's-le-Grand—a department which is continually increasing—can hardly imagine the extent to which the telegraph is now used, and the varied machinery, much of it of the most exquisite delicacy, placed at the service of the public. Many of the improvements made in the transmission and reception of messages have been the patient work of Post Office electricians, who freely put their discoveries at the disposal of the Government and the community without patent or reservation. It may safely be said that no country in the world has been better served telegraphically than this, and in none have greater developments been made quietly and unostentatiously. Under such circumstances, the silver wedding of the telegraphs and the State is worthy of cordial and hearty celebration."

The Light Railways Conference.—The following bodies were represented at the conference on light railways held yesterday at 8, Richmond-terrace, Whitehall:—London County Council: Rev. Fleming Williams, Mr. Bruce, Mr. Beachcroft. Association of Chambers of Commerce: Sir Albert Rollit, M.P., Sir Bernhard Samuelson, M.P., Sir Alfred Hickman, M.P., Mr. F. Corbett. Central

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and Associated Chambers of Agriculture: Mr. Channing, M.P., Mr. Jeffreys, M.P., Mr. R. H. Rew. London Chamber of Commerce: Sir Edward Carbutt, Mr. E. Garcke. Railway Companies' Association: Lord Claud Hamilton, Mr. J. C. Bolton, Mr. W. L. Jackson, M.P. Institute of Civil Engineers: Sir Benjamin Baker, K.C.M.G., Sir Douglas Fox. Association of Municipal Corporations: Mr. Alderman Brownsword, Mr. Harcourt Clare, Mr. G. C. Kent. Association of County Councils: Sir John Hibbert, K.C.B., M.P., Lord Thring, Lord Edmond Fitzmaurice, Mr. Henry Hobhouse, M.P. Scottish Chamber of Agriculture: Mr. Alexander Cross, M.P. Surveyors' Institution: Mr. E. P. Squarey, Mr. C. Oakley. Tramways Institute of Great Britain and Ireland: Mr. Carruthers Wain. Mansion House Association on Railway and Canal Traffic: Sir James Whitehead, Mr. Tomlinson, M.P. Institution of Electrical Engineers: Mr. Alexander Siemens, Major-General Webber, C.B. Royal Agricultural Society of England: Earl Cathcart, Mr. W. Frankish, Mr. Ernest Clarke. National Traction Engine Owners' and Users' Association: Mr. R. W. Eddison. British Dairy Farmers' Association. In addition, certain gentlemen having expert knowledge of the subject-matter attended the conference, among whom were the following: Duke of Sutherland, Lord Farrer, Lord Kelvin, Sir Juland Danvers, Sir Alexander Rendel, Mr. W. M. Ackworth, and Sir Richard Sankey.

Three Tracks.—Lately our American namesake wrote on the subject of the use of electric traction on short lines of English railway such as the City and South London, and it has now received the following rather curious suggestion from a gentleman who is described as a well-known steam railway expert, who writes: "It does not seem to me possible that one set of rails can answer both conditions—*i.e.*, keep the rails incessantly occupied with trains of the greatest possible frequency—say, with single cars or two cars running without schedule—and at the same time get high speeds. This query does, in fact, go to the root of the subject, but it seems to us that the answer lies in the resort to a third track. The New York Elevated has used this method for some time, and would use it even more if it were not to somebody's advantage to prevent it. By its means, even on its present limited scale, the Elevated can and does run its express trains down in the morning and back at night at high speeds, and with results most satisfactory to the passengers; while the two outer tracks are occupied by slow-moving trains either way. Now the conditions are very much the same on a large proportion of the English steam roads around the great cities, with several tracks extending for miles out; and we do not see any real difficulty in adjusting the bulk of the express traffic to a third track construction, thus giving a ceaseless service on the outer tracks either way and at a very high speed one way at certain hours of the day. The third track would also be available for no small amount of freight traffic in the hours when no expresses were moving. In this way it seems to us a greater traffic plying incessantly at remunerative low fares, approximating street-car fares, can be got upon part of the system, while it will be possible to run the expresses at higher speed than ever."

Electric Traction in Germany.—Two new electric traction schemes are announced in Upper Silesia. One of these is for a line from Antonienhütte to Morgenroth, Godullahütte, Schomberg, and Beuthen. The second, which is projected by Messrs. Schuckert, is to connect Königshütte, Heiduk, Schwientochlowitz, Zalenze, Kattowitz, Zawodzie, Bogutschütz, Dombrowka, Laurahütte, Rosdzin, and Schoppinitz. — Mr. Lehfeldt, of Leipsic, agent for the Allgemeine Elektricitäts-Gesellschaft, is projecting an electric tramway for Bamberg.—It is intended to construct an electric tramway to connect Cassel with Wilhelmshöhe.—A syndicate has been formed to erect a central electricity station and an electric tramway in Zwickau.—The line of steam tramways from Frankfort-on-the-Maine to Eschersheim has been acquired by the Union Elektricitäts-Gesellschaft, of Berlin. They will convert it into an electric line and propose to extend it to Oberursel.—Mr. Bachstein, a light railway contractor, has prepared a scheme for an electric tramway up the Wartburg, a matter which has been discussed for a long time. The line will pass through the streets of Eisenach.—The Munich local authorities have given permission for electric traction to be introduced on the tramway line from Färbergraben to Isarthal railway station. The tramway company will obtain plant and 12 motor cars from the Union Elektricitäts-Gesellschaft, and two reserve motor cars from Messrs. Schuckert and Co.—Mr. Otto Lohausen is seeking for a 45 years' concession for four electric lines in Berlin.—The overhead trolley electric tramway which has been constructed in Plauen by the Allgemeine Elektricitäts-Gesellschaft, is now in operation. It runs through the centre of the town and establishes communication between the two railway stations, which lie at opposite sides of the town.—A project for an extension of the Dresden electric tramway from Laubegast to Kleinschachwitz has been laid before the Minister of the Interior. A proposal is on foot to convert the Duisburg-Ruhrort horse tramways into an electric line.

Municipal Electric Lighting.—In the course of a paper read on this subject before the Canadian Electrical Association by Mr. E. Carl Breithaupt, of Berlin, Ontario, he said, after suggestions as to possible corrupt practices, that "there are other additional arguments against municipal ownership of lighting plants. The function of a Government is to regulate and control and to encourage enterprise on the part of its citizens by extending a protecting hand over the industries they establish. When a number of citizens band together, therefore, to carry on a business which is at best an uncertain one, one in which their works and plant are liable to serious injury from various causes, and in which they are not free to trade where and with whom they choose, but are restricted to localities—a business which confers a benefit to the community, and which is already more or less subject to municipal and legislative control, then it is obviously unjust for the municipality to establish and operate a plant in opposition to that of the private company. If a municipal corporation decide to enter into a field of commercial enterprise in which some of its citizens are already engaged, it is only simple justice that it shall offer to take over their works and plant at a fair and equitable price. Again, the wisdom of a municipality engaging in a commercial enterprise may be questioned; indeed, it is a grave question whether the Corporation has the moral right to risk the money of its citizens in an undertaking which is attended with such hazards, and in which the advantages to be gained are in any event small and uncertain. Many cities and towns have been persuaded by incomplete reports and alluring estimates to undertake the experiment, but it still remains to be proven that a municipal plant can supply a cheaper light than a private company. In towns which are not large enough to make the business remunerative, the installation of a plant by the corporation may be justified, because street-lighting is a public necessity; but where private plants already exist that are able and willing to supply the municipality at a fair price, the outlay cannot be regarded otherwise than as an unnecessary expenditure and a waste of public money."

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PHYSICAL UNITS.

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(Continued from page 642.)

PRACTICAL ELECTRIC UNITS.

§ 66. Let a conducting circuit be placed in a magnetic field, and let the current in this circuit be Γ under the action of an electromotive force E. Let the circuit be so moved that in time t the number of lines of force passing through it is increased by N, then the work contributed by the electromagnetic forces is measured by the product Γ N. But the work done on the current is E Γt.

$$\therefore E\Gamma t + \Gamma N = 0;$$

$$\therefore E = -\frac{N}{t}.$$

Hence, if the number of lines of force enclosed by a circuit be increased, an E.M.F. in the negative direction is set up, and the measure of this E.M.F. is the number of lines of force added per unit of time.

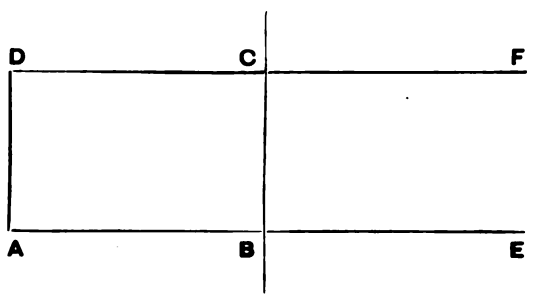

FIG. 3.

§ 67. In Fig. 3, let the circuit consist of two long parallel metallic rails A E, D F, connected permanently by a wire A D. Let B C be a slider free to move along the rails either towards A D, or E F. Suppose the plane of A B C D to be vertical, the rails to run from west to east, and that you are looking northwards at the figure, then the direction of the lines of force due to the horizontal component of the earth's magnetism is from the front of the page to the back, and these lines are practically parallel to one another. If a current in the circuit is in the direction A D C B, the slider will move eastwards towards E F, and cause an E.M.F. of the magnitude H l v to act round the circuit in the direction A B C D, where H is the number of lines of force per unit area perpendicular to A B C D, l is the length of the slider B C, and v is the velocity it has in the eastward direction. This illustrates the direction of the resulting E.M.F. Now if there be no current in the circuit, if the magnetic field be unity (one line of force per square centimetre), and if the distance between the rails be one centimetre, unit E.M.F. is induced in the circuit when the velocity of the rail is one centimetre per second. Thus unit E.M.F. is produced in any body which moves so that it cuts one line of magnetic force per second.

This unit is found to be too small for practical purposes, and a unit one hundred million times greater, called the *volt*, is taken as the practical unit. Thus, if we still suppose the rails to be one centimetre apart, and to be placed at right angles to a magnetic field of force of unit intensity, then when the slider moved with a velocity of one hundred million centimetres per second, the E.M.F. produced in the circuit would be one volt.

An E.M.F of one volt = 10^8 C.G.S. units.

§ 68. It is seen from § 59 that the dimension of resistance is a velocity, and Fig. 3 will, as first suggested by Lord Kelvin, show how a velocity may express a resistance. Instead of the linear conductor A D joining the ends of the rails, let us have a coil of vertical wire of radius r, with its plane in the magnetic meridian and a short magnet suspended at its centre. Let this magnet be deflected to an angle θ, when the uniform velocity of the slider towards E F is v units of length per unit time. Then if R be the resistance of the slider and circle of wire (the resistance of the rails being so small as to be negligible in comparison, so that the resistance of the whole circuit before the slider begins to move is R, and is still R after it has moved for some time) the current, by § 55, is

$$\Gamma = \frac{r}{2\pi} \cdot H \tan\theta.$$

But by the preceding section $\Gamma = \frac{H l v}{R}$;

$$\therefore R = \frac{2\pi l v}{r \tan\theta}.$$

If the radius of the coil be equal in length to the circumference of a circle whose radius is the distance between the rails, and if θ is 45deg., then R = v. Hence the resistance of the circuit in electromagnetic units is the velocity with which the slider of length l must move so as to give a deflection of 45deg. to the magnetic needle suspended at the centre of the coil. Note that this velocity is independent of the moment of the suspended magnet, and of the intensity of the field. It is also independent, as was pointed out by Weber, of the fundamental unit of length and of time chosen. In the centimetre-gramme-second system of units, unit velocity is a centimetre per second, hence unit resistance on this system is a centimetre per second. But for practical purposes this unit is too small, and a unit one thousand million times greater is taken as the unit of resistance, and is called an *ohm*.

A resistance of one ohm = 10^9 C.G.S. units.

§ 69. The practical unit of current derived by Ohm's law from these practical units of E.M.F. and resistance is called an *ampere*.

A current of one ampere = $10^8 \div 10^9$ C.G.S. units
= 10^{-1} C.G.S. unit.

70. The quantity of electricity conveyed by an ampere in one second is called a *coulomb*. An ampere is a coulomb per second.

A quantity of one coulomb = 10^{-1} C.G.S. unit.

§ 71. The practical unit of capacity is called the "farad," and by § 44 a condenser has unit capacity when a charge of one coulomb raises it to an E.M.F. of one volt.

A capacity of one farad = $10^{-1} \div 10^8$ C.G.S. units
= 10^{-9} C.G.S. units.

§ 72. The work done in raising a quantity of electricity Q, through a difference of potential E, is equal to the product of these two quantities. Hence

$$W = EQ = E\Gamma t = \Gamma^2 R t = E^2 t / R.$$

If these quantities are expressed in the absolute electromagnetic centimetre-gramme-second system of units, the work done in any time t is expressed in centimetre dynes or ergs. If they are expressed in terms of the practical units (for example, E in volts and Q in coulombs)

$$W = E \times 10^8 \times Q \times 10^{-1} = EQ \times 10^7 \text{ ergs.}$$

The work done by raising a coulomb of electricity through a difference of potential of one volt, is, on the suggestion of Sir William Siemens, called a *joule*.

One joule of work = 10^7 ergs.

Thus, if the difference of potential be expressed in volts, the current in amperes, and the resistance in ohms, the work done in any time t in an electric circuit is

$$W = E\Gamma t \text{ joules.}$$
$$= \Gamma^2 R t \quad ,,$$
$$= E^2 t/R \quad ,,$$

§ 73. If a joule of work be done in the circuit during each successive second of time, and if the work be done uniformly, then the rate of doing work is called a watt.

One watt = one joule per second
= 10^7 ergs per second.

Hence, expressing E in volts, Γ in amperes, and R in ohms, the activity in an electric circuit is

$$A = E\Gamma \text{ watts}$$
$$= \Gamma^2 R \quad ,,$$
$$= E^2/R \quad ,,$$

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To reduce this activity to horse-power, we have to divide by 746, for 1 h.p. = 550 foot-pounds per second

$$= 746 \times 10^7 \text{ ergs per second}$$
$$= 746 \text{ watts (see § 26)}$$

One kilowatt = 1,000 watts $\doteqdot 1\frac{1}{3}$ h.p.

The Board of Trade supply unit is one kilowatt for one hour, or a kilowatt-hour. It is, therefore, equal to 3,600 × 1,000 joules

$$= 3{\cdot}6 \times 10^6 \text{ joules.}$$

This is a departure from the decimal system, and many people specially wedded to the decimal notation state that the Board of Trade might have chosen* a million joules as the unit, and that wattmeters and joule-meters could have been graduated to such a unit quite as readily.

The practical unit of induction is called a *quadrant*, and is taken as 10^9 centimetres.

§ 74. The following table gives the ratio of these practical units to the units both in the electrostatic and electromagnetic systems:

—	Name.	Symbol.	Value in Electrostatic units.	Value in Electromagnetic units.
Quantity of electricity.	Coulomb	q Q	3×10^9	10^{-1}
Current ...	Ampere	γ Γ	3×10^9	10^{-1}
Potential difference..	Volt	e E	1/300	10^8
Resistance..	Ohm	r R	$1/9 \times 10^{11}$	10^9
Capacity.	Farad	c C	9×10^{11}	10^{-9}
	Microfarad		9×10^5	10^{-15}

§ 75. As these ratios are of great importance in the reduction of experimental results, they are given directly in terms of one another as follows:

One ampere $= 3 \times 10^9$ electrostatic units of current.

$= \frac{1}{10}$ electromagnetic unit of current.

One volt $= \frac{1}{300}$ electrostatic unit of potential.

$= 10^8$ electromagnetic units of potential.

One ohm $= \frac{1}{9 \times 10^{11}}$ electrostatic unit of resistance.

$= 10^9$ electromagnetic units of resistance.

One microfarad $= 9 \times 10^5$ electrostatic units of capacity.

$= \frac{1}{10^{15}}$ electromagnetic unit of capacity.

WHAT IS GRAVITY?

BY R. C. SHETTLE, M.D.

I think that the nature of this important form of energy is capable of being readily explained, provided we start our investigations with the conception of space as occupied by a medium the component elements of which are physically and mathematically identical in character.

It appears logically certain that such a medium must exist in one of two states—either it must take the form of a solid or of a perfectly homogeneous stuff. And as we know that the condition of the universe does not admit of the former, we are compelled to accept the latter conclusion, and to imagine space as having been occupied by stuff in a perfectly homogeneous state—in fact, by a medium in which the amount of stuff and of existent energy was disseminated with mathematical equality throughout.

It is evident that in such a medium, apart from any impressed force, there must be a state of *complete rest*, because without differentiation there could be no motion existent from within. And as we further recognise that gravity is essentially a force by which one body attracts another in proportion to the mass and inversely with regard to the square of the distance, we perceive that the energy of the stuff in which one uniform degree of density existed throughout, would tend to maintain equality of distribution and complete rest by the same laws which regulate gravity under any greater conditions of the force, because every portion of the stuff could only attract to the same extent as it was itself attracted by every other portion of the stuff with which it was in contact.

But the converse necessarily applies also, for the *energy* existent in any portion of the stuff became a *source of motion* as soon as balance of power had been disturbed by differentiation of density under *impressed force*. Therefore when motion had been originated, and matter had been formed by condensation, the sources of motion became infinite.

But it is obvious, to effect this change from a state of perfect rest to a state of incessant motion, the force must have been impressed in such a manner that *order*, and not disorder, should have resulted—*i.e.*, the consequent mechanism must have taken such form that the work done should originate the least possible degree of friction. Astronomy reveals the fact that, with few exceptions, the various bodies which constitute the universe are undergoing a special form of axial rotation, the general direction of which is the same.

The present paper attempts to define the mode in which the present condition of the universe would have been effected by the definite application of *power* to such a medium as I have described.

I will illustrate the principle to which I have referred in the following way: A number of magnets suspended in the same plane after a definite time come to rest, the general position of the magnets being the effect of the whole number, modified somewhat by the force of terrestrial magnetism. If now the position of one of the magnets be changed, the whole of the others under the influence of the general forces move also. Logically we may assume that very similar phenomena would have resulted if motion had been imparted to the homogeneous stuff which I have described.

I will now attempt to point out the very simple mode in which the general principles which I have defined appear to me to have brought the material universe into existence. The following are the points upon which I base my hypothesis of the formation of the universe under the influence of gravitation.

I.—That prior to the existence of formed matter space was occupied by a dense description of equally diffused and undifferentiated stuff, and that this stuff, owing to the perfect equilibrium which necessarily prevailed, was in a state of complete rest and devoid of any power of originating motion.

II.—That power was applied, and motion originated thereby.

III.—That the immediate effect of the motion was differentiation of mass quantity—by the condensation of some and the attenuation of other portions of the stuff.

IV.—That the secondary effect of motion was atomic cohesion; this was followed by molecular cohesion, and then by the aggregation of the larger masses under the weaker manifestation of the same force, now known as gravity.

Lord Kelvin has shown that "under certain conditions there will be produced by *pure* gravitation a force of attraction which may be of any amount however great." These conditions appear to me to be fulfilled in the perfectly homogeneous state of the primary stuff. Thus this stuff may be defined as highly elastic, the elasticity depending upon the *absolute contact* of its component parts, all of which having an equal density would equally attract and thus tend to maintain equal diffusion.

It is therefore logical to assume that any differentiation of the density of the stuff must result in a tendency of the denser portions to become more dense, partly because the parts of the stuff have been approximated under a force, the intensity of which, by the laws of gravity, must increase the more closely the parts are associated, and partly

* By the same reasoning, the earth might have made a hundred or a thousand rotations on its axis while making one complete revolution round the sun.

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because in proportion to the attenuation the energy of the surrounding medium has been locally diminished. In fact, the energy of the condensed portions would act from the circumference towards the centre. Now, as the extent of this attraction has been shown to be illimitable, the degree of compression or condensation which is capable of being exercised by absolute contact of the parts of the forming bodies would be regulated more especially by the quantity of the stuff differentiated; a point which appears to signify that the degree of density in matter is largely determined by the quantity of stuff which was apportioned to each form of matter.

V. I further venture to think that this atomic cohesion and all other forms of gravity are due to the attraction which bodies mutually exercise to *relieve pressure, regain equilibrium, and equal diffusion*, through the stress of other matter. Indeed, various natural phenomena when closely examined upon the principle embodied in this hypothesis clearly, as I think, indicate this. Thus this hypothesis shows that condensation is only a phase of a general elasticity resulting from inequality of diffusion of the original stuff, and it seems only logical to conclude that the formed thing should revert to the unformed—*i.e.*, to its original state—provided the conditions by which it was formed were removed; indeed, we know that the falling together of the celestial bodies would result in the dissociation by heat of their elements, and they would become stuff once more.

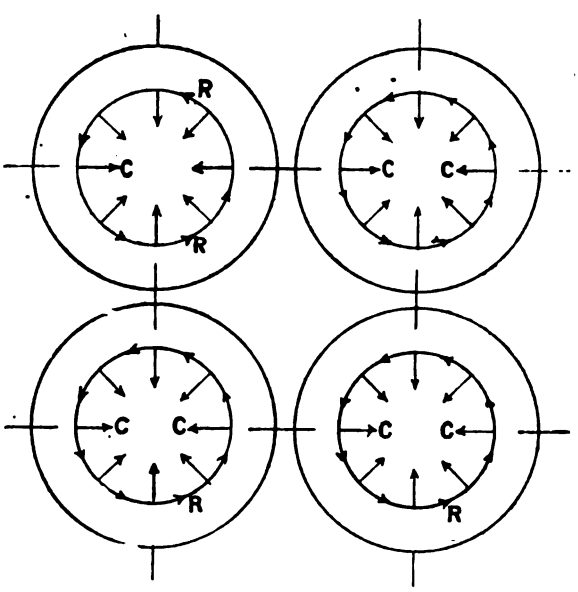

Diagram No. 1.

I append two diagrams illustrative of this point. No. 1 shows the mode in which differentiation of the stuff and the definite axial rotation of the condensed portions is supposed to have brought the material universe into existence. Under these conditions the stuff is being converted into a solid state whilst it is undergoing a definite form of axial rotation, the same general conditions resulting in the aggregation of the atoms into molecules, and subsequently into, it may be, the largest masses of the universe

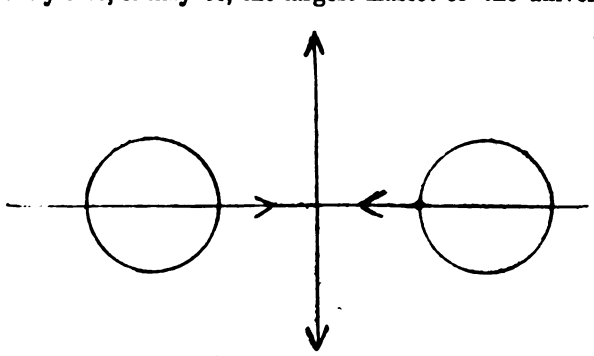

Diagram No. 2.

(in accordance with the theory of Laplace), whilst all the component elements are subject to the same description of axial rotation, performed with infinite precision. No. 2 shows the mode in which formed matter is reconverted into the original homogeneous stuff by throwing the mechanism out of gear and causing the masses to collide. In the latter state the new motion is productive of disruption, and as a consequence with proportional dissipation of matter.

VI. It is only logical to conceive that if the units of the masses were formed under *rotation* of the stuff, the centres which are undergoing condensation and conversion into formed matter would leave interspaces upon which no such condensation was exercised; but, on the contrary, the stuff in these spaces would become very highly attentuated by the dragging influence which each atom during its formation by condensation would exercise upon it. This hypothesis supposes that this residuum constitutes the *ether*, which is now supposed to pervade all matter and space. Thus, I define ether as the residuum of the primary stuff, and I think it logical to assume that just as a special quantity of stuff seems to have been necessary for the production of each form of matter, so a special quantity of the stuff was left to form a fitting medium, the ether, for the manifestation of the phenomena characteristic of the various forms of material energy. I may go further and say that it appears to me that a definite degree of tenuity would be effected, provided the stuff in the interspaces were subjected to attenuation, because the quantity of the stuff in these areas (marked S in the diagram) would always be determined by the areas in which the stuff was undergoing condensation. Upon this principle we perceive that the stress which bodies exercise upon the ether imparts great rigidity in the line of stress. I may add that I believe the ether which is condensed upon the atomic surfaces has an important function to perform in relation to animal and vegetable life. I think that Diagram No. 1, showing as it does the conversion of the stuff into a solid under rotation, necessarily conveys the idea of polar compression. I therefore assume that the formation of the atoms was attended with what may be described as double vortical motion of the homogeneous stuff.

VII. My next point is to show the mode in which the ethereal matter now pervades the larger masses of the universe with the same description of motion, either actual or relative. To define the character of these vortices as they are supposed to exist in a mass of formed matter, such as the earth, it is necessary to consider the facts closely upon which the hypothesis is based. In doing this we recognise that we have to deal with a porous mass of matter travelling through space with a high velocity. The axial rotation has a velocity of 500 *yards* a second. The orbital motion a velocity of 19 *miles* a second. The proper motion of the earth towards Hercules, as a unit of the solar system, is supposed to have a velocity of *four miles* a second. With reference to the effects of these motions of the formed matter upon the ether with which they are associated, we recognise (1) that the masses are highly porous; (2) that the ether pervades the atomic and molecular interspaces; (3) that each atom of formed matter in proportion to its mass appears to be acting as an exhaust engine upon the ether; (4) that as the ether is the residue of the stuff from which the atoms have been formed by condensation, it is necessarily very dense and closely packed upon the atomic surfaces. Consequently, every mass of gross matter is equally a reservoir of ethereal matter. This ethereal matter may be said to exist in at least three states: (*a*) that in which its density is greatest on the surface of the atoms; (*b*) that in which the density has been considerably reduced in the molecular interspaces; and (*c*) that of its highest state of rarefaction when it exists between the largest masses of the universe.

Accordingly, I think it logical to assume that in the first state it must (as Fresnel supposes) partake of the motions of the atoms. In the second, its velocity must be diminished in inverse proportion as the distance from the atom has increased, and, therefore, that it has a relative motion in the opposite direction. Whilst in the third state it has little or no motion of translation, but a relative motion opposite in direction to the motion of the masses, the velocity of which must be in proportion to their rate of motion—*i.e.*, as the stress upon the ether *takes its origin in the mass and partakes of its character and motion*, the intensity of stress upon the ether must diminish very rapidly as the

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distance from the atoms increases. It seems, indeed, certain that the ether has *a form, a character, and a motion*, which is the counterpart of that of the matter.

I therefore arrive at the conclusion that the earth, or any similar mass of matter, according to the stress which it exercises upon the stuff, throws it into vortical motion, the velocity and relative direction of which motion to the matter must be determined by the degree of stress.

I will now endeavour to point out the effect which two opposite bodies, such as the sun and the earth, mutually exercise by stress upon the ether contained in their respective masses, and with which they are otherwise associated. It is evident that the greatest intensity of stress existing between any two bodies is situated at points upon the surface of each, which may be defined by a straight line drawn through the centre of each. From thence stress is distributed in parallel lines in every direction in proportion to the mass. Thus, let A B represent two such bodies, and the line C A B D the line of the greatest intensity of stress.

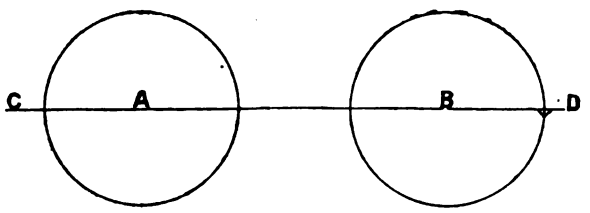

Diagram No. 3.

The effect of these stresses thus far is seen to be identical with those of gravity, but it is very important to bear in mind that whilst the formed matter traverses space as a highly porous body, the ether, except on the atomic surfaces (on which it is condensed, and to which it is therefore attached) is an immeasurably attenuated stuff which passes freely through those pores, and that it is at all times subject to stress.

It will also be recognised that A B, as parts of a system, are rotating axially in the direction shown by the arrows, and at the same time are traversing space in the direction and with the velocities already defined. With regard to the earth, we know that the resultant of the combined motions is *helical*, because it is compounded of a movable inclined plane and a lever—*i.e.*, the motion is the resultant of its axial, orbital, and proper motions. Consequently we find—

I. That each mass in proportion to its density is tending to drag the matter and the ether of the opposite mass towards itself; but whilst the formed matter under gravity pursues its well-defined motion, the ether, subject to the conditions named, is rushing through the molecular interspaces with a velocity which is in proportion to the motion of the mass, and a direction which is determined partly by the direction of the mass motion (to which it mostly has a relative motion in the opposite direction) and partly by the stress of the opposite body.

II. That in consequence of the helical motion of the masses the ether which traverses them partakes largely of the same description of motion, and as the point upon the surface of each mass where the intensity of any *external* stress is most marked is incessantly and very rapidly changing, so also are the conditions of the ether with regard to stress, and I think the only logical conclusion is that the ether is constantly being dragged by the stress through and out of the mass, the point of the greatest stress being the point where the ether makes its main exit, whilst the points which appear to most favour its entry are situated at or near the poles of rotation, thus giving origin to ethereal currents on the surface of the earth, something like the distribution of air currents from the poles to the equator, only reaching to a far greater extent.

III. That, as a consequence, the ether as it passes through a mass under the influence of external stress tends to assume double vortical motion, one of these vortices having a right and the other a left hand direction, the bases of the vortices being situated at and about the poles, and the apices at the point on the line of the ecliptic which marks the greatest intensity of stress.

IV. It is evident that none of these phenomena could be originated upon distant bodies, unless each mass by its own motion and stress originated motion in the ether with which it is associated. This also necessarily partakes of helical motion, and two vortices are formed thereby, the bases of which are situated at the line of the ecliptic, and the apices at the north and south pole. It will be observed that the bases of these vortices are situated at or near the line of the ecliptic, and the apices at or near the terrestrial poles. But in the case of the vortices which result from the action of distant bodies (as I have already stated), the bases of the vortices should be at or near the poles, and the apices where the intensity of stress is most marked on the line o the ecliptic.

V. That as each *external stress* is productive of similar effects, there exists a double vortex motion of the ether for each external stress; but the position of each pair of ethereal vortices varies with the relative position, which the bodies creating stress assume at any given moment.

VI. A necessary result of this stress upon the etherea matter is action and reaction throughout the entire mass, a process which essentially tends to keep the atoms and the mass compressed whilst undergoing axial rotation because each atom of the mass, or the mass itself, engaged in the production of stress is dragging the ether in two opposite directions at the same time, with stress which is proportional to the matter engaged in its production.

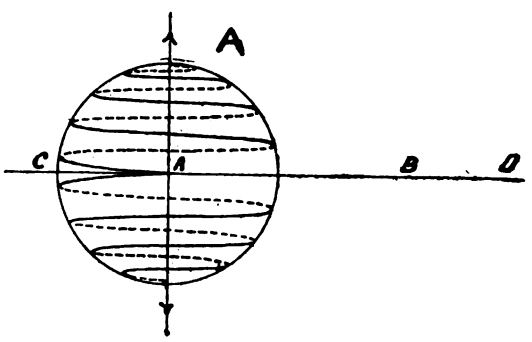

Diagram A.

The diagram marked A shows the stress of the sun producing a right and left hand helix of ethereal stuff in the earth. The central line marks the seat of the greatest intensity of stress, but the same description of stress exists, of course, all over the earth's sunward surface. There is, however, a more perfect mode of illustrating this phenomenon by the influence of magnetic stress upon iron filings. It is an experiment which I conducted many years since, and may be repeated in the following manner: Place some iron filings in a glass cell about 6in. long and 6in. wide, the interior of the cell being about ¼in. across, so as to prevent the poles of the magnet being too widely separated, then place it between the poles of an electromagnet, the filings will assume the form of rods across the cell, in the lines of magnetic force. When the cell is moved across the axis of force in either direction, each rod will rotate upon its axis on the one side to the right and on the other to the left, so as to rotate always

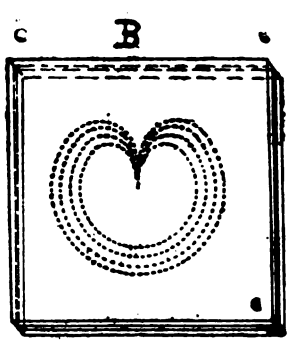

Diagram B.

towards the centre of the field. The diagram B shows the arrangement of the filings when the cell is being pushed upwards.

Supplement.

The conception of the material universe to which I have arrived from an investigation of the nature of gravity is—

(1) That the different forms of matter took their origin in a perfectly homogeneous stuff which occupied space. I

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arrive at the conclusion that the stuff must have been perfectly homogeneous, because purity of the primary stuff seems absolutely essential to the existence of that state of purity in the elementary bodies which is recognised.

(2) That axial rotation of differentiated quantities of this stuff was originated by *impressed* force, because physical science negatives the idea of any motion being originated in such a medium from within.

(3) That the character of the matter formed depended (*a*) upon the quantity of stuff differentiated, and (*b*) upon the description of axial rotation which it assumed under the stress of other bodies.

(4) That the stuff which is now recognised as ether is the residuum of the uncondensed liquid, which has been very highly attenuated under the stress of formed matter.

(5) That the density of this stuff varies with its relations to the formed matter, being most highly condensed upon the surfaces of the atoms, from which point the density rapidly diminishes until it attains its highest state of attenuation between the largest systems in interstellar space.

(6) That with regard to these axial rotations, the greatest regularity and order is essential to the maintenance of the material universe; indeed, were it otherwise, it would be resolved into the original stuff.

(7) With reference to the influence which stress exercises in the production of rotation, I would call attention, first, to electromagnetic rotations, and, secondly, to the rotation of copper spheres under the influence of electromagnetic stress—a phenomenon which I had the honour of exhibiting for the first time at a conversazione of the Royal Society in 1887.

Again, it is known that each of the planets has a special axial inclination, and this is supposed to be due to the influence which all bodies in the solar system mutually exercise. It is, I think, only logical to assume that the stress which each differentiated portion of the pure liquid exercises must act upon the same principle, and give to each portion of liquid engaged in the production of a mass a special form of rotation around a special axis.

I would further add, that the general principles embodied in this hypothesis appear to do away with all that mystery which hitherto has enshrouded so many natural phenomena.

CITY AND GUILDS OF LONDON INSTITUTE.

LECTURE XIII.—GENERAL DESCRIPTIVE KNOWLEDGE OF MAGNETS AND ELECTROMAGNETS. — BEST METHOD OF WINDING ELECTROMAGNET COILS FOR VARIOUS SERVICES.

(Specially contributed.)

The Natural Magnet.—Rodwell, in his "Dictionary of Science," says: "In Magnesia, a city of Lydia (hence probably μαγνης) a stone was found which, it was well known to the Greeks, had the property of attracting or drawing to itself small masses of iron. The Chinese also, as it appears from ancient manuscripts, were acquainted with this stone, and with certain other properties which it possesses. It is now found in many other parts of the world—in Arabia, China, India, Macedonia, Germany, Norway, and England. It is commonly called *loadstone*, and is known to chemists under the name of magnetic oxide of iron." Chemists denote the chemical composition of loadstone, or, as mineralogists call it, *magnetite*, by the formula Fe_3O_4, which may be read that three atoms of iron (Fe) combine with four atoms of oxygen (O) to form magnetite. The natural magnet is of little or no industrial importance. Its magnetic properties are weak. Whether the power of the natural magnet was accidentally discovered to impart similar powers to hard iron or steel, or whether it was noticed that hard iron or steel do under natural conditions obtain similar properties, I do not know. The discovery is lost in the mist of ages. In the "Arabian Nights" we find mention of the loadstone—poor Sinbad learned its attractive powers to his cost. The important property of the magnet first utilised was its taking a position pointing north and south when freely suspended. Whether this property was first noticed by the Chinese, and came from them through Arabia to Europe, is a question not settled. At any rate the magnet needle is first mentioned by European writers in the twelfth century, and it is rather of this magnet obtained in steel by rubbing with loadstone, or another magnet, or by means of a current, that I shall speak at some length.

Permanent Magnets.—The first systematic investigation of the properties of the magnet was by Gilbert, a native of Colchester, in 1600. Most writers on magnetism jump from the work of Gilbert to that of Faraday in the nineteenth century, and have, most unaccountably to me, ignored the work of such men as Walker at the end of the eighteenth century. I do not intend in these lectures to trouble you much with historical remarks, but must be somewhat lengthy in my references to Walker. With very little emendation, many of his sentences describe the theory of to-day. I have had reproduced as faithfully as photography will reproduce some of the illustrations in his book, and you will see that, so far as these particular illustrations are concerned, they faithfully represent the teaching of the most advanced teachers of to-day. What Walker called a *subtil effluvium*, we call magnetic flux.

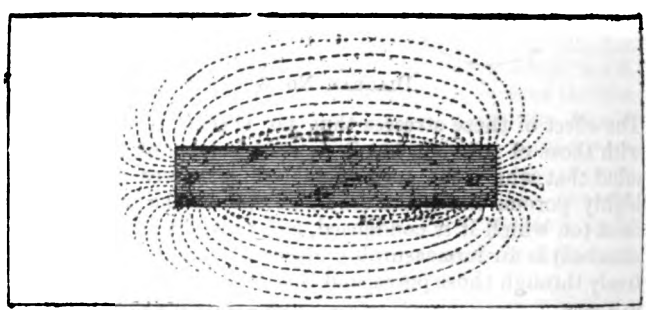

FIG. 1.

Here are two illustrations taken from Walker, and in his book form Fig. 6, plate 1, page 64, and Fig. 6, plate 2, page 64. Of the cause of magnetisation he says: "May we not apprehend this to be occasioned by a subtil effluvium, flowing from one end of the magnet and entering at the other? These two ends are called the north and south pole of the magnet. The reasons we have to believe that this effluvium does exist are:

"First. If wire filings be shaken through a gauze sieve upon a paper that covers a bar magnet the filings will become magnets, and be arranged by the incumbent magnet in the beautiful curves in Fig. 6 [our Figs. 1 and 2]. Upon

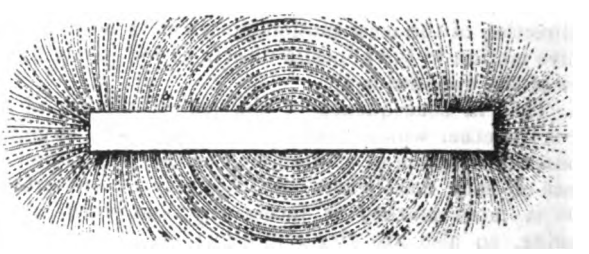

FIG. 2.

the two ends of the magnet at *a a* the filings stand perpendicular, and seem buttresses of arches that would stand over the magnet. On the sides of the magnet they slope or incline, and seem buttresses of inclining arches; so that if filings could be sustained all round the magnet they would probably assume an egg-like figure. Is not this appearance favourable to the idea of an effluvium *flowing all round the magnet from one end to the other and having a circulation through it?*"

There is no difference in Mr. Walker's views as to the subtil effluvium and the modern views of magnetic flux. Let me take as my example of the teacher of to-day Prof. Silvanus P. Thompson, F.R.S., who is *facile primus inter pares*, as Prof. Max Müller puts it. He says, page 40 of his book on "The Electromagnet":

"In the case of a bar magnet we conceive these lines as flowing through the metal, emerging at one end (the north

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pole) and curving round to re-enter the metal at the other end (the south pole). In Fig. 17 [our Fig. 3] these lines are drawn both internally and externally. Everyone knows that if we dip such a magnet into iron filings the small bits of iron stick on, more especially at the ends, but not exclusively; and if you hold it under a piece of paper or cardboard and sprinkle iron filings on the paper, you obtain curves like those shown on the diagram."

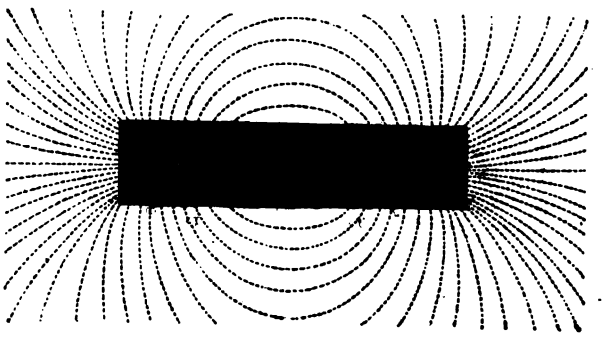

FIG. 3.

If you carefully compare Mr. Walker's diagram with that of Prof. Thompson's, I think you must admit their identity, and also you must admit the identity of the description of what constitutes the magnetic property. The greatest density of lines in all cases is shown to exist at the centre of the bar magnet. The filings do not stick there, as no lines escape from the metal. The filings cling where the lines escape; and where the lines escape most the filings are thickest. It is near the poles that the lines escape or enter most, and it is at these places the filings are thickest.

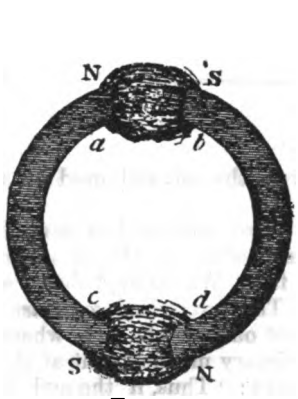

FIG. 4.

FIG. 5.

I cannot recite in detail all Mr. Walker's observations, but his Figs. 8 and 9 (our Figs. 4 and 5) and his remarks about them can be compared with what I said last week. His Fig. 8 is practically identical with my Fig. 3 of last week. He does not indicate the course of the lines through the metal, but what I have said of his views just now shows that he understood the flow to be right through the metal. See how his indicated filings bulge out in the air-gap, just as I explained they do. Here is what he says of these figures, page 45:

"Third. Two semi-circular magnets, A and B (Fig. 8), having their poles dipped into iron filings, the filings will stick radiantly to the poles in every direction. If the pole *a* be brought within half an inch of the pole *b*, and the pole *c* at the same distance from *d*, the filings leave their radiant direction and catch hold of the filings of the opposite poles; for *a* and *c* being delivering poles, *b* and *d* receiving poles, a magnetic circuit is formed, and the filings become conductors. But if the pole *a* be addressed to *c*, and the pole *b* to *d*, the filings will not unite, but repel those opposite to them, as Fig. 9 [our Fig. 5]. In one case the magnetic effluvium has a regular circular road; in the other the fluid of one magnet meeting the fluid of the other a repellency takes place. Are not these experiments strongly indicative of a magnetical effluvium?"

In the following paragraph, from page 46, there is a slip as to the number of balls, but the idea of the magnetic circuit is quite clear:

"Fifth. When three of the balls are suspended from each pole of the above magnet (for except the magnet be very strong it will not sustain more perpendicularly), if two others are so added that they all touch each other, they will adhere circularly to the two poles, and form the image, Fig. 11 [our Fig. 6]. Can this be for any other reason than because the balls and the magnet make one complete magnetical circuit."

Four years before this work of Walker, a more pretentious work in five volumes was written by Mr. George Adams, but although the diagram of the lines of force are

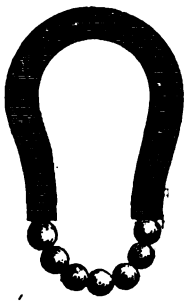

FIG. 6.

excellent, I can find no indication of the idea of a magnetic circuit. Having thus briefly glanced at history, I will return more directly to my subject. Fig. 7 shows the lines of force of the bar magnet, N S. The diagram is

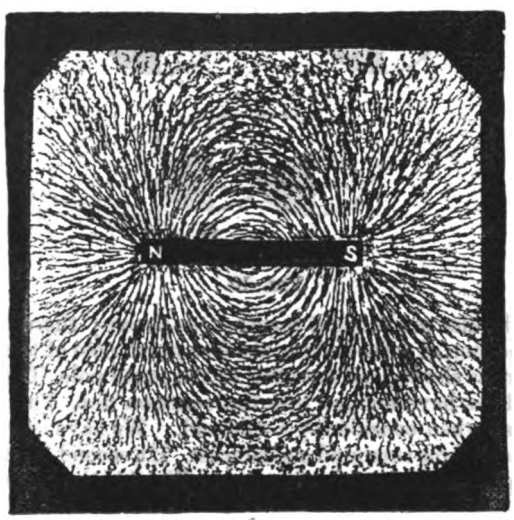

FIG. 7.

from a photograph. If I take any bar magnet, such as N S, and cut it into two parts, each part becomes a complete magnet. If I again divide each part, I again get complete magnets, and we may assume this division to be carried on till we get at last to the molecule of steel, which is the smallest quantity of steel that can exist, and must assume that the molecule is a magnet.

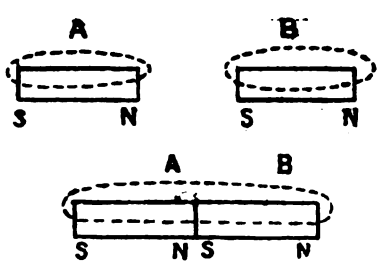

FIG. 8.

If I take these two similar magnets, A and B (Fig. 8), each one has its two poles, N S; but if I bring two of the oppositely-named poles together as shown, the combination forms one magnet with only two poles. I may assume, then, that any magnet is made up of its molecules so arranged that their opposite poles are adjacent, as indicated in Fig. 9, when the shaded part indicates the north pole of the molecule, and the unshaded part the south pole. If the molecules are not arranged in this systematical

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manner, or so as to form a polarised chain, but in a fashion so that the polarities are lost or masked by forming *complete magnetic circuits within* the boundaries of the metal, we get no external manifestation of magnetism. It is only when the polarised chains or lines are continued outside the

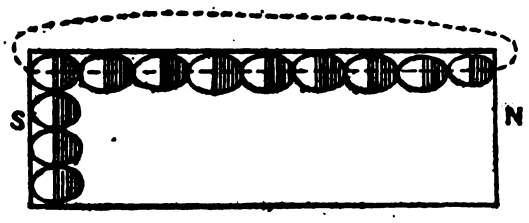

FIG. 9.

metal that we get manifestations of magnetism, and by what medium these polarised chains are continued we do not know. We may picture to ourselves a chain of polarised molecules, the axis of the chain being a line of force.

Although I have no greater authority than myself for suggesting it, let us suppose that each molecule is the seat of one line of force which leaves the molecule by the north and enters it by the south pole, Fig. 10, A and B, and that

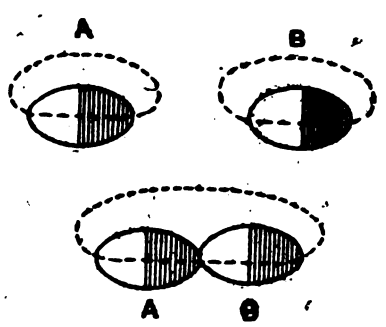

FIG. 10.

two molecules are brought together, as shown; there is still only one line of force leaving the free north pole of the combination, as shown, and entering by the south pole. The individual lines have merged into the common line. This holds good also when considering a solenoid. We have seen that the lines of force surround a conductor. If a second conductor is brought parallel to the first, as in Fig. 11, the lines, as it

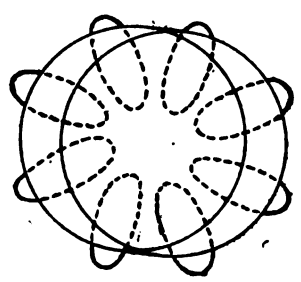

FIG. 11.

were, coalesce and surround both conductors. If a succession of conductors are used, then the lines circulate around all the conductors.

The Making of Magnets.—If I take a bar magnet, A (Fig. 12), and bring into contact with it the piece of

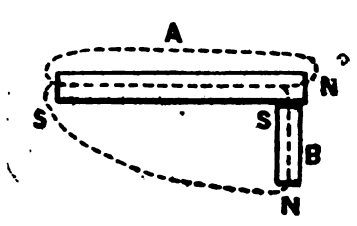

FIG. 12.

iron, B, some of the lines of force of A will go through B, and B will become magnetised with a south pole, S, next the north pole of A, and with a north pole, N, at the other end. In fact, B forms part of the magnetic circuit. If now B consists of very soft iron, when it is taken away from A it practically loses the whole of the lines of force that went through it, and will not act as a magnet when taken away from A; but if it consists of hard iron, or better, of steel, then it will retain many of the lines of force, and act as a magnet when taken from A. The number of lines it would retain, however, under these conditions would be few, and B would act only as a very weak magnet. A better way to obtain a stronger magnet would be to place B, Fig. 13, so that it can be well rubbed with the magnet, A. Let B be as shown, and bring the magnet, A, so that the north pole, N, be placed on the end C of B. Draw A along B to D so that the north pole of A leaves B at D. Raise A considerably above B, and bring the pole, N, down again at C. Draw along B as before. Do this a number of times, and it will be found that B is magnetised so that it has a north pole at C, where it is first touched, and a south pole at D, where the magnet, A, leaves it. There are other ways of obtaining magnets by rubbing steel with a magnet, but a simpler way is to make the magnets by means of a coil. We have seen that the iron core of a coil is magnetised, and just as in the other case, if we use soft iron, the core loses most of its magnetic properties as soon as the current in the coil is stopped; but if it is of hard iron or steel it retains these properties,

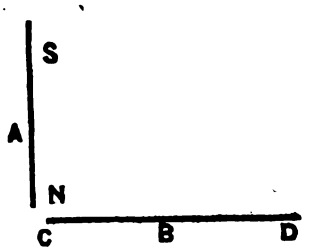

FIG. 13.

and can be moved right away from the coil and used as a magnet itself.

It is possible so to magnetise a bar that it has several poles, though it is absolutely impossible to obtain a bar with one pole. Fig. 14, taken from Walmsley,* shows a bar magnet with several poles. They are called *consequent* poles. The iron filings adhere not only at the ends where we expect them to adhere in ordinary magnets, but at the other polar points. Walmsley says: "Thus, if the end N of the bar be a north pole . . . the region A will

FIG. 14.

exhibit south polarity, the region B north polarity, the region C south polarity, and the other end, N^1, will be found to be a north pole." Magnets with consequent poles have very little industrial use. Such a magnet can be made by rubbing in an irregular manner when magnetising, or if magnetising by a solenoid, by turning the conductor back and winding in the contrary direction at the points the consequent poles are wanted.

A short time ago I indicated that pieces of iron or steel might be naturally magnetised without any individual intending them to be magnetised. From many indications we must assume the earth to have the properties of a magnet—to be a huge magnet, if you so like to term it. Now, if bars of steel or iron be accidently placed in the direction of the lines of force belonging to the earth's magnetic field, these bars will be magnetised. To find the direction of the lines of force of the earth, we use a small magnet so suspended as to be able to move vertically. The axis of that magnet will then take up a position tangential

* "The Electric Current," by R. Mullineux Walmsley. Cassell and Co. The best general book on electricity for students in the English or any other language.—ED. *E. E.*

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to the line of force of the earth, or it takes up a position so that its lines of force are parallel to those of the earth. Such a magnetic needle is called a dipping needle, and a piece of iron or steel placed parallel to the dipping needle will become feebly magnetised with its north pole at the lower end in this hemisphere. The earth's action on such a bar is very weak, and is assisted by striking the bar with a mallet or something of the kind. The mechanical jar helps the polarising action of the earth. Fig. 15 shows the action of the dipping needle. The upper needle is resting horizontally, as any piece of wire or steel would rest when not magnetised. As soon as it is magnetised it takes up a slanting position, as indicated by the lower needle of the diagram.

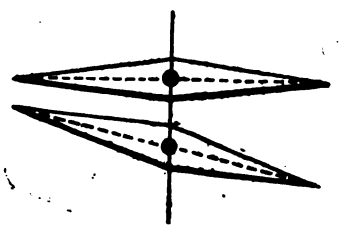

FIG. 15.

The shape of the permanent magnet is not necessarily bar-shaped—in fact, it is usually horseshoe-shaped, in order to utilise the action of both poles. Permanent magnets, too, are usually provided with soft iron armatures, so as to make the magnetic circuit when not in use as short as possible.

ELECTRICAL TRADES SECTION.

The Electrical Trades Section of the London Chamber of Commerce met at Botolph House on the 7th inst., Mr. E. Garcke (chairman of the section) presiding.

After confirmation of the minutes of the section meeting on August 14, the CHAIRMAN stated that several meetings of special committees had since been held, and as regards electric traction it was expected that the syndicate interested in the matter would shortly demonstrate their system by means of a vehicle on the streets, and that it would thus be brought under the notice of the Board of Trade and the Home Office. The chairman read a letter from Mr. R. P. Sellon with reference to the objections raised before the Board of Trade by the London County Council to the placing of transformer-chambers in the public streets, on the grounds that they formed a serious obstruction in the roadway which might interfere with future gas, water, sewer pipes, etc., and that they constituted a grave public danger. It transpired that the Board of Trade regarded the matter of such importance that its further consideration had been postponed until the 13th inst., to enable those concerned to appear by counsel or bring expert evidence in support of their contentions. The bodies represented at the meeting at which the matter was raised were the London County Council and the local authorities of Islington, Hampstead, St. Luke's, Wandsworth, and Kensington, as well as the County of London Company. The feeling of the latter company was that the question concerned all who were connected with electricity supply where transformation was necessary.

After remarks by Mr. R. P. SELLON and Mr. SIDNEY MORSE (who was of opinion that there would be less difficulty in meeting the objection on the ground of obstruction than that of public safety), it appeared to be the general view of the section that it was desirable that the interests of supply companies and others concerned should be represented at the enquiry, especially in view of the suggestion that transformer-chambers be placed in private property only. A resolution was therefore agreed to, at the instance of Major FLOOD PAGE, seconded by Mr. BULL, to the effect that the section was unanimously of opinion that the transformer-chambers in the streets would not be dangerous to the safety of the public, and could be constructed so as not to form any serious obstruction to the future use of the streets for other necessary purposes, and that representations be made to the Board of Trade to this effect.

The section approved of the terms of a draft circular letter to the supply companies, as a result of meetings of a special committee as to the manner in which such companies were likely to be affected by the incidence of local rates. It appeared to the committee from several cases which had been brought under their notice that the rating authorities were becoming alive to the fact that electric lighting companies, whose capital was not always obtained from the locality, might be made to contribute large sums in the way of rates, and thus lighten the burden of capitalists residing in the districts in which the electric light stations were situated. The enormous increase in the assessment of the St. James's and Pall Mall Electric Supply Company were detailed in the circular, which invited other companies to forward information to the secretary with a view to concerted action being ultimately taken in the interests of all concerned.

Mr. SIDNEY MORSE called attention to the methods adopted in the courts of hearing motions involving electrical questions, and the subject was deferred until the rules of the new Commercial Court have been obtained.

It was agreed that in future the meetings should be held on the first Friday in the month, commencing with January, 1895.

INSTITUTION OF ELECTRICAL ENGINEERS.

The following is the house balloting list for Council and officers for the year 1895:

PRESIDENT.

R. E. Crompton, M.Inst.C.E.

VICE-PRESIDENTS (*four to be elected*).

Sir David Salomons, Bart., M.A.
Sir Henry Mance, C.I.E., M.Inst.C.E.
Prof. George Forbes, F.R.SS. (L. and E.)
Robert Kaye Gray, M.Inst.C.E.

ORDINARY MEMBERS OF COUNCIL (*12 to be elected*).

Major A. H. Bagnold, R.E.
Frank Bailey.
W. B. Esson.
Walter T. Goolden, M.A.
Prof. A. B. W. Kennedy, LL.D., F.R.S., M.Inst.C.E.
Prof. John Perry, D.Sc., F.R.S.
Augustus Stroh.
James Swinburne.
*G. von Chauvin.
*S. Z. de Ferranti.
*William E. Langdon.
*Prof. S. P. Thompson, D.Sc., F.R.S.

ASSOCIATE MEMBERS OF COUNCIL (*three to be elected*).

*Augustus Calder.
*Captain George Carr, R.E.
*J. M. V. Money-Kent.

HONORARY TREASURER.

Sir David Salomons, Bart., M.A. (Vice-President).

HONORARY AUDITORS.

Frederick C. Danvers, India Office, S.W.
Augustus Stroh.

HONORARY SOLICITORS.

Messrs. Wilson, Bristows, and Carpmael, 1, Copthall-buildings, E.C.

* New members recommended by Council.

Telephony in Germany.—Direct telephonic communication has been established between Chemnitz and Leipsic, by which the service which was previously carried on through Meerane has been expedited. It has also allowed of Döbeln, Waldheim, Mittweida, Frankenberg, Zschipau, Annaberg, Bucholtz, Lugan, Stollberg, and Burgstädt, which are connected to Leipsic, being able to communicate with Chemnitz. They were not formerly in a position to do so owing to the heavy traffic on the Meerane line.—A telephone exchange has been established at Celle for the town. It is also connected with Hamburg and Hanover.—A telephone system has been established at Nauendorf in the Saal district, comprising Nauendorf, Löbejun, and Wettin. The system has connections with Halle, Leipsic, and Berlin.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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TRACTION HORSE-POWER.

It is perhaps not unnatural for those who have never studied the details of electric traction to wonder why it is that the generating plants installed at supply stations for operating electric tramways are usually calculated on such a generous, if not excessive, basis, when the number of cars on the line is taken into account. For engineers to be surprised at the apparent discrepancy shows, however, that they do not believe in, or bear in mind, the comparatively high efficiency of electric traction—otherwise they would see that no real discrepancy exists at all. If this efficiency is as stated, there can be no such excessive waste of power in the generating plant, and the simple fact is that the electric cars travel at a higher speed and carry more load up heavy grades at high speeds—that is, in short, do more work—than would be possible with horse cars. If all this extra work is done for poor returns, then that is the fault of bad management or traffic superintendence; but it is absurd to say that electric traction is wasteful because the output from the generating station per car on line may reach a maximum of thirty or forty amperes—that is, from twenty to thirty horse-power—whilst an ordinary horse car is worked by a couple of animals. The dynamometer is too seldom used on horse cars, or it would then be admitted more freely that the strains at starting or running uphill are in exact accordance with the demands of load and speed, whether the cars be driven by animal power or mechanical appliances. It must be remembered, moreover, that from ten to twelve horses are allotted to each horse car, and this represents as great a maximum horse-power in the stables as in the generating station, per car in service, for in starting the animals (as everyone knows) exert far more than a single horse-power each.

In a recent issue, one of our contemporaries published an article which treats of this matter in the defective way we have thus outlined: and we think it is to be regretted that the respective cases should not be put more fairly. Quoting from an American source, it speaks of a generating station with three two hundred horse-power boilers and corresponding steam plant for a line nine miles long, with a half-hourly service, thereby involving the use of only four or five cars: it then asks "How would the four cars look with one hundred and fifty horses to each? Even if one boiler alone be worked, this implies a capacity of fifty horse-power for each car at work." Criticism such as this does not do electric traction even bare justice. In the first place, it is quite erroneous to assume that because three large boilers are installed, therefore the small traffic named will require all of them to be used. One such boiler would be ample for the work; and if more are put in, the fault must be placed at the door of the man who designed the station. He may have been instructed to build for future traffic, if the neighbourhood is a growing one, or there might be numberless other reasons. The proper course is to assume nothing but facts, and to go by the plant actually required and used rather than the available capacity of the station.

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Assuming, however, that one boiler alone is employed, then the maximum output ever demanded from it, if all the cars were starting simultaneously or ascending steep grades in unison, would not reach its full load at, say, thirty horse-power per car—a very fair allowance. Yet if horses are employed, there must be kept at least ten or twelve for each distinct car, and the violent strains to which they are subjected make their life so short that the annual renewals will reach very nearly 50 per cent.

For lines where the traffic is small, the maximum output is notoriously much higher than the average, and for any number of cars on line up to, say, ten, it is advisable to allow for a maximum of thirty amperes per car. When we have one hundred cars to deal with, the economy is much more marked, and twenty amperes per car would probably be ample. The use of two motors with each car, coupled in series, then in parallel, as now universally adopted, has helped to bring down the average power per car enormously, as will be very evident to all those who have seen diagrams of the current consumption on such lines, and in traffic where motor regulation is effected solely by the use of resistances. This appears to be another piece of evidence against the too common idea of cable traction being superior to electricity where large traffic has to be coped with.

TRANSFORMER-CHAMBERS.

It may be considered that the question of the position of transformer-chambers could have little interest or evoke opposition, but such seems to be not the case. Various authorities are opposing the construction of such chambers in the streets on the score of possible interference with the laying of gas, water, and other pipes in the future, and their danger. Let us consider the latter first. The various parties interested in transformer-chambers cannot prove a negative. They may point out that no accidents have happened, they may point out that no reasonably competent man will admit the possibility of accident, they may insist that this word "danger" is merely the bogey which all opponents of the electrical industry trot out upon every possible occasion—but all this leads nowhere. What is a transformer station, and what are the accidents put forward as possible? It is a chamber containing transformers, things made of iron and copper, with some combustible insulating material. Suppose a transformer burns out, what is the danger? A little flame, a great stink, and darkness of the lamps on the secondary circuit. The flame won't hurt because there is nothing to burn. The lamps being out is not a danger in the sense of personal injury at the transformer station. There is the bogey of shock. Well, in the first place, no person unconnected with the work ought to enter a transformer-chamber—and it is not, we hope, suggested that someone may get a shock outside the chamber. At any rate, if this is the argument, the position of the chamber won't make much difference to the possibility, which, however, we deem non-existent. The real opposition comes from those interested in "gas and water and other pipes." Even supposing—a supposition which we deny—that transformer-chambers did in some way interfere with these "pipes," it may well be asked if these pipes have a claim for all time upon the under street portion of the earth. Are civilisation and progress played out, that gas-pipes, for example, claim not only what strip of earth they do want, but also some small cubical area they do not now want, and may or may not want in the future? A few of the streets of London and in one or two other towns are pretty extensively utilised below the surface, but the opponents of electric lighting are not contented with suggesting that in these particular streets—say, twenty miles or so all told—exception to ordinary practice may be required, but would impose disabilities everywhere and under all circumstances, even in an eighty-foot carriageway, when twelve feet only are used for gas and water mains. We admit exceptional cases call for exceptional procedure, but for the Board of Trade to be asked to promulgate a general order rigidly defining what shall be done in all cases savours somewhat of the absurd. The result of the enquiry at the Board of Trade on the 13th inst. should be in favour of admitting transformer-chambers duly constructed under the streets because they neither interfere with traffic nor, with certain exceptions, with existing pipes, nor are a source of public danger.

THE INSTITUTION COUNCIL LIST.

This list has just been issued to members, and on the whole will no doubt be approved. There is evidently a desire to represent all interests upon the Council, but there is also as evidently a tendency to over-represent some interests, and to permit considerable lag before awakening to the rise and progress of other interests. It is too late this year to attempt an organised substitution of any other names than those proposed. Last year the Council was somewhat peremptorily pulled up for its neglect of cable interests. This year an effort has been made to avoid adverse criticism in that direction. What we desire to call attention to is the lack of appreciation of the importance of municipal electrical engineers. These men will soon number a formidable body, and not only will their numbers be large, but their influence will be greater. They will have among them all the best of the practical men, and will have at their fingers' ends the up-to-date practice of the industry. They will represent the largest moneyed interests, before which even the millions of the cable companies will take second place. It would seem but natural that the Council of an Institution whose motto should be progress would realise all this, and would hasten to have among its members a good representative of this body. But it is not so. The municipal engineers are ignored, and one name at least is found upon this list that has no claim to be thereon. We cannot but think this view of the question has not been presented to the Council when framing the house list, otherwise it is difficult to account for no name representing this class

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appearing. The difficulty of pleasing all parties is very great, but the list includes no less than six or seven representatives of manufacturers—viz., Messrs. Crompton, Kaye Gray, Esson, Goolden, Swinburne, Ferranti, and Money-Kent. Probably these names should be reduced to six by taking Mr. Kaye Gray as a representative of cable interests, than whom indeed no better representative could be found. The manufacturers' interest is great, but not so preponderatingly great as this number indicates, and one could have been spared to enable the municipal authorities to be represented. We do not wish to be misunderstood. There is no desire to disparage in any way the name of any man on the list. No doubt each will do yeoman service. Our aim is simply to urge the representation of all branches of the electrical industry.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ELECTRIC LIGHTING OF HARROW.

SIR,—A statement appears in your last number regarding the scheme for electric lighting at Harrow which is rather confusing, and I shall be glad if you will allow me to correct the same.

The state of affairs at Harrow is this: The local authority, having considered the question of electric lighting, decided to invite tenders. A specification was drawn up by me and sent to 10 of the leading firms of contractors. After carefully considering the tenders sent in, the Board decided that that of Messrs. Crompton and Co. was the most suitable, and they accepted the same provisionally. Promises of support of the Board's scheme were received from the house masters of Harrow School and others, and the Board wrote to the head master to ascertain if the governors of the school would introduce the light into the school buildings. The head master replied that the governors would be prepared to favourably consider the proposal for lighting the chapel, library, and other school buildings, provided they received from the Board full particulars as to the probable cost of the lighting. Messrs. Crompton and Co.'s tender was to the local authority for generating plant, mains, and street-lighting, and has nothing to do with the lighting of the school buildings, as would appear from your note. Will you kindly make the correction as soon as possible, as it has already caused some confusion?—Yours, etc.,

W. C. C. HAWTAYNE,
Consulting Engineer to the Local Board.

3, Princes-mansions, Victoria-street, S.W., Dec. 4, 1894.

MADRID LIGHTING.

SIR,—There have been several reports recently in the electrical journals of the repeated breakdown of the electric light supply in a portion of Madrid, and I find that many persons are under the impression that the Electricity Supply Company for Spain, Limited, is referred to.

As the above company is fully equipped with English plant, manufactured by my company, Messrs. John Fowler and Co., of Leeds, and the Electric Construction Company, of Wolverhampton, I think it only fair in the interest of all to ask you to correct this impression in your valuable paper.

The English company has not broken down, but has continued to supply light without intermission, although during the progress of the 50 per cent. addition to its plant last year, the machinery supplied in 1890 was often loaded quite 10 per cent. above its normal capacity, in consequence of the rapid increase of business.

The plant which has failed is that of a company financed by a German syndicate. It was manufactured in Belgium and Germany, and is on the low-tension continuous-current system.—Yours, etc.,

P. A. LATHAM, Secretary,
Leeds and London Electrical Engineering Company, Limited.

London, E.C., December 6, 1894.

ELECTRIC LIGHT AND POWER.

SIR,—I note in your issue of last week a report of a lecture given by me at Warrington. I beg leave to state that the report was not authorised by me, and that for the concluding sentence, in particular, concerning smoke abatement, which has provoked ironical remarks in a contemporary devoted to the gas industry, I will not hold myself responsible.—Yours, etc., FRANCIS G. BAILY.

University College, Liverpool, December 2, 1894.

ELECTRIC TRACTION.

SIR,—The question of electric traction has been discussed for some years. Is any practicable system known by which dust-vans can be propelled at a cost which is not prohibitive?—Yours, etc., T. W. E. HIGGENS.

Town Hall, Chelsea, S.W., December 4, 1894.

REVIEWS.

American Electric Street Railways. By KILLINGWORTH HEDGES, C.E. London: E. and F. N. Spon.

This book is another instance of the *parvum in multo*, with an elaborate crimson binding and gilt embellishments. It might from exterior appearance rank with an *edition de luxe* of Doré or Ruskin, but wide margins, good paper, and tolerable printing make a brave show that is not by any means maintained in the substance of the book or the methods adopted by the compiler. We use the latter term advisedly, inasmuch as the greater part, if not all, of the book consists solely of reprints and quotations from different sources bearing upon electric traction. This very fact, however, tends, of course, to give the book a certain value, since a great many engineers may be glad to have in a form easy for reference information and facts, perhaps, at present lying loosely on their book-shelves, as press clippings, etc.; but whether they will pay so heavily for elaborate binding and printing is a question for time to decide. We cannot help thinking that the public—being mostly foolish—is far too easily led by the nose in these matters, and books are bought for their outside appearance instead of their sterling worth. This has the bad effect of encouraging many incompetent authors and discouraging a number of those with some power of original thought, for publishers are apt to please the eye in order to sell (*vide* recent *Times* correspondence).

The "scrap-book" character of this work is an advantage when the material is drawn from reliable sources; and as trade lists, with working instructions, papers read before societies, and articles contributed to various journals by different writers which largely compose its pages are tolerably representative of good practice, we should be unfair to their respective authors if we did not acknowledge such value as they may have. In those places where Mr. Hedges treads alone we cannot compliment him in the least upon his scientific accuracy, nor yet award praise to the general scheme of this book. What does he mean in the preface by "staring advertisements greatly increasing the dead-weight"? And what grounds has he for dealing so glibly with the question of municipal control? We doubt very much whether corporations *will* grant new licenses, and still more do we doubt whether tramway companies will desire new licenses under the existing law, except on the principle that half a loaf is better than no bread at all.

In describing the action of electric motors, electrical engineers will probably feel that they know better than the teaching here given, whilst surveyors, municipal engineers, or the non-technical public will inevitably be mystified and befogged by the statements. Thus we read of "the attraction of the magnets causing the armature to re-

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volve . . . because the magnet attracts each coil of the armature," etc.; then directly afterwards, "it is not *the coils* which are attracted by the magnet, but the influence of the latter on the *current of electricity* which flows through these coils of copper wire" (the italics are Mr. Hedges's). Of countless other loose or incorrect statements, we may note these: "One of the new forms of alternating currents, called the 'multiphase,' in which the electricity is generated in waves." "Current passes through the gunmetal wheel, which is usually either of 5¾in. outside diameter, but sometimes only 4⅜in.," etc. We might go on quoting indefinitely, and commenting even more strongly. An erroneous description of three-wire running is evidently taken from the diagram—which is wrong—there being no connection shown between the rails and middle wire. The method of winding large generator armatures "is a sort of 'Drum' and 'Siemens's' winding applied to a ring core." This, to say the least, is hardly a lucid description. Mr. Hedges found a "lightning generator" at the Minneapolis power station: another piece of evidence that we are behindhand in traction matters over here. Then he says that high-speed engines are in a measure out of date for railway work: does he mean engines running with high piston speed or a high number of revolutions per minute? Some of the Corliss engines running at 80 to 100 revolutions per minute have as high a piston speed as a Westinghouse or Willans.

These few instances will serve as types of the crudities in this book; the final point which we have space or inclination to criticise lies in the loss of excellent opportunity by Mr. Hedges in the book of initiating improvements upon the barbarous terms and slang used by the Americans for tramway purposes. We say nothing about "street railway" for "tramway"—these are tweedledum and tweedledee (except that our word has the merit of shortness)—but it is much to be hoped that on this side we shall speak of "hangers" instead of "ears," "cut-outs," not "circuit breakers," "resistances" instead of "current diverters," etc.

Mr. Hedges's glossary of technical terms is carefully to be avoided if real knowledge be sought. There is hardly a single definition upon which we can congratulate him as logical or complete. The idea, moreover, of defining "indicator diagram," "road bed," and "motorman"!

Taken all in all, we should say that this book will only be of service as a compilation of matter which ought to have great intrinsic value, and is certainly worth more trouble than has been taken to put it together so as to avoid the trouble of search.

An Introduction to the Theory of Electricity: with Numerous Examples. By LINNÆUS CUMMING, M.A. Fourth edition, with Corrections and additions. Macmillan and Co.

Since the first edition of this book in 1876, the subject of electricity has become of world-wide interest. Then there was no electrical industry. The industrial applications were restricted to land and submarine telegraphs. Students of what we may call the higher science there were few or none. Our views have expanded since then, and the schoolboy of to-day has a better knowledge of the science than the prominent members of the telegraphic world of that day, and yet their knowledge in various directions was extensive and accurate. The various editions of this work have always been fairly up to date, and looking upon it as an elementary mathematical treatise for students, it would be difficult to find any work in which the propositions are more clearly stated or more elegantly solved. We might in some cases differ as to definitions, but once granting Mr. Cumming's definitions, the student must be charmed with the method of treatment. We might also prefer a very different method of treatment of the subject, but it is difficult to point out wherein we would have this treatment altered. To those who have used the previous editions, we can say that the alterations and additions have increased the value of this edition. To those who have not used the book, we would say it treats the subject more by giving solutions to various propositions than by attempting any physical explanations of phenomena. It gives, in fact, a mathematical expression for the result, accepting the accuracy of the premises, as stated. It is essentially a school or college text-book, and not a workshop manual. In its own sphere it is excellent.

SLIDING ROOF FOR THEATRES.

In our issue of November 23 we referred to the introduction at the theatre and concert hall—"La Cigale," in the Boulevard Rochechouart, Paris—of a sliding roof worked by electric motors. A few further particulars concerning this somewhat new departure should be of interest.

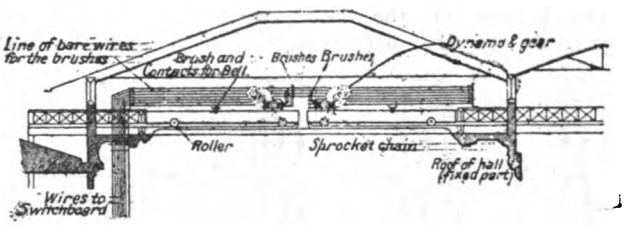

FIG. 1.

The oval roof of the hall is divided into two parts, each of which is carried on four rollers travelling on a track, as shown in Figs. 1 and 2. When once open, the movable parts of the roof travel and press upon two sheltered platforms placed one above the stage and the other above the entrance hall. The rollers nearest to the centre of the roof are arranged on each side on two axles, which are put respectively into motion by means of a sprocket chain and a train of gearing, the latter including a pinion arranged on the shaft of an electric motor, as indicated in the illustrations. The arrangements are due to Messrs. J. Julien and Co. and Mr. Pacoret.

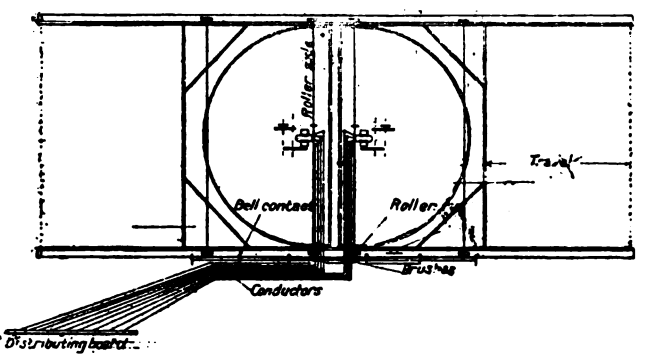

FIG. 2.

The position from which the travelling bridges or sliding parts of the roof are operated is at the distributing switchboard in the entrance lobby, where it is impossible to see either the roof or the hall. It was therefore necessary to design the installation in such a manner that the attendant would know at what moment to stop the motor either on the opening of the roof or on closing it.

The current is obtained from the Edison Company's mains, and the connections on the board are shown in Fig. 3. The two motors, one arranged on each side of the roof, are of the Hillairet-Huguet type, series wound; they are calculated for a speed of 1,000 revolutions at a pressure of 110 volts, and are capable of absorbing 10 amperes. On one side of the roof below the track are suspended seven bare copper wires, upon which rub sliding contacts fixed to the two parts of the bridge. These wires are numbered, and are connected to insulated conductors leading to the switchboard from which the roof is operated.

The two circuit wires connected to the Edison mains are brought in through a double-pole cut-out protecting a two-pole switch, which is not shown. From this switch one of the conductors is led to two switches, or magnetic cut-outs, which are regulated in such a manner that the circuit of each motor is automatically opened if the intensity of the current exceeds 10 amperes. Leaving these appliances, the two circuits are conveyed each to a changing switch having suitable resistances for regulating the current. These changing switches carry two

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movable contacts which are insulated from each other; the upper is for putting in or out of circuit a smaller or larger amount of resistance, and consequently varies the intensity of the current, this corresponding to alterations in the speed of the motors. Moreover, it assists the lower one in serving as reverser, and in changing the direction of the current in the armature without altering that passing through the magnets in such a manner as to assure the change of the direction of rotation of the motors. In the positions occupied by the changing switches, as indicated in the diagram, the switches are out of circuit, and no current traverses the motors, which are, of course, stationary. The two large semi-circular segments placed at the bottom of the two switches are connected respectively to the bare wires Nos. 5 and 3; the

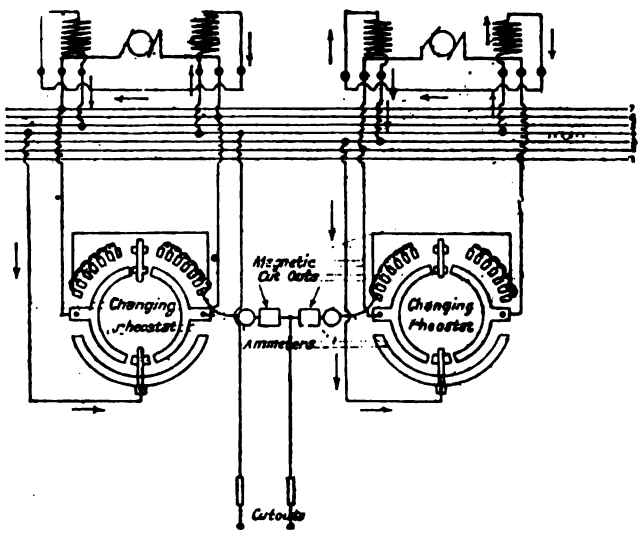


FIG. 3.

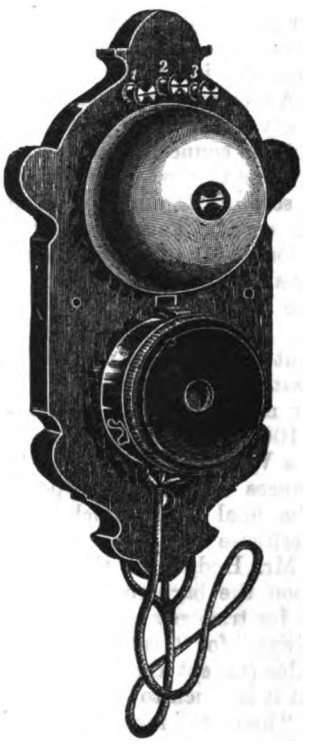
brushes connected at the entrance of each of the armatures make contact on these wires; the two exits make common contact on wire No. 4. The latter wire is, moreover, in permanent communication with the conductor connected to the main. Two ammeters allow of the fluctuations in the current being followed, and consequently of the rheostats being manœuvred. The brushes of the left armature make contact on the wires Nos. 6 and 7; those of the right armature on the wires Nos. 1 and 2. The working of the changing switches connect these four wires respectively, sometimes in one way, sometimes in another, with the general circuit.

On starting, the motors absorb between nine and ten amperes, but once in operation the current used ranges from five to seven amperes. The operation of putting the sliding roof in or out of position is effected in less than one minute at a cost of about one penny.

Arranged upon the two halves of the roof and on the vertical face of the bridge are two contacts, which shortly before each part of the roof reaches the end of its travel press upon two buttons, each actuating an electric bell placed under the switchboard. The latter are arranged in a battery circuit, and on ringing they indicate to the attendant first that stoppage is near (which allows the man to manipulate the rheostat so as to diminish the speed, and, secondly, on ceasing to ring, that the sliding parts have reached the end of their course, the contacts having passed over the buttons. If at this moment the attendant were to forget or neglect to interrupt the current, it might happen, the motor being unable to revolve because of its being wedged up, that the current would reach a value which would put the motor out of use. At that moment, however, the magnetic cut-out acts and breaks the circuit. This apparatus is simple, and works well. We are indebted for the foregoing particulars and annexed illustrations to our contemporary *L'Electricien* of November 24.

THE NEW "STENTOR" TELEPHONE.

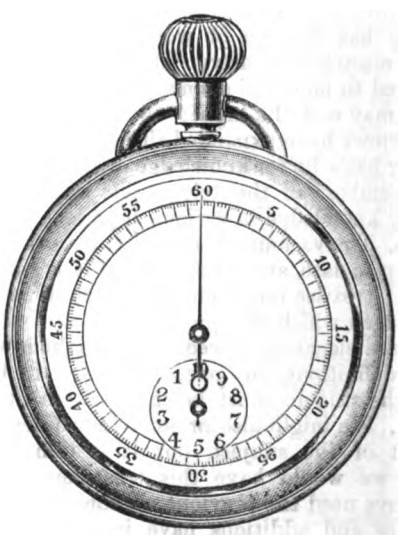
In the annexed illustration is shown the new "Stentor" telephone, which, we are informed, has been very favourably received by the trade. This instrument is essentially for domestic use, being very suitable for service in business offices, hotels, factories, and private houses. Take, for instance, the case of hotels. One of these telephones fixed in a bedroom allows of an order to be given direct to the attendant without the necessity of the latter proceeding to the visitor's room to ascertain the latter's requirements. It is claimed that the instrument's granular microphone is the most sensitive, loud-speaking, and perfect transmitter yet produced; that it requires



in most cases not more than one, or, on long distances, two cells to work it; and that it lends itself specially to replace the old style of electric bells and pushes, its cost being very little in excess of that of an electric bell installation. The "Stentor" telephone, which can be easily used on existing bell lines, is made in two sizes by the International Electric Company, of 55, Redcross-street, Barbican, London, E.C., who report that repeat orders for the instrument are being constantly received.

NEW CHRONOGRAPH.

The annexed illustration shows a small chronograph which has been brought out by Mr. R. W. Paul, of 44, Hatton-garden, E.C. It is an ingenious instrument which is intended for the use of students and experimenters in timing experiments. The



chronograph, which reads in fifths of a second up to 10 minutes, is started by pressing the button at the pendant, and is stopped instantaneously by repeating that operation. After taking the reading the hand flies back to zero on pressing the button a third time, when the chronograph is ready for use again.

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ELECTRICITY ON BOARD SHIP AND ITS APPLICATION AS MOTIVE POWER FOR AUXILIARY MACHINERY.

I am very much alive to the fact that naval architects are placed at a great disadvantage, if they are not entirely prejudiced, in forming an opinion as to the merits or demerits of electrical apparatus and methods. In the first place, their judgment is liable to be warped by the very plausible way in which each manufacturer nowadays, driven by keenness of competition, claims for his own particular apparatus some technical superiority. This is, of course, very bewildering except to an electrical expert. But further in this connection, it is to be observed that as yet there is a marked absence of any extensive installation of electrical machinery in the fleets of the present day. This effect of competition has not been so keenly felt in the sphere of electric lighting as it has in the direction of the application of electric power to the auxiliary machinery on board ship, for the simple reason that electric lighting has made great progress, and obtained a substantial footing on land, and the naval architect has consequently brought himself to conform to public opinion and provide a place in the ship for the necessary dynamo. On the other hand, the improvement and development of electrical machinery for the transmission of power has not been a question of public interest or public demand. But we must look yet further to discover what other circumstances have militated against a more extensive adoption of electrical machinery on board ship, for it must be admitted that electrically-driven machinery is, and has been for some considerable time, in successful operation on land. Undoubtedly, one of these circumstances is the fact that what would be a suitable design in the one case might not be at all appropriate for a similar purpose in the other, and therefore the development has been slower. Another of these circumstances is a deeply-rooted suspicion on the part of those actually interested in navigation that the magnetic action of the electric current affects the compasses. This idea is, however, gradually being dispelled. A better class of electrical work is being done, obviating all danger in this direction, and more scientific officers are gradually taking the place of the old hands who first witnessed the introduction of electricity into the naval service. Another adverse circumstance is that owners of vessels which have been fitted with the electric light have had a somewhat unenviable experience. The installations have been fitted up by contract in a very large number of cases, especially in the smaller class of steamships, with regard only for making the most profit out of the job. This has led some shipbuilders to permanently employ a qualified electrician to look after their interests, and the result has been a much better execution of the details of the work and improvement also in the quality of the material employed. Another circumstance which accounts in part for the non-development of marine electrical machinery is undoubtedly the absolute reliance which has to be placed upon the action of the auxiliary machinery; in connection with it should be mentioned that skilled labour also would have to be employed in operating some portions of it. This, however, does not apply to all the mechanical work that might be done by electrical methods, as I will presently show.

Each of the three circumstances to which I have referred is sufficient in itself to account for tardy progress in the use of electrical transmission of power on board ship. It is no wonder, therefore, that as yet we have not a single instance in which the electrical engineer and the naval architect and shipbuilder have collaborated to design and arrange the machinery with a view to supersede steam-pipes by electric cables for auxiliary purposes. But if there has been no collaboration, electrical engineers have, nevertheless, set themselves separately to the task, and it is the result of their efforts which I will endeavour to point out. The following is a list of the auxiliary machinery to which electricity has been applied as a motive power: electric winches, electric cranes, electrically-driven lathes, electric steering-gear, drills, capstans, refrigerators, fans, pumps, and ash-hoists. These may be divided into two classes—viz., (1) those which have been specially designed for use on board ship; (2) those which have been proved practically successful for land purposes, and which could readily be adapted for use on board ship. In the first list may be classed electric winches, cranes, steering-gear, capstans, and fans. In the second list may be classed electrically-driven lathes, electric drills, refrigerators, pumps, ash-hoists, etc. Having described Siemens's electric winches, Crompton's electric winches and cranes, Siemens's electric steering-gears, drill, and electric capstans, and Holmes's electric fans, the author said:

I have now pleasure in drawing your attention to the fact that an experiment is about to be carried out in Hull with electric winches. I am enabled to give you a few particulars, through the kindness of Mr. Spear, who proposes to make the trial on one of Messrs. Wilson's boats. The motor designed by Messrs. Crompton and Co. will be supplied, and the entire work carried out by Mr. H. S. Tadman, who has also kindly given me details of the construction of the winch. As an experiment between Mr. Spear and Messrs. Crompton, a departure from adopting the special designs of electric winches has been made, inasmuch as they are going to convert an ordinary winch fitted with steam power into one driven by electricity, substituting the steam-engine portion by an electromotor, which will, of course, be adequately protected. This is a point of economy, as of course to discard an entire arrangement would be an expensive matter, and where a large portion of the machinery is not required to be altered, there is no necessity, in the case of existing vessels, to make an entire replacement.

I will now endeavour to point out a few of the advantages arising from the substitution of electricity for steam or hydraulics as a motive power for auxiliary machinery. In the first place, let me remark that I am quite aware of what has hitherto been considered the great drawback to the employment of electromotors on board ship. I refer to the attention which the commutator and brushes undoubtedly require; but in admitting this, I must confess I am of opinion that a great deal too much prominence has been given to it, and that the attention required has been unduly emphasised. It should be considered side by side with the necessary repairs to steam plant, just in the same way as the actual working costs and efficiencies of the respective systems are compared. Here I may incidentally remark that such comparisons are quite overlooked by those whose knowledge is limited to that of one system; the hope that steam will be supplanted by electricity for auxiliary purposes is really based on the fact that the present candidates for marine engineering situations possess a fair knowledge of what are the actual facts concerning electrical apparatus. Repairs to the auxiliary machinery on board ship are mainly necessitated by the reciprocating action of the steam-engines, which in suddenly starting and stopping put abnormal and undue strains upon the gearing or load. This is especially the case with steam winches and cranes, where a sudden jar frequently breaks the teeth of spur and bevel wheels, upon the repair of which the engineers are constantly engaged. While I am speaking of commutators and brushes, it will be as well to remind you that the development of electrical apparatus does not stop short at the generation of continuous currents, which perforce require a commutator and brushes. By the use of polyphase currents, commutators and brushes are entirely superseded. Polyphase currents are alternating in their nature, but they are quite distinct from the high-tension single-phase alternating current which is used extensively for electric lighting from central stations. The starting of polyphase motors is effected electrically and automatically under much the same principle as a compound engine is started by steam—that is to say, no initial momentum has to be given by means of a flywheel or other arrangement. Polyphase motors can be as easily started, stopped, or reversed as those of continuous currents, and the only attention required is to see to lubrication. Polyphase currents are also equally serviceable for lighting and power.

The most important advantages, however, of electric motive power may be considered under two headings—viz., motors *v.* steam-engines, cables *v.* steam-pipes. In the first place, I will briefly enumerate the advantages under the first heading, which are as follows: (1) Greater facilities in starting, stopping, and reversing consequent on a rotary instead of a reciprocating motion, and obviating the evil effects of condensed water in steam-cylinders, etc. (2) No leaky drain cocks, defective stuffing-boxes or glands. (3) Noise in working is reduced to a minimum, which is a matter of considerable importance in passenger vessels, where cargo is loaded and unloaded at night, and where the cranes and winches are frequently in proximity to cabins. (4) Less coal per brake horse-power, due to the highest efficiency of an electric motor as a converter of energy, taking into consideration only the diminished losses of power in working one large instead of several small steam-engines. On board ship this is very largely a question of temperature. For instance, a 50-h.p. steam-engine driving a dynamo would be placed in some position adjoining the boiler-hold and engine-room where the temperature is always fairly high. The engine running constantly, we may take the efficiency of the brake horse-power to be 8 per cent. for any load. Under such circumstances the useful energy applied to any of the auxiliary machinery, including the conversion from the dynamo to the motor, at any proportion of load not less than one-fifth, would be at least 80 per cent. of that developed by the steam-engine, or a total steam efficiency of 6 per cent. With the use of small steam-engines, however, to drive the auxiliary machinery direct, even assuming the boiler pressure to be maintained to the cylinders of the engines, an additional loss occurs of 50 per cent. of the heat energy of the steam owing to radiation in the open air, and condensation of stopping and starting, thereby reducing the total efficiency to probably less than 4 per cent. (5) Less room is occupied by the motor than by the steam or hydraulic engines, and in the case of electric cranes, by leaving

* Abstract of paper read recently by Mr. A. H. Gibbings before the Hull and District Institution of Engineers and Naval Architects.

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a clear space in front of the operator, the guidance and direction of the crane can be more readily and safely effected.

I will now briefly consider what advantages accrue from the use of electric cables in the place of steam-pipes: (1) The disadvantages of leaky steam joints are avoided. (2) Less space is occupied and greater facility in fixing is obtained. Steam-pipes are always more or less unsightly and inconvenient, and especially so when they pass through cabins and alley-ways. When they are carried on the surface of the deck, and have to be protected by large iron casings or coverings, they are a distinct source of danger to passengers and crew. On the other hand, electric cables can be carried the whole way on the underside of the deck or on the face of bulkheads, and the deck is thus left free and clear on the surface. (3) Electric cables can be bent to suit any angle. (4) No heat or any other unpleasant effects are experienced with electric cables. (5) No corrosion and no alternate expansion and contraction occurs, as with copper steam-pipes. (6) No loss of power, as with condensation of steam in pipes.

The loss of power in electric cables where the current does not exceed 500 amperes per square inch of section may be stated to be, on a 65-volt circuit, 1 per cent. of the total energy transmitted per 100 yards. This loss, moreover, is directly proportional to the length, which is hardly true of the loss of steam transmitted in pipes, such loss becoming greater in proportion after a certain distance from the boilers. A 1½in. copper steam-pipe covered to a thickness of 1in. all round with woollen felt, loses by radiation 73 thermal units per foot run per hour at a boiler steam pressure of 120lb. The loss, therefore, for 50ft. will be 3,650 thermal units or 1·5 h.p. per hour, which is a very large factor in the case of the small engines required for auxiliary machinery. It will be within the mark to estimate this power loss from 10 to 20 per cent. The economy, therefore, with the electric current is so marked and distinguished that there is no necessity for me to dwell longer on the subject, and I suppose it will readily be admitted by all that this advantage alone is a very prominent and important one. I have made only casual reference in this paper to the use of hydraulic power on board, because it is well known that this power is very wasteful and costly. Hydraulic machines take more pressure water when running unloaded than when working at their full load. They possess, moreover, several other disadvantages which are analogous to the drawbacks of steam power. In cold climates they are practically prohibitive, as the water could not be kept from freezing. I have endeavoured to place a few descriptions and comparisons before you this evening, more for the purpose of drawing attention to the subject generally than to prove facts. After all, and proverbially, the proof of the pudding is in the eating, and by actual test a satisfactory and ready comparison can always be made in specific instances.

THE ROYAL SOCIETY.

The anniversary meeting of the Royal Society was held on Friday at Burlington House.

The **President** (Lord Kelvin), in delivering the anniversary address, said that science had lost severely during the past year. In the list of Fellows deceased which had been read to them they had heard the names of Tyndall, Milnes Marshall, Van Beneden, Pengelly, Brown-Séquard, Romanes, Alder Wright, Helmholtz, Marignac, Topley, all well known to them as having been in their lives zealous and successful scientific investigators, who had largely contributed to the object for which the Royal Society worked—"the increase of natural knowledge."

A year ago, in his anniversary address, he called attention to Hertz's experimental demonstration of electric waves, which he found in working out an experimental problem originally proposed by Helmholtz to him when he was engaged in experimental researches in the Physical Institute of Berlin in 1879. An English translation by Jones of Hertz's book, describing his work on electric waves, dedicated "with gratitude" to Helmholtz, was published in England and America in December, 1893. On the first day of the new year the disciple died, and within the year the master followed him. Of the whole of Helmholtz's great and splendid work in physiology, physics, and mathematics, he doubted whether any one man might be qualified to speak with the power which knowledge and understanding could give; but they could all appreciate, to some degree, the vast services which he had rendered to biology by the application of his mathematical genius and highly-trained capacity for experimental research to physiological investigation. The president then reviewed some aspects of the work of Helmholtz, and dealt with administrative questions connected with the society.

The establishment of the Faraday-Davy Research Laboratory in connection with the Royal Institution was a splendid benefaction which science had gained during the past year through the untiring and grand generosity of Mr. Ludwig Mond. The Royal Society interested itself in all work contributing towards the object for which it was founded—the increase of natural knowledge; and while gratefully remembering the assistance so generously given to it in the humble but highly valuable work of cataloguing papers which described the results of scientific investigations already made, it hailed with delight this grand foundation of a practical laboratory, of which the purpose was not the teaching of scientific truths already discovered, but the conquering of fresh provinces from the great region of the unknown in nature.

The greatest scientific event of the past year was, to his mind, undoubtedly the discovery of a new constituent of our atmosphere. If anything could add to the interest which they must all feel in this startling discovery, it was the consideration of the way by which it was found. In his presidential address to Section A of the meeting of the British Association at Southampton in 1882, Lord Rayleigh, after calling attention to Prout's law, according to which the atomic weights of the chemical elements stand in simple relationship to that of hydrogen, said: "Some chemists have reprobated strongly the importation of *a priori* views into the consideration of the question, and maintain that the only numbers worthy of recognition are the immediate results of experiment. Others, more impressed by the argument that the close approximations to simple numbers cannot be merely fortuitous, and more alive to the inevitable imperfections of our measurements, consider that the experimental evidence against the simple numbers is of a very slender character, balanced, if not outweighed, by the *à priori* argument in favour of simplicity. The subject is eminently one for further experiment, and as it is now engaging the attention of chemists we may look forward to the settlement of the question by the present generation. The time has perhaps come when a redetermination of the densities of the principal gases may be desirable—an undertaking for which I have made some preparations."

The arduous work thus commenced in 1882 had been continued for 12 years by Rayleigh with unremitting perseverance. After 12 years of it, a first important part of the object—the determination of the atomic weight of oxygen with all possible accuracy—was attained by the comparison of Scott's determination of the ratio of the volumes of hydrogen and oxygen in the constitution of water with Rayleigh's determination of the ratio of the densities. The result was 15·82, which was almost 1 per cent. (0·87 per cent.) less than the 16 which it would be according to Prout's law. It was very slightly less (¼ per cent.) than Dittmar and Henderson's value, obtained by an investigation for which the Graham medal of the Glasgow Philosophical Society was awarded in 1890. Values not quite so small as these for the atomic weight of oxygen had been previously found by Cooke and Richards (15·869) and by Leduc (15·876). There could be no doubt whatever now that the true value was more than ¼ per cent. smaller than according to Prout's law, and that in all probability it agreed exceedingly closely with the results obtained by Rayleigh and Scott, and by Dittmar and Henderson. The question of Prout's law being thus so far set at rest, Rayleigh, persevering in the main object which he had promised in 1882, "a redetermination of the densities of the principal gases," attacked nitrogen resolutely, and stimulated by most disturbing and unexpected difficulties in the way of obtaining concordant results for the density of this gas as obtained from different sources, discovered that the gas obtained by taking vapour of water, carbonic acid, and oxygen from common air was denser by 1/230 than nitrogen obtained by chemical processes from nitric oxide or from nitrous oxide, or from ammonium nitrite, thereby rendering it probable that atmospheric air was a mixture of nitrogen and a small proportion of some unknown and heavier gas. Rayleigh and Ramsay, who happily joined in the work at this stage, had since succeeded in isolating the new gas, both by removing nitrogen from common air by Cavendish's old process of passing electric sparks through it, and taking away the nitrous compounds thus produced by alkaline liquor, and by absorption by metallic magnesium. Thus they had a fresh and most interesting verification of a statement which he took occasion to make in his presidential address to the British Association in 1871: "Accurate and minute measurement seems to the non-scientific imagination a less lofty and dignified work than looking for something new. But nearly all the grandest discoveries of science have been but the rewards of accurate measurement and patient, long continued labour in the minute sifting of numerical results." The investigation of the new gas was now being carried on vigorously.

A Royal medal was awarded to Prof. J. J. Thomson, who had distinguished himself in both mathematical and experimental fields of work. A Royal medal was awarded to Prof. Victor Horsley for his laborious and fruitful researches in physiology and pathology, and particularly for those relating to the functions of the nervous system and of the thyroid gland. Prof. Horsley had himself shown—and this was not the least of the merits which it was desired to recognise in the bestowal of the Royal medal—in how many instances the knowledge which was acquired by patient and skilful work in the laboratory might be made available for the saving of life, or the alleviation of human suffering. The Davy medal was awarded to Peter Theodor Cleve, professor of chemistry in the University of Upsala, for his services to chemical science during the last 30 years, and in particular for his long-continued and valuable researches on the chemistry of the rare earths. The Darwin medal was awarded to Thomas Henry Huxley. Of Mr. Huxley's general labours in biological and geological science he need say nothing there. They were known of all men, and the society showed its appreciation of their worth when it awarded to him the Copley medal in 1888. The present medal was a token of the value put by the society on the part of his scientific activity bearing more directly on the biological ideas with which the name of Charles Darwin would always be associated.

The medals having been presented, the society next proceeded to elect the officers and council for the ensuing year. The following is a list of those elected:

President, Lord Kelvin; treasurer, Sir John Evans; secretaries, Prof. Michael Foster, Lord Rayleigh; foreign secretary, Sir Joseph Lister; other members of the council, Andrew Ainslie

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Common, William Crookes, Francis Darwin, Andrew Russell Forsyth, Sir Douglas Galton, Prof. Alexander Henry Green, Sir John Kirk, Prof. Horace Lamb. Prof. Edwin Ray Lankester, Prof. Alexander Macalister, Prof. John Henry Poynting, Prof. Arthur William Rücker, Osbert Salvin, Prof. J. S. Burden Sanderson, Thomas Edward Thorpe, William Henry White.

The anniversary banquet of the society was held in the evening at the Whitehall Rooms of the Hôtel Métropole.—*The Times.*

GREAT NORTHERN TELEGRAPH COMPANY.*

If the science of stock-splitting makes slow progress in its native country, it begins to find favour abroad. An interesting application of it has been mooted among the shareholders of the Great Northern Telegraph Company, which owns one of the largest of the Eastern cable systems. It is a Danish corporation, administered in Copenhagen, but the bulk of its shareholders are in London and Paris. Its shares have long been honourably known on our official list, where they now stand at a premium of fully 100 per cent. Their par value is £10, but they can no longer be purchased under £21, and only in small lots at that. The dividends actually paid do not represent a very large yield on their market price. It is the undivided earnings which go to swell the reserve fund and to pay off debentures that account for the high premium. Many of the shareholders, the French ones in particular, consider that the future has been pretty well provided for by a reserve which exceeds one-half of the Company's total capital. Being so large, it might now, they think, grow fast enough with smaller additions than from £60,000 to £80,000 a year. Recently this argument has acquired greater force and plausibility from the healthy expansion of the Company's revenue.

The Great Northern Telegraph Company has a peculiar way of dividing its surplus profits, and this is another matter which a section of the shareholders would fain have simplified. The share warrants have a set of three coupons attached to them for each year. Two are for interest at the rate of 5 per cent. per annum, which is paid in January and July. The third is a surplus coupon, payable in April, which varies in amount according as the year's profits exceed 5 per cent. From 1890 to 1893 the surplus distribution was 7s. 2d. per share, making a total of 17s. 2d. But this was only two-thirds of the profits actually earned, the other third, amounting to £83,000 out of a total of £250,654, having been carried to reserve—a sum equal to another 11s. per share of dividend. The increased earnings up to the end of October—about £8,000—represent rather more than 1s. per share, and, without reckoning any further gain in November and December, they ensure a moderate addition to the surplus divisible next April. The total dividend on the present basis should be 18s. per share, but if any concession were to be made to those shareholders who consider the reserve unduly favoured, a reduction of its annual increment by £15,000 a year—a mere trifle out of fully £80,000—would raise the dividend to a round 20s. per share, or 10 per cent. on their par value.

At the same time it is suggested that the shares might be made more negotiable if the interest coupons and the surplus coupons were separated. This would be equivalent to splitting the shares into 5 per cent. preferences and deferred, the latter starting with a present surplus of 3 per cent., which might by a very moderate restriction of the reserve be at once raised to 5 per cent. The existing certificates, which carry all three coupons, could be called in by the Company and split certificates issued in place of them, one with the interest coupons and the other with the surplus coupons. The nominal amount of each would be a million and a half sterling, the same as the existing capital; but in place of an unwieldy share forced up to over 100 per cent. premium, we should have a preference half standing about 13, and a deferred half ranging from 10 to 12, according to the surplus distribution. That this would be not only a more marketable, but a sounder capitalisation than the present, may be proved from the example of English cable companies operating in the same part of the world as the Great Northern, and under similar conditions.

The Great Northern Telegraph Company, with only one-fourth of the capital of the Eastern Telegraph Company, earned about one-half its revenue, both in gross and net. The former was for the year 1893 £352,975, and the latter about £270,000. The strong point of the Great Northern is its light capitalisation—the result of the liberal expenditure for improvements and extensions made out of revenue. It has to pay charges on only £1,700,000, while the Eastern has to pay on over £6,000,000. Its gross annual earnings are equal to nearly 25 per cent., and its net earnings to more than 14¼ per cent. on its whole capital, debentures included. The gross earnings of the Eastern Company represent only 12 per cent. on the total capital, and its net earnings barely 5¾ per cent. The financial features of the two companies exhibit a very instructive comparison for shareholders who care to know where their dividends come from, and how they are capitalised. Fair allowance being made for its larger earning power, both in relation to capital and to cable mileage, Great Northern shares, if split, should find as much appreciation in the market as corresponding shares of the Eastern.

Whatever may come out of the splitting movement, Great Northern Telegraph dividends have a promising future before them.

* Abstract of article in *Financial Times*, December 1, 1894.

GENERATION OF ELECTRICITY AT COLLIERIES.

At the present time it appears, Mr. Walter J. May writes in the *Colliery Guardian*, as if an important and cheap mode of generating current has been quite overlooked. Where the Semet-Solvay coking system is adopted it would also appear that the generation of current would be more or less a cheap matter, as surplus gas is always to hand, which could be used to produce current at a much less cost than it can be produced by steam power at town works. The conveyance of high-tension current is not all an insuperable difficulty, and overhead cables would be possible in most instances until near the town where it was intended for use, and then, of course, it would be carried in underground mains to the distributing centres.

At the town where the writer resides the electric light has been installed by the Corporation, the capital expenditure being £26,000; 1,700 tons of slack is the year's allowance for the two boilers, two contracts of 800 and 900 tons respectively having been advertised, the average price being 12s. per ton plus 1s. 3d. per ton for cartage, making a total cost for fuel of £1 126. At the collieries the value of the coal used would be not more than 4s. per ton, and thus the difference in the cost of fuel alone would be £786. Besides this, it must again be considered that a colliery using enough coal to produce 10 times the current produced at the works to which reference is made, only the same staff of men employed would be practically wanted. Even on the score of fuel and labour costs alone it would pay to produce the current where the fuel is raised, and probably the cost of cables for the conveyance of current would be less than the capital which has to be invested in local generating stations.

Beyond this, it has to be considered that at most coalpits there is a more or less plentiful supply of dirty fuel which is practically unsaleable, but which would make fairly good boiler fuel if the boilers were in sufficient number to allow of their being run without driving, thus again reducing the cost of production of current. Still, too much stress must not be placed on this dirty fuel, as every pit is not alike, and it is well to take costs from general values rather than from special ones. Beyond the current for lighting, there is a probable demand for more or less current for motor purposes during that part of the day when light is not required, and thus the boilers would be in active work at all times instead of being banked down for part of each day, and there would be no fuel wasted as a consequence, whereas at local stations the boilers are not in use for part of each day. Combined with the lower cost of the fuel, this continuous working would tend to economy in the cost of the production of the current, and with a well-arranged generating plant of a sufficient size the cost per Board of Trade unit should be under 2d. at the generating station.

At cokeworks two products could bo sent out—coke and electric current, the gas being stored and used to actuate gas-engines. In this we should have even better results than with steam boilers and engines, as there would be no loss even if the current was only used for a portion of each 24 hours, as the gas would be used only when the engines were running. Beyond the ordinary gas, the breeze could be converted into gas of good power for gas-engines, and the actual cost of power would be much smaller than where steam is used as the primary power. In fact, gas-engines are too little used for the motive power in electric lighting stations, and the result is often to put several pence per unit on the current, particularly in small places.

The following comparison of the amount of 16-candle light obtainable in London for a penny may be not only instructive, but also useful in regard to the electric lighting question, because it shows that unless the electric current is much reduced in cost it will never displace gas:

	Hours.
Gas with Welsbach burners	22·2
Incandescent electric lamps, current generated by gas-engine and Dowson gas	10·6
Petroleum with duplex burner	8·6
Petroleum with good single-wick burner	8·0
Gas with argand burner	6·4
Gas with fishtail burner	4·7
Incandescent electric lamp with current from town mains...	2·2

Assuming that these figures are approximately correct, it will be seen that the cost of current must be very considerably reduced in many places before it can compete with gas on anything like equal terms, and it appears to the writer that it would be chiefly through the production of the current at mines, or in close contiguity to mines with fuel of small value, that this low cost can be obtained.

REFUSE DESTRUCTORS AND ELECTRIC LIGHTING AT WESTON-SUPER-MARE.

REPORT BY THE CONSULTING ENGINEER.

We have been favoured with a copy of a report prepared by Mr. Francis H. Medhurst, M.I.E E, for the Weston-super-Mare Local Board, who received and passed it on Wednesday. The report, from which the following is extracted, deals with the questions of refuse destruction, electric lighting, and electric tramways. The further consideration of the report has been deferred for the new district council.

Refuse Destruction.

The report first draws attention to the fact that the only satis-

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factory method of disposing of town's refuse is by the operation of a refuse destructor. Special stress is laid on the point that a destructor must, first, be considered as a sanitary apparatus, and, secondly, as an auxiliary to an electric lighting undertaking. The report weighs the merits and describes the characteristics of the two essential types of refuse destructors, and it recommends for adoption the Horsfall destructor, mainly on account of the high temperature (2,000deg. F.) to which the fumes from the drying refuse and the half-distilled products of combustion are subjected.

Mr. Nettleton, the Local Board's engineer, has given Mr. Medhurst's figures showing approximately the amount of refuse collected at Weston during the winter and summer months. Taking these figures as a basis, the Horsfall Company have offered to erect at Weston three of their refuse furnaces in one battery, and to supply all the steam that will, in the engineer's opinion, be required for some years to come for electric lighting purposes for £460 per annum. The consulting engineer recommends the Local Board to accept this offer. The cost of raising the same amount of steam using coal as a fuel would in all probability work out at £530 per annum, showing a direct saving of £72 per annum if a refuse destructor be erected and worked in conjunction with the electricity supply works. If a refuse destructor be erected at Weston, but be kept absolutely distinct from the electric lighting undertaking, then it is shown that the combined cost of raising steam on the one hand, and of working the destructor on the other, would be about £850 per annum—*i.e.*, more than £300 per annum more than would be the case if the scheme recommended in the report be carried out.

Electric Lighting.

In order to ascertain the amount of support that would be given to an electric lighting undertaking in the hands of the Local Board, one of his assistants made a canvass of the district. The result was satisfactory, inasmuch as the equivalent of 4,500 lights of 10 c.p. were promised. The engineer recommends that mains for private supply should at once be laid in the following streets—namely, High-street, Regent-street, Kewstoke-road, Meadow-street, Magdala-buildings, Waterloo-street, and Orchard-street. The only public lighting recommended for the present is that along the sea-front from the sanatorium to Anchor Head. It is pointed out that the present cost of lighting the sea-front is £190. 5s. 2d, per annum, and the total candle-power of all the lights burning simultaneously is equal to about 1,360 candles. If the recommendations of the report be carried out, the cost of lighting the sea-front will be increased to about £300, and the total light emitted simultaneously will be increased to 34,000 candles. The site recommended is one already belonging to the Local Board, situate in Uphill Drove-road, close to the statutory hospital. It is pointed out that there is ample room here for the erection of the dust destructor as well as of the electricity works.

The system recommended is the high-pressure alternating-current system, with transformers in sub-stations, and a low-pressure network of mains for private supply. The current will be generated at a pressure of 2,000 volts at the generating station, and will be conveyed by means of insulated stranded copper cables drawn through cast-iron pipes with drawing-in boxes at intervals of about 100 yards apart along Severn-road and the esplanade to the corner of Regent-street, down Regent-street to the corner of Regent-street and High-street, down High-street to the post office. Transformers, fixed in underground vaults or sub-stations will tap the high-pressure mains at the corner of High-street and Regent-street, and at the post office. The low-pressure mains will likewise consist of insulated stranded copper cables drawn into cast-iron pipes, with junction-boxes at intervals of about 50 yards apart. The low-pressure mains will be laid in the streets previously mentioned. The public lighting cables will be drawn into 4in. cast-iron pipes, and there will be a junction-box opposite each lamp-post.

The machinery at the generating station will consist of one water-tube boiler of 150 actual horse-power, and the dust destructor boilers one second 150-h.p. boiler. The result will be that, whether the dust destructor be erected or not, there will be a spare boiler of 150 actual horse-power. There will also be two compound steam alternators of 130 b.h.p. each, one being spare, and three Ferranti rectifiers to transform the ordinary alternating current into an undulating or practically direct current. In addition, the buildings will contain the necessary feed pumps, switchboard, etc., and, lastly, if the electric lighting undertaking be carried out apart from, and not in conjunction with, the dust destructor, there will be a 20-b.h.p. gas-engine, driving its alternator by means of a belt. The effect of the gas-engine will be to reduce the working expenses to a minimum by enabling the boilers to be banked up, and the stoker sent away during the daytime or time of light load. Of course, if the refuse destructor be in operation, there is no advantage in making the capital expenditure to pay for a gas-engine, for probably the minimum amount of firing of the destructor will produce more heat than will be required for the maximum demand for steam during 13 to 16 hours out of the 24.

Capital Expenditure.

The capital expenditure, if the present scheme be carried out, is estimated as follows: plant and buildings, £8,466; pipes and trenching, £3,944; cables, £2,547; and engineering charges and contingencies, £1,043; being a total of £1,600. If a refuse destructor be not erected it is estimated that the cost will be increased to £17,000.

Statistics prove that the average price to be expected per lamp of 10 c.p. per annum is 10s. Therefore the total revenue from 4,500 lamps will be £2,250. The Local Board can borrow the requisite capital at 3 per cent., whilst 2½ per cent. must be set aside annually to form a redemption fund for liquidation of the loan. We have, then, the following results: Revenue—4,500 lights, £2,250; present cost of esplanade lighting, £190; and meter rents, £100; or a total of £2,540. Working expenses—cost of steam production, £460; engineer, £200; wages, £416; interest and redemption 5½ per cent. on £16,000, £880; and upkeep, renewals, and depreciation, £300; being a total of £2,256.

Thus it will be seen that the scheme recommended for adoption is not only likely to be self-supporting from the very commencement, but will in all probability actually earn a profit of over £250 per annum, which, as the report suggests, might be used for the reduction of the local rates. It is also stated that as the demand for electric lighting increases, the profits from the undertaking will compare still more favourably with the expenditure.

Electric Tramways.

The various systems of electric traction are described, and the method which is said would probably have to be adopted at Weston is the conduit system. The capital cost is estimated at £14,500 for a tramway from the sanatorium to the pier, with a branch along Regent-street to the railway station. It is assumed that a 15-minute service would be necessary along the sea-front and a half-hour service along the branch line.

Calculations are made which show that the probable gross earnings would not exceed £990 per annum, owing to the fact that the tramway would only be used, at the most, for five months out of the twelve. The loss on the tramway undertaking is estimated at from £450 to £600 per annum, and the engineer is, therefore, unable to recommend the Local Board to adopt an electric tramway at Weston on economical grounds, though he recognises that it would in many respects be a great convenience to visitors and to the inhabitants along the sea-front.

Conclusions.

The following are the concluding remarks of the report, expressed in the engineer's own words. He says: "I think the only conclusions to be drawn from the above considerations are (1) that electric tramways will not pay at Weston; (2) an electricity supply undertaking will pay a profit if carried out quite independently, and will provide a brilliant illumination along the sea-front, which is of itself likely to prove a great attraction to Weston; (3) if a refuse destructor be erected, and if it be worked in conjunction with the electricity supply works, the paying capacity of the latter will be enhanced, whilst Weston will be supplied with a much-needed sanitary reform—a fact of great importance to every town, and especially to a town that is essentially a health resort."

ELECTRIC LIGHTING AT HARROW.

It is satisfactory to note that the scheme for the establishment of an electric light station at Harrow, to which we have referred from time to time, is progressing, a tender having been provisionally accepted by the Local Board, as mentioned in our last issue. After considering the various tenders received, the Electric Lighting Committee of the Local Board drew up a report, of which the following is an abstract:

The committee have opened and considered, with the assistance of the engineer, Mr. W. C. C. Hawtayne, tenders from the British Thomson-Houston, Limited, the Brush Electrical Engineering Company, Limited, Messrs. Crompton and Co., Limited, the Electric Construction Company, Limited, Messrs. John Fowler and Co., Limited, the India Rubber, Gutta Percha, and Telegraph Works Company, Limited, Messrs. Siemens Bros. and Co., Limited, and Messrs. J. G. Statter and Co., Limited. Specifications were also sent to Messrs. S. Z. de Ferranti, Limited, and Messrs. Mather and Platt, Limited, but no tenders were received from them. All the tenders received, except one, are as a whole below the estimate furnished to the Board by Mr. Hawtayne.

After dealing with the objections raised to the scheme, the report continues: The most important proof of the soundness of the scheme is to be found in the actual tenders which the Board have received. The tenders were for the full equipment of the undertaking exclusive of buildings and trenching, and for working the station year by year. The contractors were asked to give alternative tenders for erecting the station either at the Harrow Pond and Gardens site or at the Board's depôt at Bessborough-road. It was thought that the buildings should be erected by builders in Harrow, but tenders could not be invited until the requirements of the contractors as to floor space and other details were known, and it was also thought that labour in the district should be employed for making the trenches for the mains. After a careful examination of the tenders, that of Messrs. Crompton and Co., Limited, appeared the most suitable, but the Board propose that they should themselves carry out such part of the work as relates to mains for private lighting, in which respect they believe it may be possible to save from £500 to £1,000 by a modification of the system proposed. Without, however, taking this branch of the work from Messrs. Crompton and Co.'s tender, their figures amount to £8,139. 15s., to which must be added about £1,000 for trenching and transformers, bringing the total amount to £9,139, as against Mr. Hawtayne's estimate of £9,300. Messrs. Crompton and Co.'s tender is based on the assumption that the station will be erected at the depôt, which the Board have decided is the preferable site. About £150 would have to be added to either amount for purchase of meters. Messrs. Crompton and Co.'s tender for working the lighting varies with the number of

of

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units consumed each year, and is as follows: If the output reaches

50,000	units the cost would be	£1,331*	equal to	6¼d. per unit
60,000	,,	1,411	,,	5$\frac{13}{16}$,,
80,000	,,	1,541	,,	4¾ ,,
100,000	,,	1,686	,,	4$\frac{11}{16}$,,
120,000	,,	1,900	,,	3¾ ,,
150,000	,,	1,975	,,	3$\frac{3}{16}$,,

Mr. Hawtayne estimated that when all the lamps were taken up there would be an output of about 115,000 units, and his estimate for working expenses was at the rate of 4¼d. per unit. Messrs. Crompton and Co. furnish the following figures for the yearly working of the station according to the number of lamps estimated for by Mr. Hawtayne:

Output of Station.

3,400 lamps in masters' houses and private houses, each consuming 18 units per annum	61,200 units.		
600 lamps in school buildings, each consuming seven units per annum (modified from Mr. Hawtayne's original estimate of 10,800 units)	4,200 ,,		
		65,400 units.	
Street-lighting		43,000 ,,	
		108,400 ,,	

Revenue.

65,400 units at 8d. (private lighting)	£2,180	0	0			
Street-lighting (credit price paid for gas lighting)	550	0	0			
Meter rents, say	20	0	0			
				2,750	0	0

Working Cost.

Messrs. Crompton and Co. guarantee that this shall not exceed for the above output	1,736	0	0			
Add expenses of office and collection	100	0	0			
				1,836	0	0
Balance available				914	0	0
Repayment of instalments and interest on capital expenditure 6 per cent. on, say, £12,000				720	0	0
Leaving a yearly profit of				£194	0	0

The committee are aware that the gas company do not give discount to the consumers on punctual payment, but they would recommend the Board to adopt that course if they supply the electric light. It would amount, at 5 per cent., to £109. The Board could well afford to do this, especially if they worked the station themselves and so saved the contractor's profit. Mr. Hawtayne's figures being so remarkably confirmed by the experience of working in large and small towns and the actual tenders received, the committee think it would be a misfortune if the lighting of Harrow by electricity were to pass out of the Board's hands. It seems to the committee that the Board would be able at no distant date to reduce the price at which they would supply the light, and that if they handed the scheme over to a company they would not be doing their duty as representatives of the ratepayers, even if they succeeded in obtaining repayment of the money already spent in obtaining the provisional order and the information they have collected. While the concern is in their hands every advantage obtained would go directly to the ratepayers, and their interests would be consulted. A company would naturally look after its own interests before those of the place, and if the Board wished hereafter to acquire the concern they would have to pay heavily for it.

LEGAL INTELLIGENCE.

ALABASTER AND OTHERS v. HARNESS.

In the Court of Appeal on Tuesday and Wednesday, before the Master of the Rolls and Lords Justices Lopes and Rigby, the appeal of the defendant in this case was heard and decided. It was an appeal by the defendant in an action brought by the proprietors of the *Electrical Review* against Mr. Harness, who had been connected with the "Medical Battery Company," to recover damages for "maintenance." The case for the plaintiffs was that the defendant had instigated Dr. Tibbits to bring an unfounded action for libel against them in respect of an article that had appeared in their journal reflecting upon Dr. Tibbits, the present defendant, and the "Medical Battery Company." The verdict in the case was in favour of the present plaintiffs, on the ground that the alleged libel was a privileged criticism, but the plaintiffs were unable to obtain their costs, amounting to £435, from Dr. Tibbits. The plaintiffs thereupon brought the present action against the defendant, Mr. Harness, to obtain payment of the costs in the first action, on the ground that the defendant had instigated Dr. Tibbits to bring the action. At the trial before Mr. Justice Hawkins, the defendant contended that he had a common interest with Dr. Tibbits in bringing the first action, and that therefore no action for maintenance would lie against him in respect of anything that he might have done in the way of promoting the litigation. The learned Judge, however, upon further consideration, held that the defendant had no common interest in the action brought by Dr. Tibbits, and that therefore he was bound to pay the plaintiffs the costs they had incurred in the action. The defendant appealed. Mr. Jelf, Q.C., and Mr. F. Dodd appeared for the defendant.

The respondents were not called upon.

Their **Lordships** held that the attack in the article in question formed no part whatever of the ground of Dr. Tibbits's action, and that therefore the defendant, who had undoubtedly induced Dr. Tibbits to bring that action, must pay the amount of the costs incurred by the present plaintiffs in defending the action.

Judgment was given accordingly.

LONDON ELECTRIC SUPPLY v. CRAWFORD.

A case of considerable importance to electric supply companies, and one which should serve as a warning to the public, was decided in the Law Courts on Wednesday. The action was brought by the London Electric Supply Corporation against Mr. Crawford, of the Lytton Club, to recover £20, damages claimed for alleged breach of agreement.

The plaintiffs' case was that the defendant had entered into an agreement with them for one year for the supply of current to the equivalent of 150 incandescent lamps, and that he had cancelled the agreement, although the plantiffs had been put to expense in getting out plans, etc., in connection with the supply. The plaintiffs brought the claim as a test case. The defendant consented to a judgment of £15 and costs.

This case shows plainly that the agreements entered into between supply companies and consumers are valid, and this fact should be borne in mind by the public.

CLAIM FOR COMMISSION.

The case of South *v.* Perry and Co. was tried in the Westminster County Court on Friday before his Honour Judge Lumley Smith, Q.C. It was an action by the plaintiff, who is an electrical engineer, to recover from the defendants, who are dealers in electric light fittings, the sum of £7. 10s., being commission at the rate of 10 per cent. on a quantity of electric light fittings supplied to the plaintiff's customer at a house in Grafton-street, Bond street. The evidence of the plaintiff's witness went to show that they were employed to fit up the electric light at the house of a Mr. Johnson in Grafton-street, and as there was some difficulty as to the choice of the fittings, it was agreed that the plaintiff was to get them. In pursuance of that arrangement, several firms were negotiated with, and ultimately the goods were obtained from the defendants on the distinct understanding that the plaintiff was to have a commission of 10 per cent. After they were fixed up, however, the customer did not quite approve of them, and he was given the address of the defendant firm, in order that he might choose for himself. The result of that was that Mr. Johnson got into communication with the defendant firm and purchased a new set of fittings altogether at a cost of £75, and the agreed commission of 10 per cent. on the order was now claimed, but for some reason or other the defendant objected to pay.

For the defence **Mr. Bartlett** was called, and said he was the sole proprietor of the firm of Perry and Co, carrying on business at Albemarle-street, Bond-street. He did not recognise the plaintiff's claim in this action because he considered that the sale was brought about by an interview which he personally had with Mr. Johnson. The latter gentleman called at his place of business and chose an expensive pendant, and gave instructions for it to be fixed up in his dining-room. When witness went to the house he at once recognised that the pendant already existing in the room was an iron one which had been previously purchased by the plaintiff, but considered by Mr. Johnson to be unsuited to the room.

His **Honour** said the whole question was as to whether or not Mr. Johnson gave this order to the defendant in consequence of the introduction of Mr. South. He was of opinion that he did, and therefore judgment would be for the plaintiff for commission at the rate of 10 per cent. on the amount of the order and costs.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Madrid.—Tenders are invited by December 20 by the Ministère d'Outre Mer, Madrid, and by the General Government of Havana, for the construction of a telephone system in the island of Santa Clara.

London, N.—The tenders for the Great Northern Railway Company for telegraph and electric lighting material, referred to in our last issue, must be delivered at King's Cross by 10 a.m. to-morrow (Saturday) morning.

Coventry.—The Corporation invite tenders, from manufacturers, for electricity meters. Particulars may be obtained at the office of Mr. Robert Hammond, the consulting electrical engineer, Ormond House, Great Trinity-lane, London, E.C. Tenders to be delivered to Mr. Lewis Beard, town clerk, by Wednesday, December 12.

Enniscorthy (Ireland).—Tenders are invited for providing the Enniscorthy District Lunatic Asylum with internal telephonic communication, about 13 stations being required. Tenders will be considered by the Board on December 12, and should be sent,

* This and the following sums do not include rent, rates, and taxes, but there are allowed sums varying from £100 to £130 for office and collection expenses, which if carried out by the Board may be deducted.

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addressed to the chairman, so as to reach the asylum by 6 p.m. on December 11. Further particulars can be obtained from the resident medical superintendent.

Blyth.—The Cowpen District Local Board (Blyth, Northumberland) invite tenders for the efficient lighting, by electricity or otherwise, of the lighting area within their district for a period of seven or ten years respectively, commencing from August 15, 1895. A plan of the district can be seen and further information obtained at the surveyor's office, Commercial-buildings, Waterloo, Blyth. Tenders, endorsed "Lighting," to be sent to Mr. Robt. T. Guthrie, clerk to the Board, not later than December 20.

Swindon.—Tenders are invited for lighting works, for the Swindon New Town Local Board as follows: (1) supply of gas, oil, or other light to, and lighting and cleaning of all lamps within the district of Swindon New Town for one year commencing January 1; (2) supply of gas, oil, or other light, only for all lamps within the district for one year commencing January 1; (3) lighting and cleaning all lamps within the district for one year commencing January 1. Tenders by 10th inst. For further particulars apply to Mr. Henry Kinneir, clerk, Public Offices, Swindon.

Hanley.—The Corporation of Hanley are prepared to receive tenders for the supply and erection of the following plant: Contract No. 10—extension of engine-house plant, including 200-kilowatt alternator, 25-kilowatt alternator, and 20-kilowatt exciter, each separately driven by a compound steam-engine, with all necessary steam and exhaust pipes, valves, switchboard, and appurtenances; Contract No. 11—extension of condensing plant, consisting of circulating pump, air-pump, boiler pump, surface condenser, with all necessary pipes and appurtenances. The drawings can be inspected, and specifications, prepared by Mr. G. H. Cottam, Corporation electrical engineer, together with general conditions and forms of tender, can be obtained at the offices of Mr. Joseph Lobley, Town Hall, Hanley, on payment of 5s. Tenders are to be delivered to Mr. Arthur Challinor, town clerk, on or before January 5, 1895. The Corporation do not bind themselves to accept the lowest or any tender.

RESULTS OF TENDERS.

Sunderland.—The Town Hall Committee have accepted the following tenders: Messrs. Reed, Ferens, and Co., for wiring the Town Hall; and Messrs. Crompton and Co., for altering the gas fittings.

London, W.C.—For carrying out repairs at the Covent Garden latrines, including the installation of electric light, for the Strand Board of Works, the tender of Mr. G. Jennings, at £1,440 has been accepted.

Bournemouth.—The following four tenders have been received for the electric lighting of the Punshon Memorial Wesleyan Chapel:

W. Haydon	£99 10 0
W. H. Aish	96 16 0
Roger Dawson	87 10 0
Bacon and Curtis	84 0 0

The last has been accepted.

Harrow.—The following tenders have been received by the Local Board (and are referred to in a report given in another column) for establishing a central electric light station: British Thomson-Houston, Limited; Brush Electrical Engineering Company, Limited; Crompton and Co., Limited; Electric Construction Company, Limited; J. Fowler and Co., Limited; India Rubber, Gutta Percha, and Telegraph Works Company, Limited; Siemens Bros. and Co., Limited; J. G. Statter and Co., Limited. As mentioned in our "Business Notes" last week, the Local Board have provisionally accepted the tender of Messrs. Crompton and Co.

BUSINESS NOTES.

Radcliffe.—The Local Board intend to charge 8d. per unit for current.

Kendal.—The Town Council are enquiring into the subject of electric lighting.

Burnley.—The equivalent of 6,000 8-c.p. lamps are now connected to the mains.

Buckland.—Messrs. Mannering's mills at Buckland, Kent, are to be lighted electrically.

Newport (Isle of Wight).—The Hermite purification of sewage system is being used here.

Chelmsford.—An extra electric light has been placed in the centre of the Maltese-road.

Folkestone.—Mr. Webster has installed the electric light in Maestrani's refreshment-room.

Wishaw.—The Town Commissioners intend to apply for a provisional electric lighting order.

Great Northern Telegraph Company.—For the month of November the receipts were £26,400.

Stanton.—Negotiations are on foot for having Stanton lighted electrically from the Stanton-lane Colliery.

Bacup.—The Town Council are considering the advisability of adopting the electric light for the Maden public baths.

Passage.—The directors of the Passage Docks have bought the electric lighting plant lately used at Donnybrook Fair.

Dewsbury.—The Board of Guardians propose to introduce the electric light into the Dewsbury and District Infirmary.

Commercial Cable Company.—The Board has declared a quarterly dividend of 1¾ per cent., payable on January 2.

Wolverhampton.—The building for the central electric light station is practically completed, and the plant is all down.

Isle of Man.—Mr. Tennant, of King Orrey, has carried out an electric light installation at St. George's Woollen Mill, Laxey Glen.

Cuba Submarine Telegraph Company.—For the month of November the receipts were £100 more than for the corresponding period.

Eastern Telegraph Company.—The receipts for the month of November were £64,095, as against £60,995 for the corresponding period.

Nottingham.—Four 4,000-c.p. Brockie-Pell arc lamps have been placed in the Market-place. They take the place of nine large gas lamps.

Croydon.—A temporary electric light installation is to be placed in the new municipal buildings until the public supply is ready.

London, W.C.—The London County Council have authorised the expenditure of £30 for the purchase of electric lamps for the central offices.

Halifax.—The machine-room at the central electric light station is virtually finished, and the plant will shortly be running for testing purposes.

Direct Spanish Telegraph Company.—For the month of November the receipts were £1,733, as against £2,442 for the corresponding period.

Huddersfield.—The electric light is now installed in the infirmary and in the Theatre Royal, current being taken from the Corporation mains.

Yarmouth.—A company is applying for powers to construct tramways in Yarmouth, and to use animal power or mechanical power other than steam.

St. Helens.—A sub-committee of the Gas Committee of the Town Council has been appointed to enquire into the question of introducing the electric light.

Eastern Extension Telegraph Company.—For the month of November the receipts show an increase of £2,817 as compared with the corresponding period.

Wantage.—Messrs. Robinson and Auden, Limited, have lighted their works electrically. The engine is of their own make, and the dynamo by Mr. Newton, of Taunton.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 2nd inst. amounted to £902, as compared with £565 in the corresponding week of last year.

St. Austell.—A new building has been erected for the Young Men's Christian Association which is lighted throughout electrically. The installation has been carried out by Messrs. Veale and Co., St. Austell.

Bury.—Arc and incandescent lamps have been installed in Messrs. Milnes Bros.' works at Lumn, near Bury, the work having been carried out under the superintendence of Mr. W. H. Campbell, Tottington.

Isonomy Patentees Co-operative Trust, Limited.—This Company has been registered with a capital of £500 to acquire, work, or otherwise utilise British and foreign patents of practical value and public importance.

Ipswich.—Colonel Ducat, R.E., one of the inspectors of the Local Government Board, has sat to enquire into an application by the Ipswich Corporation for sanction to a loan of £2,000 for an experimental trial of the Hermite system of sewage purification.

Worcester.—The Town Council are applying to the Local Government Board for sanction to borrow £18,030 for electric lighting purposes, in addition to £1,000 authorised in October, and also to borrow £1,200 for wiring the Guildhall and Public Hall.

Clifton.—Sixty-four 16-c.p. incandescent lamps are being installed by Messrs. Crompton at Clifton College, and they are also wiring three houses connected with the college. The work is being carried out under the superintendence of Mr. H. T. Sully, of Bristol.

Stock Exchange Notice.—An application has been made to the Stock Exchange Committee to appoint a special settling day in Willans and Robinson, Limited—20,459 6 per cent. cumulative preference shares, Nos. 30,001 to 50,459, and 19,375 ordinary shares, Nos. 1 to 19,375.

Ayr.—The committee of the Town Council, which, as we mentioned last week, was appointed for the purpose, have purchased a site for the electric light works. The ground secured is near the head of Mill-street, and runs from the street to the river. The purchase price is £1,550.

Blackpool.—It is stated that the applications for shares in the new Blackpool, St. Annes, and Lytham tramways have not been sufficiently large to warrant the directors in proceeding to allotment. The project, however, is not to be abandoned, for a syndicate of gentlemen have taken the work in hand.

Brentford.—Mr. Sarbury, London-wall, has asked the Local Board the terms upon which they would grant a concession for lighting the district electrically. The Board have returned an evasive answer, to the effect that sufficient details were not before them to enable them to come at present to a decision.

City and South London Railway.—The receipts of the Company for the week ended December 2 were £928, against £905 for the corresponding week of 1893, or an increase of £23. The total receipts for the current period of the present half-year amount to

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£19,576, as against £18,275 in the corresponding period of 1893, an increase of £1,301.

Liverpool.—The special committee recently appointed by the Council to deal with the lighting of the city are understood to be considering a proposal for the adoption of electricity as a means of lighting the principal thoroughfares, and have had a conference on the subject with the directors of the Liverpool Electric Supply Company, Limited.

Barnet.—Mr. J. G. Walker, butcher, of High-street, Barnet, has had the whole of his premises fitted up with the incandescent light, from Messrs. Swain's installation, under the superintendence of Mr. Holt. The outside lights consist of four 25-c.p. lamps. He has also three 16-c.p. in the shop, five 8-c.p. and two 16-c.p. lamps for his premises at the rear, and 8-c.p. lamps for the various rooms in the house.

Fareham.—The Local Board have made application to the Local Government Board for permission to borrow £7,000 for electric lighting purposes (including the purchase of the undertaking of the Fareham Electric Lighting Company). A public enquiry will be held by Colonel J. T. Marsh, R.E., a Local Government Board inspector, at the offices of the Local Board to-day (Friday).

Salford.—In reply to a question by Mr. Alderman Dickins, Mr. Holland, chairman of the Gas Committee of the Town Council, has stated that the householders of Salford need not expect to have the electric light this winter. The contractors appeared to be hopelessly behind their time. The committee had decided to sell the electric light at 7d. per unit., which was 1d. less than was charged at Manchester.

Change of Address.—The Epstein Electric Accumulator Company, Limited, have removed from 21A, Blythe-road, West Kensington, to 215, Gresham House, Old Broad-street, E.C. Mr. Frederick Nell, of 26, Mark-lane, notifies that on and after the 12th inst. his address will be 97, Queen Victoria-street, E.C, where he has taken showrooms and offices for an exhibition of the "Victor" turbine and pumping machinery.

Peckham.—Additions are being made to the premises of Messrs. Jones and Higgins at the junction of Rye-lane and High-street, Peckham. The electric light will be adopted in parts of the premises, and the electrical plant has been supplied by Messrs. J. Slater and Co., of Holborn. An Adamson steam-boiler is employed. A well has been sunk at the rear of the premises, and the water will be pumped by means of a electrically-driven pump.

Dan Rylands, Limited.—The sixth annual general meeting of this Company was held at the works at Stairfoot, near Barnsley, on Monday. The report submitted stated that the accounts for the year ending August 31 show a loss of £1,159 after providing interest on the debenture debt and loans. Owing to adverse weather in the summer, the coal strike, and the consequent bad trade in the colliery districts, a large loss was sustained. The report and accounts were adopted.

Newcastle.—The Newcastle and District Electric Lighting Company, Limited, Forth Banks, have entered into a contract with the Co-operative Wholesale Society for the supply of the electrical current required for the lighting of the latter firm's large new warehouse now in course of erection in Blandford-street. This will be the largest electric lighting installation in Newcastle, being equal to about 2,500 10-c.p. incandescent lamps. The Board of Guardians intend to light the workhouse by electricity.

Rugby.—Messrs. Willans and Robinson have just acquired 30 acres of land in Newbold-road, Rugby, close to the railway, and are preparing to erect works on a large scale for the construction of stationary engines, their works at Thames Ditton having become too small for their requirements. The works, which will have a frontage to the London and North-Western Railway of about 1,000ft., will cover about 20 acres of land, and it is estimated, when in full swing, will provide employment for about 300 men.

Aberdeen.— The Gas and Electric Lighting Committee of Aberdeen Town Council have opened the tenders, seven in number, for the work of extending the plant at the electric station in Cotton-street, and considered by the committee. The offerers were English firms, and the prices quoted ranged from £3,300 to £3,860. It was decided to remit the tenders to Prof. Kennedy, London, who will report to a future meeting as to what offer should be accepted. The lowest tender is that of Messrs. Holmes and Co., Newcastle-on-Tyne.

Hanley.—A correspondence has taken place between the Town Council and the Brush Electrical Engineering Company as to the character of the plant and apparatus supplied by them at the Hanley electricity works. The company stated that it was their desire that the equipment of the works should give entire satisfaction, and they agreed to a proposal to send one of their engineers to supervise and be responsible for the running of the plant for a month in order to demonstrate what they believed to be the fact—that the plant was in good working order.

Removal.—The Nalder and Harrison Construction Syndicate, Limited, writing from Trafalgar House, Great Newport-street, Charing Cross-road, inform us that owing to the increase of business they have found it necessary to transfer their offices to 47, Victoria-street, S.W., to which address all communications should in future be sent. The works will continue to be at Trafalgar House, the space hitherto used for offices being converted into additional workshops. The syndicate have also opened a branch office at 33, Old Broad-street, E.C.

Dundee.—The question of the extension of the mains in order to supply the technical institute in Small's Wynd with the electric light has been under the consideration of the Gas Committee of Dundee Town Council. It appeared that a capital expenditure of about £500 would be required for the purpose, and that the Institute Committee hesitated to pay that amount. The Gas Committee, after considerable discussion, decided that they could not incur so large an outlay outside the district prescribed by statute, and the town clerk was instructed to communicate that resolution to the Institute Committee.

Appointment Vacant.—An assistant electrician is wanted by the Manchester Corporation. He will have to take charge of an eight-hour shift, must have had technical education, and passed through the usual routine of pupilage. It is essential that he shall have had central-station experience of boilers, engines, dynamos, secondary batteries, and switching gear. The salary is £2. 10s. per week. Applications to be made in writing, with copies of testimonials, and forwarded to the Gas Department, Town Hall, Manchester, not later than the 15th inst., addressed to the chairman of the Gas Committee, and endorsed "Application for Assistant Electrician."

Pretoria Lighting Company.—A communication from Johannesburg dated November 5 says: "At the meeting of the Pretoria Lighting Company on Tuesday, the new contract with the Government cancelling the electric and gas concessions and extending the contract for the lighting of the town for 15 years was adopted, and also a reconstruction scheme and an offer of Messrs. Lewis and Marks, Eckstein and Co., and Julius Jeppe, guaranteeing to advance up to £40,000 on debentures of the company, shareholders having the right to participate in the application for debentures *pro rata* to their holdings. The report and accounts were also adopted. The new scheme will take effect from December 1."

Belfast.—The Town Council have approved of a formal report presented by the Electric Light Committee. Councillor Harrison said that Alderman Pirrie six months ago had announced to the Corporation that about November they would have the electric light. He wished to know when they were likely to have it. Councillor Reid asked how many of the citizens had applied for the electric light. Alderman Pirrie, in reply, pointed out that it was little more than six months ago since the committee was appointed. It would probably be January before the light was ready to be given to the people who applied for it. In answer to Councillor Reid's question, he said that about one-fourth of the installation had been already applied for by various people.

Lancaster.—On Saturday the Morecambe Electric Light Company were summoned by the Morecambe Local Board for causing an effluvia which was a nuisance and injurious to the health of the inhabitants. The works of the company are in the centre of Morecambe, and in the generation of electricity they use as motive power engines driven by water-gas, in the manufacture of which the smells complained of were caused. Mr. Callis, of Blackburn, urged on behalf of the company that the gas manufactured was passed through tanks of water, and the tainted water turned into the main sewer, and that the sewer traps of the houses being defective allowed the smell to come from the sewer. The magistrates fined defendants £1 and costs, and the company undertook to abate the nuisance.

Fleetwood.—Mr. R. Walton has held an enquiry at Fleetwood with regard to the Improvement Commissioners' application for borrowing powers for the proposed electric lighting scheme. Mr. J. Tildeley, town clerk, stated that the Board wished to borrow £11,816. Mr. Geipel (of the Brush Electrical Company) explained that the scheme proposed to be adopted was the alternating system, 100-volt, fed by high-tension feeders. Mr. S. Fletcher, secretary of the Fleetwood Tradesmen's Association, and Mr. R. F. Addie (Fleetwood Estates Company) supported the application. Mr. Sutton (barrister) made a few observations on behalf of the railway company, who opposed the scheme. There were other schemes which were much more pressing—viz., sewerage. The electric light was only premature yet.

Glasgow.—The work of placing the fittings for the electric light in the new cars is going on apace, and within the next few weeks the people of Glasgow will have an opportunity of judging of the merits of the new illuminant. So anxious is the London company who has the work in hand to make a speedy success of it that during the last week not only has the inventor (who is the managing director of the concern) been at Coplawhill and Kinning Park superintending the work, but other directors from London have also been on the scene. That the work is of some magnitude may be shown by stating that for the 350 cars a stock of 2,800 accumulators will be necessary. These, with half that number of lamps, globes, and fittings, had all to be made specially for the contract, which was only signed some two months ago.

Western and Brazilian Telegraph Company, Limited.—The representative of the companies in Rio de Janeiro advises the London office that an amendment to the Budget was presented on Saturday by the commission, and officially published on Sunday, to the effect that the Brazilian Government is authorised to purchase the undertaking on the conditions of the contract, and also to make the necessary credit operations for the purpose. The Bill is now before the Chamber. For the past week the receipts of the Company were £3,353. The following telegram has been received from the Western and Brazilian Telegraph Company's representative in Rio de Janeiro: "Urgent—4th, 5 p.m.—Amendment to Budget presented by Commission of Public Works passed to-day in third discussion. It now forms part of Budget, which goes to Senate to-morrow."

Aberdeen.—The town clerk, at a meeting of the Town Council, read a letter from Messrs. New and Mayne, electrical engineers, stating that, as the Chamber of Commerce had expressed dissatis-

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faction with the telephonic service, it was now a favourable opportunity for the Council to consider whether they should have a system of their own, managed by themselves. The firm expressed their readiness to give the Council the necessary information. Treasurer Bisset suggested that the letter should be sent to the Finance Committee, to whom a remit was made some time ago in regard to this matter. The committee had been waiting until the agreement between the National Telephone Company and the Postmaster-General should be made known. After that they intended to recommend the Council to make application for a license. The treasurer's suggestion was agreed to.

Edinburgh.—On the motion of Messrs. Mackenzie and Cranston, it was remitted to the Lord Provost's Committee of the Town Council to consider and report as to whether it is desirable at this stage to arrange for laying down electric light high-tension cables from the station to Nicolson-street for the purposes of supplying domestic lighting through transformers. Some discussion took place on this motion, the contention of some members being that it was not desirable to proceed further with the electric light until the installation as at present adopted had been tried. Mr. Mackenzie explained that under their Act if six or more of the citizens made a requisition for light, the Council was bound under certain conditions to give them the light, and this motion was for the purpose of showing how best that could be carried out economically, as such a requisition had been received. On the Lord Provost explaining that this was a motion merely to obtain information, it was adopted.

Birkenhead.—An enquiry has been held by Mr. R. Dalton, M.I.C.E., an inspector under the Local Government Board, into an application by the Birkenhead Town Council for sanction to borrow £20,000 for purposes of electric lighting £10 000 for works of street improvement and sewerage, and £5,000 for the erection of a fire station. The town clerk (Mr. Alfred Gill) represented the Corporation, and there was no opposition to any of the proposed schemes. Mr. Shoolbred, the engineer, explained the intentions of the Corporation with regard to electric lighting, and said it was proposed to supply with this means of illumination a district embracing a mile radius from the generating station, which would be situated in a position to take in all the principal thoroughfares of the borough. Low pressure would be used, so that accidents such as those which had occurred in London and elsewhere, where high pressure was in use, would be almost impossible. It was proposed to fill the street boxes with oil, as was done in Brighton, where there had never been an accident of any sort, or even extinction.

Guildford.—A meeting of the founders of the Guildford Electricity Supply Company, Limited, has been held at the County and Borough Halls. Mr. A. F. Asher was voted to the chair. Mr. Sidney Sharp, the engineer, proceeded to give at some length the history of the negotiations which took place between the company and the Guildford Corporation, and explained the difficulties in the obtaining of the order consequent on the opposition of the Corporation. Eventually, however, they were successful in obtaining an exceedingly good order, which had received the Royal assent, and which gave them a practical monopoly of the electric lighting of the borough for 35 years. There were very few, if any, other companies which had obtained such good terms. Almost immediately after the order was obtained, the holidays intervened, and it was only recently that they had again been making progress with the matter. The meeting then proceeded to the consideration of formal business, and steps were taken for the issue of the prospectus and the appointment of directors. The share capital is £20,000.

Peterborough.—The Lighting Committee of the Town Council have reported as follows: "At a special meeting for the purpose of considering what action should be taken with respect to the powers obtained by the Corporation in the matter of electric lighting, and in pursuance of a resolution passed that the Corporation take steps to establish an electric lighting installation in accordance with the powers vested in them, the engineer read a further report, in which he gave his opinion and information upon the subjects of (1) the site of the proposed central station, (2) the system of supply, and (3) the preparation of the scheme. A discussion of considerable length ensued, and it was resolved "that the engineer draft a form of circular to be sent to the inhabitants within the compulsory area, with a view of putting before them as nearly as possible the terms of the proposed supply, and ascertaining the extent of the demand; that he have his report printed and supplied to the members of the committee; and that he also prepare a further report, with estimates, etc., showing what consumption would be required to produce an income sufficient to pay the capital and working expenses of such an installation as he proposes."

Tramways Company of France Limited.—An extraordinary general meeting of this Company was held on Monday at the Cannon-street Hotel for the purpose of considering resolutions for the increase of the capital of the Company by the creation of 15,000 new shares of £10 each, to be preference shares, and entitled to a cumulative dividend at the rate of 6 per cent. per annum, and authorising the directors, if they think fit, to sell the 7,094 shares of 500f. each in the Rouen Tramways Company belonging to this Company "for such sum as, after satisfying or providing for the liabilities of this Company, shall be equal to 30s. per share on the 14,248 issued shares of this Company." Lord R. H. Browne occupied the chair. The Chairman proposed the resolutions and explained the reason of the course proposed—viz., the substitution of electric traction for horse power. He said for some months past tramways had been very successfully worked at Havre by means of electricity, and there was a strong feeling in favour of that system at Rouen, where, if they did not adopt it, they were threatened with opposition. It was expected that permission would be given by the authorities to use overhead wires, and an application had been made for an extension of the term of the concession for 26 years, making 50 years to run from the present time. That application was likely to be granted if electric traction were adopted. After a short discussion, the motion was carried by four votes to two.

New Electric Launch.—A new electric launch has been built to the order of Messrs. Mavor and Coulson, of 57, West Nile-street, Glasgow, by Messrs. Denny and Bros., Dumbarton, to the design of Mr. T. L. Watson. This launch, according to the *Steamship*, is suitable for use in harbours and on lochs. It is intended for hanging at the davits, and is constructed so as to give the maximum of strength with the minimum of weight. The hull is made of a double skin of cedar wood, laid on diagonally, the two layers crossing each other. The motor is placed towards the stern and low down, a wooden cover protecting it from injury. The power is derived from a set of accumulators placed under the seats, which extend round the sides of the boat. The supply of current to the motor is regulated by a switch under the control of the steersman. The batteries hold a charge sufficient to propel the boat at a speed of 6·38 miles per hour for 5·7 hours, or a total distance of 36·36 miles, or at a speed of 4·5 miles per hour for 9·75 hours a distance of 43·2 miles. The recharging of the cells is done alongside the vessel or on the davits. The launch has round her a cork fender about 8in. square. This is said to be sufficient to support the launch when filled with water and with four passengers. The motor is of the Sayers type. The dimensions of the launch are: length, 27ft. 6in. by 4ft. 9in. The weight of the boat and fittings is 14cwt.; machinery, including cells, switches, etc., 1 ton 2cwt.; awning, fenders, etc., 2cwt. 3lb., being a total of 1 ton 18cwt. 3lb. The "Velvo," to whose trial on the Thames we recently referred, is also equipped with a Sayers motor, which was made by Messrs. Mavor and Coulson.

Cardiff.—A special meeting of the Electric Lighting Committee of the Cardiff Corporation was held on Thursday last week, under the presidency of the Mayor (Alderman Carey). Out of the three candidates chosen at a previous meeting for the position of foreman of the works, Mr. Charles H. Yeaman, of Victoria-street, London, was accepted. Some discussion took place in reference to the disappointing results of the installation. Mr. Massey explained that everything which had been done so far was in the way of an experiment by the contractors. Those experiments had not been quite satisfactory. He would suggest that the lighting of the public lamps should be postponed until there was a sufficient "load" on the engines. Alderman Jacobs thought this was not a very fair statement of the matter. In the first place, the rectifiers and other portions of the machinery had gone wrong, then when the machinery was put right there was not sufficient "load" to run the current steadily enough. The Mayor explained that the machinery had not yet been taken over by the Corporation. The lighting of the town or such portions of the town in which electric lamps had been erected was entirely experimental on the part of the contractors. Two or three members of the committee stated that in view of the supply of electrical energy tradesmen had given notice to discontinue the supply of gas, and it was explained that there would be no difficulty in supplying the private incandescent lights. A long discussion followed on several points connected with the electric lighting, and eventually a resolution was carried by which the contractors were asked not to attempt any more experiments until they had received a further intimation from the Corporation.

Dover.—A discussion has taken place in the Town Council on the subject of the renewal of the contract with the gas company for street-lighting. Alderman Peake (who is a director of the gas company) explained the details of the letter and pointed out that the lighting of the streets from the Market-square to Buckland Bridge by the incandescent light under terms offered by the gas company would be a saving of £38. 5s. a year on what is paid for the ordinary lamps, and if this experiment were tried and justified the directors in so doing, they would be pleased to consider an extension of this form of light. The Mayor (who is chairman of the Dover Electricity Supply Company) said they would bear in mind that for the last eight or nine years the ratepayers had really been at the mercy of the gas company, which had practically made its own terms as to the price per lamp they should charge. They must not forget that it was the electric light company, and that company only, which had brought the gas company to their bearings. Having done that, were the Council going to desert the electric light company at the very time they most required assistance? The electric company had been the actual lever by which the gas company had been brought to their bearings. The question would have to be proved which was the cheapest and best illuminant, and the advantages and disadvantages of the two lights. The Town Clerk said the gas contract would run out on December 31. After a deal of warm discussion, during which Alderman Pepper pointed out that it had been ruled over and over again that any member of such a body as the Council holding shares or being the director of any company should not endeavour to influence them, a statement which was borne out by the town clerk, it was decided to postpone further consideration of the subject.

Chester.—On Wednesday Mr. Wm. Jno. Bird Clerke, M.I.C.E, an inspector of the Local Government Board, held an enquiry at Chester Town Hall respecting the application of the Chester Town Council for sanction to borrow £25 000 for the purpose of electric lighting, and to appropriate a portion of the Tower Field Gardens as a site for the generating station. The Mayor (Mr. W. H.

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Churton), the town clerk (Mr. S. Smith), and a large number of members of the Town Council attended. The Town Clerk, in the course of an explanatory statement, said the land in question which was to be appropriated for the installation belonged to the Corporation. The proposal was to provide a generating station in the Tower Field Gardens with a distributing station at the back of Hamilton-place. The area of supply was the whole of the city, but what was usually termed the compulsory area of supply comprised Northgate-street, Bridge-street (not including Lower Bridge-street), Eastgate-street, Watergate-street, Grosvenor-street, to opposite the gate of Chester Castle, John-street, and Pepper-street. Mr. Smith then gave a history of the various stages through which the question passed before the Corporation since 1889, stating that the Council from the outset had been strongly of opinion that it was better, in the interests of the citizens, to retain the electric lighting in their own hands. The estimate furnished by Dr. Hopkinson for the first installation, including contingencies and engineering expenses, was £19,697, and therefore was within the vote of the Council; but if street-lighting were included, and if in the course of the development of the works the demand arose in the first year or two, Dr. Hopkinson thought they might have to spend £25,150. The Council for that reason thought it better to ask the Local Government Board, in the first instance, to assent to the expenditure of £25,000, the whole of which, of course, would not be spent except under the order of the Town Council.

New Swindon.—A special meeting of the Local Board has been held to consider and, if so determined, to pass a resolution to the effect that application be made in the ensuing session to the Board of Trade for a provisional order under the Electric Lighting Acts, 1882 and 1888, to authorise the Local Board to supply electricity for public and private purposes within their district. Mr. Adams asked the length of time over which the provisional order would hold good, and also the probable cost. The Clerk said he did not think there was any limit to time, but it was usual to carry out the order within two years or the order might be cancelled. The area proposed to be included was the whole district, as it was impossible to say now what portion of the district should be dealt with first. They might get the order restricted to some particular area. Mr. Adams said he thought they should not proceed with this matter now if it was going to cost £300 or £400. The Deputy-Clerk: You have to deposit £50 with the Board of Trade, and it may not cost you much more than another £50. The Chairman: There is a strong probability that it will not cost more than £200. Mr. Fox was not in favour of spending any money until the new council was in power. Mr. Longland proposed that the necessary steps be taken to obtain the provisional order. If a certain portion of lamps were taken by private consumers, it would result in a saving of money to the Board and the whole community. The members of the Board would all agree that they would like a better light than they had in New Swindon at the present time from the gas. By adopting this course now they would be securing for the new body who would succeed them a position which they could not otherwise obtain for another year if this step was not taken. Mr. Protheroe seconded the proposition, believing it would be beneficial to the town in the end. The proposition was carried, Mr. Jones dissenting. On the proposition of Mr. Batt, seconded by Mr. Mills, the Board decided to make a formal memorial to the Board of Trade in the matter.

Brighton.—At yesterday's meeting of the Town Council the Lighting Committee submitted a report they have received from their electrical engineer with reference to the extensions which he considers it will be necessary to make during the ensuing year to the electricity generating station and plant therein, in order to cope with the increasing demand for the supply of electricity throughout the borough. In this report it is stated that whereas in 1891 the number of lamps connected was 5,706, in 1892 the total was 11,229, an increase of 5,523; in 1893, 17,760, an increase of 6,531; and in 1894, 28,000, an increase of 10,240; this last total being exclusive of the 10,000 lamps taken over from the Brighton and Hove Company. Assuming, in order to be on the safe side, the rate of increase during the past year will continue, it is estimated there will be connected to the system in the winter of 1895 something like 48,000 lamps, and that in that year the sale of electricity will be about 1,000,000 units, representing at present prices a revenue of about £25,000. As the present works are just sufficient to supply this winter's demand, the necessity of extensions being made during the next year will. it is remarked, be obvious. It is proposed that these extensions should be regarded as part of the general scheme for ultimately bringing up the generating capacity of the North-road central station to supply about 200,000 lamps, which is about the limit it is considered advisable to supply from that site. The extension now recommended includes the erection of new chimney shaft 200ft. high, a second boiler-house, and an enlargement of the engine-room to double the present size; and the addition of six boilers, two steam dynamos, etc. This additional machinery will provide for an increase in the number of lamps supplied from the generating station from 38,000 8-c.p. lamps (22,800 alight at one time) to 62,000 8-c.p. lamps, of which 37,200 may be alight at the same time, still maintaining one-fifth of the power in reserve. It is recommended that a loan of £42,000 be obtained for a period of 40 years to defray the cost of the proposed works, the estimate including an item of £1,000 for mains for the purposes of street-lighting.

Hampstead.—The Works Committee of the Vestry reported that they had considered the question of lighting the Vestry Hall with the electric light, together with a report from the electrical engineer on the subject, and found that the probable cost of the installation would be £420; that the present cost of lighting by gas was about £80. 12s. 11d. per annum, and that the cost of lighting by electricity was estimated at £88. 4s. per annum; and that, pursuant to the authority delegated in that behalf, the committee had given instructions for certain electrical engineering firms to be invited to submit tenders for carrying out the installation in accordance with the specification of the Vestry's engineer. The Vestry approved of the report. The Electric Lighting Committee recommended that Messrs. Yerbury and Sons be paid the sum of £589. 12s. for the cartage of clay in connection with their contract as and when the architect shall so certify, and that they be also paid the sum of £1,112. 19s. 6d. for extra works in connection with their contract as and when the architect shall so certify; that electric lighting mains be laid in Dalehamgardens at a cost of £308, and from the junction of Gayton-road and High-street to the Vestry Hall at a cost of £1,050; that a transformer and necessary fittings be obtained for the use of the stoneyard installation at a cost of £20. 5s. 6d.; that the engineer be authorised to obtain dies at a cost of £8. 10s. This report was adopted. The same committee reported that they had accepted the tender of Messrs. Yerbury and Sons for erecting the shed at the rear of the station, already sanctioned by the Vestry, for the sum of £56, the work to be carried out to the satisfaction of the surveyor; that they had given instructions for the engineer's cash account for station expenses to be paid monthly; that they found that the cost of the gas supplied to the town clock amounted to £30 annually, and that the cost of installing the electric light therein would be £20, and it was estimated that the annual cost of that light would be £36, and they recommended that the committee be empowered to take the necessary steps to cause the town clock to be lighted by electricity. On the suggestion of the chairman, this recommendation was withdrawn pending the election of a new Vestry.

South Staffordshire Tramways Company. — The case of Marshall *v.* the South Staffordshire Tramways Company has been before the Chancery Court again on the question the form of order was to take. This was a debenture-holder's action, and the difficulty was in respect of the person acting as manager since the date of the order. At present there was no money to pay the wages of the servants and to keep the concern going. Mr. Bramwell Davis, who moved in the matter, said he was prepared to offer on behalf of a responsible man that only the net earnings should be handed over to the receiver. After some discussion, Mr. Justice Kekewich intimated that he should discharge the manager and order him to give up the direction of affairs. Mr. Davies said Mr. Dickinson, who was acting under Mr. Gully, declined to do anything or to pay over the wage money. After some argument, Mr. Davies said he presumed Mr. Dickinson would hand over the money. Mr. Warmington, Q.C., replied that Mr. Dickinson was Mr. Davies's servant. The matter then dropped. Mr. Buckley, Q.C., has appeared in support of the petition of Messrs. W. Smallman and others, trade creditors, for a compulsory order to wind up this Company, which had a capital of £86,580 in preference shares and £129 650 in ordinary stock. The stock had all been issued. In May, 1893, Mr. Justice Kekewich heard a debenture-holders' action, and appointed receivers and managers. On November 21 last he discharged the order as to managers, and appointed Mr. Sully sole receiver. This put the receipt of the takings in the hands of the directors, and they now had filed an affidavit which practically confessed insolvency. Mr. Theobald, for the Electric Construction Company, who had supplied the electric motive force, etc., said his Company had only received 6d. out of 9d. per mile agreed, and there was still a large sum due. He supported the petition. Mr. Swinfen Eady, Q.C., opposed the petition on behalf of the Company. Mr. Justice Williams said the debts of the petitioners were small trade debts, and he did not see why the directors should not pay them now they had the management of the Company in their own hands. The tramway was going on and money coming in daily. He should, however, require to hear more about the petition, because he was not satisfied it was a *bonâ fide* trade creditors' petition. Petition adjourned for a week.

Westminster Electric Supply Corporation, Limited.—An extraordinary meeting of holders of founders' shares in the above Corporation will be held at the registered office, Eccleston-place, Belgravia, S.W., on Thursday, 13th inst., at 10.45 o'clock in the forenoon, when the following resolution which was passed at an extraordinary meeting of the holders of founder's shares held on the 28th ult., will be submitted for confirmation as a special resolution: "That the assent of the holders of the founders' shares be given to the proposals for issue of new share capital to be presented to the shareholders at a meeting to be held this day—viz., that out of the newly-created share capital of £100,000, £40,000 in 8,000 shares of £5 each be forthwith issued at a premium of £1 per share, and in the first instance allotted to shareholders on the register on November 14, 1894, in the approximate ratio of one to every complete eight shares then held, and that the Board be empowered to allot any balance of the 8,000 shares not allotted to the shareholders to members of the staff of the Corporation, or to such other persons as they may think fit on the same terms. That the amount due on the shares be payable as follows: £1 (premium) on January 3, 1895; £2 on January 15, 1895; and £3 on July 1, 1895, and that the new shares rank for dividend (on amount of capital paid) from January 1, 1895. That the balance of 12,000 shares be retained, and that the Board be authorised to issue them as required, they being first offered to the shareholders on the register at the time of such issue, and on such terms as the Board may consider desirable." An extraordinary general meeting of the shareholders of the

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Corporation will then be held, at 11 o'clock, when the following resolutions which were passed at an extraordinary general meeting held on November 28, 1894, will be submitted for confirmation as special resolutions: "That out of the newly-created share capital of £100,000, £40,000 in 8,000 shares of £5 each be forthwith issued at a premium of £1 per share, and in the first instance allotted to shareholders on the register on November 14, 1894, in the approximate ratio of one to every complete eight shares then held, and that the Board be empowered to allot any balance of the 8,000 shares not allotted to the shareholders, to members of the staff of the Corporation, or to such other persons as they may think fit on the same terms.—That the amount due on the shares be payable as follows: £1 (premium) on January 3, 1895; £2 on January 15, 1895; and £3 on July 1, 1895, and that the new shares rank for dividend (on amount of capital paid) from January 1, 1895.—That the balance of 12,000 shares be retained, and that the Board be authorised to issue them as required, they being first offered to the shareholders on the register at the time of such issue, and on such terms as the Board may consider desirable."

PROVISIONAL PATENTS, 1894.

NOVEMBER 26.

22856. **Instruments for measuring the frequency of alternating or periodically varying electrical currents.** Hermann Clark Haycraft, 48, Breakspears-road, Brockley, London.

22866. **A regulating lever-action (dummy) "sounder" practice telegraph instrument.** Frank Edward Morriss, Postal Telegraph Office, King's Lynn, Norfolk.

22880. **Electric arc lamp.** Radley Mott Trille, Egyptian Lodge, Val Plaisant, Jersey.

22883. **Improvements in electrical measuring instruments.** Gustav Binswanger and Edward Stanley, 73, St. Stephen's-road, Upton-park, London.

22890. **Improvements in apparatus for the manipulation of electric or limelight boxes, scenes, curtains, and wings operated by electric current.** Arthur Taylor, 106, Priory-park-road, Kilburn, London.

22919. **An electrically-driven hydro-extractor.** Thomas Barnet Grant, 15, George-street, Mansion House, London.

NOVEMBER 27.

22965. **Improvements in or relating to electrically heating metal or other conducting bodies or welding metals electrically.** William Phillips Thompson, 6, Lord-street, Liverpool. (Charles Lewis Coffin, United States.) (Complete specification.)

22966. **Improvements in or relating to the production of compounds applicable for such uses as for paints for electric insulating and waterproofing, as substitutes for vulcanisable rubber and gum compounds, and for other purposes.** William Phillips Thompson, 6, Lord-street, Liverpool. (William Griscom, jun., United States.) (Complete specification.)

22973. **Improvements in and relating to storage batteries.** Charles Stephen Wheatley Brown, 3, Ellacomb-villas, Hertford-road, Edmonton, London.

22985. **Improvement in the means of fastening to incandescent electric or other lamps and globes any shade or ray diffuser.** Ernest Oldenbourg, 11, Warwick-street, Regent-street, London.

22986. **Improvements in and relating to primary batteries for producing portable electricity for light and power and other purposes.** Charles Jones Hubbell, 46, Lincoln's-inn-fields, London. (Complete specification.)

23012. **Electric signalling systems.** Horace Everett Walter, 40, Chancery-lane, London. (Complete specification.)

NOVEMBER 28.

23083. **Electrical and mechanical appliances for extracting shives, etc., from casks and other vessels and examining them inside.** Joseph Thomas Thompson and Alfred Slatter, De Frene-road, Sydenham, London.

23098. **Improvements in the feed-regulating mechanism of electric arc lamps.** William Kirkham Partington, 11, Furnival-street, Holborn, London.

23117. **An improved electrolytic process and apparatus for obtaining rich alloys of the metals of the alkalies or alkali earths and the production of halogen elements.** Léon Paul Hulin, 53, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, May 5, 1894, being date of application in France.)

NOVEMBER 29.

23159. **Improvements in and relating to electric brushes and such like.** Edward Lewis Levetus, 47, Vittoria-street, Birmingham.

23160. **Improvements in and relating to primary batteries and such like.** Edward Lewis Levetus, 47, Vittoria-street, Birmingham.

23177. **Improvements in dynamos.** Anthony George New and Arthur James Mayne, 55, Chancery-lane, London.

23203. **Improvements in the application of springs for electrical switches and other purposes.** William Thomas Burbey, 570, Hatton-garden, London.

NOVEMBER 30.

23219. **Improvements in the method of fixing electric arc lamps, with special reference to ease and safety for adjustment, trimming, etc.** George Marshall Harris, Bray Electric Light and Power Station, Bray, Ireland.

23250. **Improvements in gauges of electric exhaustion, positive and negative, caused by surroundings, buildings, or atmosphere.** Edmond Savary d'Odiardi and Eva Savary d'Odiardi, 218, Gloucester-terrace, Hyde Park, London.

23279. **Improvements in electrically-propelled carriages for common roads.** Frank King, 47, Lincoln's-inn-fields, London.

DECEMBER 1.

23294. **An improved electrical lamp.** Edwyn Grahame, 56, Sanscroft-street, Kennington, London.

23297. **Improvements in and relating to an apparatus and a method for causing chemical changes of gases and mixtures of gases by dark electric discharges.** Nicolas van der Sleen and August Schnellen, 37, Chancery-lane, London.

23354. **Improvements in and connected with the electric lighting and heating and also the ventilation of railway carriages and other vehicles.** Edwin James Preston, of the firm of J. Stone and Co., and Arthur Bernard Gill, 77, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1893.

21434. **Electrically-heated ovens.** Schindler.

1894.

249. **Electric switching apparatus for electrically-propelled vehicles.** King.

444. **Electric light fittings.** Northcote and Verity.

1657. **Communicating electricity to vehicles.** Holt.

17281. **Converting alternating into direct currents.** Still.

17365. **Raising and lowering electric or oil floor standards, etc.** Braham.

18910. **Electrolytical vessels.** Jensen. (Cappelen and another.)

19185. **Electric switches.** Stevens and Kesteven.

19186. **Electric thermostatic fire-alarms.** Rowand.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	5	5⅞-6
Bournemouth Electric Company	—	—
Brush Company, Ordinary	3	2⅞-2⅝
—— Nom. Cum., 6 per cent. Pref.	2	2⅛-2¼
—— 4½ Debenture Stock	100	110-113
Charing Cross and Strand	5	4½-5½
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	13-14
—— 6 per cent. Cumulative Pref.	10	14⅞-15½
—— 5 per cent. Debenture Stock	115	131-133
City and South London Railway, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	122-124
—— 5 per cent. Pref. Shares	10	13⅞-14½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2⅞-3¼
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	96-101
Electric Construction, Limited	2	⅝-¾
—— 6 per cent. Debentures	—	93-97
—— 7 per cent. Cumulative Pref.	2	1⅛-2
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1⅛-1⅞
Elmore's French Company	2	⅜-½
Elmore's Wire Company	2	1-1⅛
Fowler-Waring Cables	5	½-1⅛
W. T. Henley's Telegraph Works, Ordinary	10	8⅜-9½
House-to-House Company, Ordinary	5	2⅛-2⅜
—— 7 per cent. Preference	5	6¼-6⅝
India Rubber and Gutta Percha Works	10	25½-26½
—— 4½ per cent. Debentures	100	102-104
International Okonite, Ordinary	—	—
Kensington and Knightsbridge	5	4⅛-4⅜
—— 6 per cent. Pref.	—	6¼-6⅝
Liverpool Electric Supply, Ordinary	5	7 5/16-7 7/16
—— Pref.	—	—
Liverpool Overhead Railway	10	8-8½
—— Pref.	10	13-13½
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric	5	⅜-1⅛
Metropolitan Electric Supply	10	10-10½
—— 5 per cent. Reg. Debentures, 1-10,000 in Bonds of £10, £20, and £40	—	—
National Telephone, Ordinary	5	5-5½
—— 6 per cent. Cum. First Pref.	10	15-16
—— 6 per cent. Cum. Second Pref.	10	15-16
—— 5 per cent. Nom. Cum. Third Pref.	5	5⅛ 5⅜
—— 4½ per cent. Deb. Stock	—	110-113
Notting Hill Company	10	6½-7⅛
Oriental and Electric Company, £1 shares	1	1-1⅛
—— £5 Shares	—	7-7⅞
—— £4½ shares	—	5⅜-6¼
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7⅞-8⅛
—— 7 per cent. Pref.	5	8⅜-9
Swan United	—	—
Telegraph Construction and Maintenance	12	41-43
—— 5 per cent. Bonds	100	106-109
Westminster Electric Supply, Ordinary	5	7⅛-7⅞
Yorkshire House-to-House	4½	4¼-4½

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NOTES.

Electric Lighting in Italy.—The communes of Desenzano and of Montechiari are to be provided with a central electric station.

Train-Lighting.—The railway postal vans running between Frankfort-on-the-Maine and Basle are now lighted electrically from accumulators.

Technical Institutes.—A meeting has been held at Wandsworth Town Hall in furtherance of the project to establish a technical institute in the locality.

London Chamber of Commerce.—Lord Brassey will on Tuesday afternoon next deliver an address in the council-room, Botolph House, on "The Indian Currency Question."

Bedford Central Station.—As notified in another column, this station was started last week, since which time a supply of the electric light has been available both day and night.

Lecture.—The members of the Newport Literary Society were on Friday evening entertained to a lecture by Mr. R. Hammond, the consulting engineer to the Corporation, on "The Electric Light."

Gas Does Not Pay.—It appears that the Rotherham Town Council have during the past half-year made an approximate net loss of £1,993 on the working of the gas-works. They had better now give electric light a trial.

Gustavus Adolphus.—In connection with the celebration of the three hundredth anniversary of the birth of Gustavus Adolphus in Stockholm, the Gustavus Adolphus monument was illuminated at night by thousands of electric lights.

Telephony in Austria.—Telephonic communication has been established between Vienna and Linz, thus connecting Lower and Upper Austria. The subscribers can also be switched on to St. Pölten, Wilhelmsburg, Lilienfeld, and Hainburg.

Electric Construction Company.—We are informed by the Electric Construction Company, Limited, that Mr. Garcke will retire from the position of managing director of the company upon the expiration of his agreement at the end of the year.

Society of Arts.—On Monday, at 8 p.m., the fourth Cantor lecture on "Modern Developments in Explosives," by Prof. Vivian B. Lewes, will be delivered. On Wednesday, at 8 p.m., a paper on "Forestry," by General J. Michael, C.S.I., will be read.

Empire of India Exhibition.—The corner-stones of the Imperial Palace and Empress Theatre, which are to form part of the forthcoming Empire of India Exhibition at Earl's Court, were laid on Wednesday. The exhibits will include electrical appliances.

Long-Distance Telephony.—The works of Messrs. George Angus and Co., of Cardiff, have just been put in communication with their establishment at Newcastle-on-Tyne by the G.P.O. trunk line. The distance between the two towns is upwards of 300 miles.

Institution of Engineers and Shipbuilders.—The third general meeting of the North-East Coast Institution of Engineers and Shipbuilders will be held on Wednesday next, in the lecture hall of the Subscription Literary Society, Fawcett-street, Sunderland.

Companies Acts. — The council of the London Chamber of Commerce have decided to form a special committee for the purpose of preparing suggested amendments in the Companies Acts, and to supply information to the Board of Trade Committee, which has just been appointed.

Liverpool Engineering Society.—The fifth ordinary meeting of the session will be held at the Royal Institution, Colquitt-street, on Wednesday next, the 19th inst., at eight o'clock, when a paper, entitled "The Second Law of Thermo-Dynamics," will be read by Prof. Oliver J. Lodge, D.Sc., LL.D., F.R.S.

Personal.—Sir David Salomons has decided to signalise his mayoralty of Tunbridge Wells by a New Year's dinner, to which 300 guests will be invited.—Mr. Mavor, of Glasgow, has been retained by the Wishaw Town Commissioners as electrical engineer in connection with the proposed electric lighting of the town.

Naval Electricity.—Plans have been forwarded to the Admiralty of the new electric shop in Portsmouth Dockyard, and it is hoped it will be shortly proceeded with. One part of the convict prison will be utilised for the dynamos, but the remainder of the shop will be an entirely new building inside the prison walls.

"Yule-Tide."—Messrs. Cassell and Co. send us a copy of this Christmas annual, which comprises "The Avenger of Blood," a novel by Mr. J. McLaren Cobban; a large coloured plate, by Mr. W. E. Britten, of two children and a dog playing hide-and-seek; two smaller coloured plates of ducklings, toads, and chickens, and four plates in tints.

Electro-Medical Exhibition.—Under the auspices of the Société Française d'Electrothérapie, of Paris, there will be held in April next an exhibition of electric apparatus, instruments and generators for physiological, medical, and surgical purposes. The address of the secretary is Dr. D. Labbé, 46, Rue Pierre Charron, Paris.

Telephony in Switzerland.—The Budget of the Swiss Federal Council for 1895 provides for a sum of 133,000f. (£5,320) for telephonic communication between Geneva and Zurich; and for 53,000f. (£2,120) for a telephone line between Lucerne and Basle. Provision will be made in the following Budget for a telephone line between Geneva and Basle.

Electric Lighting in France.—Mr. J. Leroy, the representative in the eastern district for Messrs. Sautter, Harlé, and Co., has undertaken the work of fitting up an electric light installation for the work of constructing the batteries at the Frouard fort, near Nancy. There are six arc lamps and a number of incandescent lamps. The same firm has electrically lighted the Saint-Michel fort at Toul.

The Lighting of the Reichstag Building.—There are employed in the new Reichstag Building, Berlin, which has just been completed, 5,500 incandescent lamps of various candle-power, and 67 arc lamps of from 1,000 c.p. to 4,200 c.p., the total amounting to 180,000 c.p. The work has been carried out by the Berliner Elektricitätswerke, and the arrangements of the lamps as carried out have proved very satisfactory.

Dundee Institute.—The first ordinary meeting of the Dundee Institute of Architecture, Science, and Art for the session was held in the hall of the Young Men's Christian Association yesterday (Thursday) evening, when a lecture was delivered on "Some Principles of Decoration, in Marble, Mosaic, Sculpture, Painting, etc.," by Mr. Alexander N. Paterson, M.A., A.R.I.B.A., architect, Glasgow, president of Glasgow Architectural Association.

New Mode of Mill-Lighting.—A new system of lighting has been introduced by Mr. Lester Betts, the manager of the Calcutta branch of the Oriental Telephone and Electrical Company, Limited, in the case of the Empress of India Cotton Mills, at Budge-Budge, which are entirely lighted from the outside, special zinc fittings with 50-c.p.

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lamps being fitted to each window. This system, which has proved a complete success, saves the extra premium for fire insurance.

Electric Traction in Austria-Hungary.—There is a perfect epidemic of electric traction projects for Vienna. Among the schemes at present before the public are proposals by the Allgemeine Elektricitäts-Gesellschaft, of Berlin, by the Anglo Bank, by the Austrian Länderbank (in conjunction with the Vienna Tramway Company), by Messrs. Ritschl and Co., by the Kahlenberg Railway Company, by the New Vienna Tramway Company, and by Mr. Hermann Frühe.

Institute of Mining Engineers.—A general meeting of the members of the South Staffordshire and East Worcestershire Institute of Mining Engineers has been held at the Mason College, Birmingham, under the presidency of Mr. Sopwith, when Mr. E. J. Bailey read a paper on the main and tail rope system of electric haulage in operation at Abercanaid Colliery, Merthyr Tydfil. He explained the system in detail, and said that, taking into consideration the character of the work, the results obtained had been satisfactory.

Royal Meteorological Society.—An ordinary meeting of this society will be held at 25, Great George-street, Westminster, on Wednesday next, the 19th inst., at 7.30 p.m. Papers on the following subjects will be read: "Report of the International Committee on the Cloud Atlas," by Mr. Robert H. Scott, M.A., F.R.S.; "Rainfall and Floods in the Catchment Basins of the Severn, Wye, and Usk, November, 1894," by Mr. Henry Southall, F.R.Met.Soc.; and on "Meteorological Observations at Mojanga, Madagascar, 1892-1894," by Mr. S. C. Knott.

Quinquennial Rating Rovision, 1895.—The council of the London Chamber of Commerce draw the attention of members interested in manufacturing and industrial premises to the fact that in April next the assessment committees will make their quinquennial revision. From information already placed before the council, it would appear probable that these committees will suggest considerable increases. In order that the way may be prepared for such united action as may be found desirable at the proper time, the council have issued a form putting questions on the subject.

The Electrophone.—Last week a party of visitors was invited to hear the new instruments provided by the Electrophone Company, which is organising arrangements by which the music and performances at the theatres, sensational cases at the Law Courts, and other interesting electrophonic transmissions of sounds can be heard at various stations in the Metropolis and its suburbs. Selections from the entertainments going on at the Empire, Gaiety, Lyric, Prince of Wales's, and Daly's were given. The entertainment was given in one of the apartments of Pelican House, Gerrard-street, Shaftesbury-avenue.

Northern Society of Electrical Engineers.—The following is the list of officers and council for 1895, as elected at the annual general meeting held on Monday last: president, Mr. Henry Edmunds; past-president, Dr. John Hopkinson, F.R.S.; vice-presidents, Mr. G. E. Preece and Mr. W. P. James Fawcus; hon. solicitor, Mr. John B. Parkinson; hon. treasurer, Mr. George J. Somerville; hon. secretary, Mr. John Darney; and members of council, Messrs. A. B. Blackburn, Thomas Browett, E. A. Claremont, S. V. Clirehugh, G. S. Corlett, E. W. Cowan, C. M. Dorman, G. W. Lowcock, E. Manville, J. H. Rider, James Taylor, and C. H. Wordingham.

Gulcher Thermopiles.—To those interested in the subject of thermopiles we commend for consideration an article by Mr. C. Brüggemann published in the *Elektrotechnische Zeitschrift* of November 29. The author, who is one of the assistants at the technical high school, Aix-la-Chapelle, deals with measurements undertaken by him at that school with the Gülcher thermopile, in which slight improvements have been made. The thermopiles tested were four, each comprising 66 cells. Two of these (Nos. 263 and 228) were in operation about 200 hours; No. 333 was longer in use, but not over 500 hours; whilst the fourth (No. 306) has for almost two years served for the charging of accumulators.

Railway Rates.—The London Chamber of Commerce remind members that, as a measure of precaution, complaints to the Board of Trade in respect of increased railway rates under the Act of 1894 should be formulated and deposited not later than the 25th of February next, as there appears to be some doubt as to the precise construction of the section relating to the recovery of over-charges. The test cases referred to in a previous issue are proceeding, and it is understood that the Board of Trade have now received communications from the railway companies on the subject. It has not yet been possible to form an opinion as to when decisions can be given, but it is hoped, the council of the Chamber state, that they may be pronounced early in the New Year by the Railway Commission.

Extinction of the Musical Bore (!).—The *Pall Mall Gazette* young man who hunts about electrical and other matters for that paper is progressing. He did pretty well over "electric belts," but left patent agency business alone. Now he desires to get rid of the musical bore. Who does not? Listen to what he says about one instrument at the musical exhibition opened at the Aquarium on Wednesday afternoon: "One singular application of science to pianos is to be found in an electric piano, which passes a gentle, or if needs be, a severe shock through the frame of the performer. There is a future for an instrument of this kind. If all the drawing-room pianos were only fitted with a thousand volts or so it would be easy to extinguish the musical bore." It is not put very neatly, but it will do. Fortunately we do not live in a musical boring district. If we did, we should only take one vault—of the music-hall type.

State Telegraphy.—There is an expressed desire among those associated with the postal-telegraph system, the *City Press* states, that the twenty-fifth anniversary of the absorption of the telegraph by the State should be made the occasion for a festivity or an exhibition of curiosities. In the present building in St. Martin's-le-Grand, there are over 4,000 persons employed in telegraphy. The cheapening of the telegraph and the facilities offered for the exchange of messages in all portions of the kingdom form one of the wonders of the age, and it is only natural that those interested should desire to make the coming anniversary the occasion for a public demonstration of some kind. It seems to be a fitting opportunity, our contemporary concludes, for the exercise of a little public spirit on the part of the Corporation or one or more of the wealthy livery guilds, seeing that the State is not likely to exert itself in the matter.

Electric and Magnetic Experimental Apparatus.—To those engaged in experimental work, and particularly in colleges and scientific institutions, the new price-list of electric and magnetic apparatus just issued by Messrs. King, Mendham, and Co., of Narrow Wine-street and Fairfax-street, Bristol, comes out at an appropriate moment. Practically every kind of apparatus required for experimental work by lecturers, science teachers, and amateurs is fully detailed in the list. Commencing with

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Wimshurst influence machines, of the types furnished to the South Kensington Science and Art Department and other scientific establishments, the list passes on to static electromotors, inductive electric machines, electroscopes, electrometers, condensers, and the numerous accessories. Then follow Leyden jars, battery parts, voltaic batteries, and dry batteries, together with magnets and magnetic apparatus, electro-depositing apparatus, Ruhmkorff and induction coils, vacuum tubes, thermopiles, galvanometers, portable testing sets, etc. The list concludes with electric motors, telegraphic and telephonic appliances, incandescent lamps, lanterns, arc lamps, etc.

Effect of the Electric Arc on Carbon.—In the course of the series of experiments undertaken with the electric furnace during the past two years, M. Henri Moissan has had occasion to deal with the vaporisation of carbon. After having detailed his investigations before the French Academy of Sciences, he concludes as follows: (1) that in vacuum, as in ordinary pressure, carbon passes from the solid to a gaseous state without assuming a liquid form, and from this point of view it may be compared to arsenic; and (2) when gaseous carbon reassumes a solid form it always furnishes graphite. M. Moissan estimates, however, that carbon can be brought to a liquid state, but this phenomenon would only be produced under the action of more or less strong pressures. In the case of high pressures, as his previous experiments established, the density of the carbon would increase and the diamond would be obtained. In fact, he has been able to prepare small diamonds. Both at the Cape and in Brazil diamonds are found which possess no trace of apparent crystallisation, and which have rounded forms such as can be taken by a fluid maintained in the centre of a "milky" mass. Carbon under pressure could then take up the liquid state and be solidified as water, either by presenting a confused mass of crystals or by taking a rounded and amorphous form.

Chloride Accumulator Litigation.—The *Electrical Engineer* of New York says: "A decision was rendered on November 15 in the United States Court of Appeals for the Second Circuit, in the case of the Accumulator Company *v.* the Edison Electric Illuminating Company and the Electric Storage Battery Company, by Judge Wallace, affirming the decision of Judge Lacombe enjoining the Edison Electric Illuminating Company, of New York, from using the chloride battery, for the reason that it is an infringement of the Swan reissue patent." Before this confirmation was made, the Electric Storage Battery Company, of Philadelphia, wrote to our contemporary as follows: "In reference to the decision of the United States Court of Appeals for Second District, in case of Accumulator Company *v.* Edison Electric Illuminating Company: The day following the opinion of the Court upon the application of the counsel for the Edison Company, the Court gave leave to file an application for rehearing to be submitted in printed form, and accompanied with a printed argument in support thereof, and denied the motion of the counsel for the Accumulator Company for the mandate, holding that in abeyance until the decision was given upon the petition for a rehearing. The decision in no way affects the business of the Electric Storage Battery Company, but applies solely to the New York Edison contract, and even if affirmed will only delay that work until May next, when the Swan patent expires."

Society of Engineers.—The members of this society held their forty-first annual dinner on Wednesday evening at the Holborn Restaurant, the president, Mr. G. A. Goodwin, in the chair. Among those present were Sir R. Rawlinson, Mr. Alexander Siemens, Mr. J. Bernays, Mr. Jabez Church, Mr. C. Gaudon, Prof. H. Robinson, Mr. W. A. McIntosh Valony, Mr. A. T. Walmsley, Mr. J. W. Wilson, Mr. S. H. Cox, Mr. G. M. Lawford, Mr. W. G. Pierce, Mr. W. W. Beaumont, Mr. W. Bradford, Mr. J. C. Fell, Mr. H. O'Connor, Mr. S. Sellon, and Mr. G. A. Pryce Cuxson, secretary. The usual loyal and patriotic toasts having been honoured, the chairman proposed "Success to the Society of Engineers." In doing so he congratulated the members on the satisfactory position the society had maintained for so many years, and on the increasing number of new members. He pointed out the advantages which would be gained by the younger members, who would one day be called on to carry on their work, from attendance at their discussions and at their visits to works of engineering interest. He thought they should not be discouraged by the high point of scientific knowledge already attained, but should remember that although the field of research was becoming apparently restricted by continued improvements, it was also extending its circumference and thereby furnishing outlets for further discoveries. In conclusion, he advised them, while knowing something of everything, to know everything of something, and so become expert in some one subject.

Whirling and Vibration of Shafts.—The fourth ordinary meeting of the Liverpool Engineering Society was held at the Royal Institution, Colquitt-street, on the 5th inst., the president, Prof. H. S. Hele-Shaw, M.I.C.E., in the chair. The West premiums for the past sessions were presented to Messrs. Morgan and Duncanson. The remainder of the evening was devoted to the reading of a paper "On the Whirling and Vibration of Shafts," by Mr. Stanley Dunkerley, M.Sc., in which the author stated that a shaft, however nearly balanced, when driven at a particular speed bends, and unless the amount of deflection be limited might even break, although at higher speeds the shaft again runs true. The particular or "critical" speed depends on the manner in which the shaft is supported, its size and modulus of elasticity, and the sizes, weight, and positions of any pulley it carries. The formulæ giving this speed have been worked out for two simple cases, with unloaded shafts, by Profs. Rankine and Greenhill. A general theory applicable to all cases has been deduced by Prof. Reynolds, and the author has obtained mathematical formulæ giving the critical speed in terms of the diameter and length of the shaft, weights, and positions of the pulleys, etc., in particular cases applicable to the different conditions under which a shaft works. The formulæ so obtained cover all cases which are likely to arise in practice, and the object of the present paper is to give those results in such a form that they can be applied directly to practice by any ordinary engineer.

Electric Lighting at Agra.—Messrs. A. John and Co. are using the electric light, not only for their business premises, but also for the private dwelling-houses connected with the same. The buildings connected with the firm stand in a compound of about half a square mile, and consist of a medical hall, a store and office, a coach-building factory, a soda-water factory, a printing-press house, and four private dwelling-houses. The engine-room and dynamo-house have been built almost in the centre of the compound and contain a Marshall's 18 h.p. vertical engine and boiler. The dynamo is of the new pattern lately introduced into India by the Oriental Telephone and Electric Company. The medical hall, which is specially fitted up to show off the electric light to rajahs and other native nobility, is illuminated by a massive cut-glass hanging vase in the centre, hanging coloured lamps in each window, and a 300-c.p. lamp in the centre dome of the hall. All the showcases have imitation candle-

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lamps fixed among the cut-glass scent bottles, etc., and can be switched on or off one by one. The hall is also provided with an electric clock and an electric kettle. The grounds are also illuminated by 50-c.p. lamps in watertight fittings fixed to trees, walls, etc., and the coach building department is fitted with a complete set of lights to work at night in case of press of work. The plant was supplied and erected by the Calcutta branch of the Oriental Telephone and Electric Company, Limited, under the personal supervision of their manager, Mr. Lester Betts, M.I.E.E.

Mr. S. Walker on "Electric Traction."—Mr. Sydney F. Walker, of Cardiff, writes to a local paper as follows: "May I point out that when contemplating the purchase of the Cardiff tramways, it would hardly be wise for the Corporation to look forward to driving the t rams by electricity for several years to come, at the very least. The only system of electric railway that has yet paid for ordinary street work is that in which overhead conductors are used, and that, I imagine, would hardly be tolerated in Cardiff. The accumulator system is barred, even on perfectly level roads, by the excessive cost of renewal of the plates, while their weight is such that no car can carry sufficient accumulators to climb a gradient of 1 in 10 with a full load on a wet day. The underground slot system, which is used at Blackpool, is very expensive and very troublesome. The Blackpool line only pays owing to the special conditions of the traffic, and the dividend is very moderate even with that advantage. Further, the alternate-current system adopted in the Cardiff electric lighting station is not adapted for tramway work at all, as far as invention has gone at present. I believe that not only tramways, but 'buses, and even carriages and carts, will eventually be worked by electricity; but there is a good deal of work to be done before that comes to pass, principally in the direction of lightening and improving the accumulator. Possibly by the time the accumulator is so far improved that tramcars can be worked economically by their aid, the present fancy for alternate currents—the third I have witnessed—may have died out."

Electric Traction Catalogue.—Now that the question of light railways and electric tramways is being so prominently discussed in different circles, special interest will be excited in the "Electric Traction" catalogue just issued by the Electric Construction Company, Limited, of Wolverhampton and Queen-street-chambers, Queen-street, E.C. The great necessity for the substitution of electric for other methods of traction from the point of view of the shareholder is pointed out, and the benefits thereby accruing to the public are also emphasised. The catalogue, which is profusely illustrated, deals first with the storage battery systems, and then with the conduit method as being furnished by the company for Madras. A short line constructed on this principle is to be seen in operation at the works in Wolverhampton. Following is the overhead system, with centre suspension of the trolley wires and arc lamps arranged on the top of the standards. Reference is then made to the system carried out by the company on the South Staffordshire Tramways, where the method of side collection of the current devised by Mr. A. Dickenson has been introduced. A noteworthy point in this connection is afforded by a comparison of this system with the American method of transverse span wires with poles on both sides of the streets, the great difference between the two being prominently illustrated. Further emphasis is laid upon the superiority of the South Staffordshire system by comparative plans showing the method of overhead wiring adopted in the two cases. The success of the Liverpool Overhead Electric Railway is demonstrated, and the catalogue, which will be of value to all interested in tramway working, concludes with photographs of the motor trucks at Birmingham, and of the motors employed at Walsall and Liverpool and of generators.

Cost of Electric Transmission of Power.—Before the North of England Institute of Mining and Mechanical Engineers on Saturday, Mr. Alexander Siemens, president of the Institution of Electrical Engineers, read a paper on "The Cost of Electric Transmission of Power." He said that some time had elapsed since Lord Armstrong and Sir William Siemens installed electricity for this purpose, as well as for lighting, at their respective residences at Craigside and Tunbridge Wells. Those applications of electric transmission were perfectly successful, though it was only lately that the transmission of electric power had been taken up in earnest. First of all, electric tramways were developed, and their rapid extension was sufficient proof that reliable electric motors could be erected, and would work reliably and without trouble. There was a belief in the minds of some people that an electric motor cost about as much for repairs as a steam locomotive did for coal. His firm had electric motors on tramways which had run 60,000 miles without any repairs whatever. If they made a motor sufficiently strong so that it could do its work comfortably, it would not use up the brushes. Mr. Siemens then described the system of electric transmission in use in the works of Messrs. Siemens Bros. and Co. at Woolwich, which has been put in to supersede steam power. The works were lighted from the same generators. If engineers introduced electric power for pumping or hauling in mines they could use the same mains for lighting purposes, and they would find it worked perfectly well. Having given the result of careful experiments as between steam and electricity, he said there could be little doubt about it that for new works electric transmission was the cheapest. Whether a change from the old system to electric transmission could be recommended could only be decided by local circumstances. As a rule, electric transmission was most valuable where power was required to be transmitted to various and distant portions of works, and especially in such places as mines, etc. By the conversion the colliery owner would save sufficient to repay the outlay in 10 years. In other words, the cost of erecting the plant for the year would be less than the present cost by an amount equal to 20 per cent. of the outlay.

"Electric Engines."—This was the subject of a lecture delivered by Prof. Silvanus P. Thompson at the London Institute on Monday last. Starting with a little historical retrospect, the professor pointed out how curiously the now so very obvious principle of the electromagnet evaded discovery in the early years of the century. Experimenters got wrong by sending their currents of electricity through the bar of iron instead of round it. This, of course, was very natural. How could one expect that something would happen inside a house from merely walking round it. Prof. Thompson showed his audience two large examples of electromagnets. A thick bar of iron was instantly sucked up into the centre of one of these "solenoids," and remained gracefully suspended in the air in utter defiance of the laws of gravity. This sucking of a piston into a cylinder suggested to the inventive mind at once a means for making a motive electric engine. Why not have solenoid coils for cylinders, and iron pistons sucked in and out like a steam-engine, and connecting rods and cranks and things? Simply because this was precisely the worst way of harnessing electricity to work that could be devised. On the contrary, the rotatory system, which had proved to be the worst for steam, was the best for

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electricity. The lecturer explained the various stages of development of the electric motor, pointing out that the ring armature of Pacinotti spinning round between the poles of powerful electromagnets was the original model upon which nearly all dynamos and motors had been framed up to the present day. He pointed out how largely our American cousins use small motors for domestic purposes—to drive fans and turn sewing machines. The United States had thousands of miles of electric tramways running, which had effected quite a social revolution in the towns. Working-men, instead of crowding in confined and unhealthy houses in the heart of the cities, now went home to open suburbs on electric trams at a rate which would probably frighten the Board of Trade in this country. Prof. Thompson concluded by showing the famous experiments with polyphase currents that he recently made at the Royal Institution at the Royal Society's soirée. Pieces of copper, rings, coins, and cylinders were made to gyrate rapidly when brought within the magnetic field without any mechanism whatever. The lecturer declared that in this direction lay an entirely new development in the engineering possibilities of electricity.

Electric Lighting in Germany.—The Allgemeine Elektricitäts-Gesellschaft intend to erect a central electricity station at Ober-Schönheide, on the Upper Spree, to supply current for lighting and power purposes to the villages in the neighbourhood.—A municipal committee at Munich have under consideration the designs for electric street lamps. Work has been commenced in connection with the erection of the municipal electric light station.—Several schemes have been submitted for the proposed electric lighting of Haynau.—At Dortmund the question of establishing a central station is again being discussed.—A central station is to be erected near Gersthorfen, having 6,000 h.p., for supplying current to Lugsburg and its suburbs.—The local authorities of Posen have appointed a committee to enquire into the matter of the erection of a central electric light station. Offers have been received from Messrs. Siemens and Halske, from the Helios Company, and from the Union Company. The last also proposed to convert the horse tramway into an electric line.—Messrs. O. L. Kummer and Co., of Niedersedlitz, have obtained the contract for the municipal electricity station at Niederlössnitz, near Dresden.—A committee of the Görlitz Municipality have visited Dresden and Chemnitz in order to inspect the electricity stations there, with a view to the adoption of the electric light at Görlitz.—The question of the introduction of the electric light at Blankenese, a watering place near Hamburg, is under consideration.—In future the Hanover municipal central station will replace consumers' incandescent lamps.—A deputation from the Plön Municipality have visited the electric light installation which has been carried out by Messrs. Max Schorch and Co. at Kappeln, with a view to the introduction of the light in their own town.—The newly-erected central station at Riedlingen, which has been erected by Mr. W. Reisser, of Stuttgart, is giving every satisfaction.—Mr. Kosch, a factory owner at Lautenburg, proposes to establish at his works a central electric light station to supply the town. Water power is available, and operations will be commenced next year.—Applications have been received for 4,500 incandescent lamps by the Stuttgart municipal electricity works.—The management of the Brunswick municipal gas and water works have enquired into the extent of the local electric lighting. They found that there were 27 isolated plants with 284 arc lamps and 4,988 incandescent lamps; seven block stations with 160 arc lamps and 3,537 incandescent lamps; the Court Theatre installation with seven arc lamps and 2,350 incandescent lamps, and the installation at the principal railway station with 14 arc lamps and 11 incandescent lamps.—A number of private electric light installations is projected at Dortmund.—Mr. Guttach has projected an electric lighting scheme for part of the town of Elbing.

The Block Telegraph.—The telegraph and signal superintendents of the Caledonian Railway Company have, says the *Glasgow Herald*, made an interesting addition to the existing system of block working. At present, block working is carried out on all our railways, but admittedly in such a way that a signalman is liable to make an accident at any moment by a mere slip of memory. When the improvements mentioned have been effected, however, accidents of this kind will be well-nigh impossible. The Caledonian block telegraph, like that of several other companies, consists of an instrument with miniature arms, corresponding to the signal arms on the outdoor starting signals. When a train is ready to proceed from section No. 1 to section No. 2, the signalman at No. 1 gives what is known as the "Be ready" signal on the warning bell, and if the section between No. 1 and No. 2 is clear the signalman at No. 2 responds by pressing a plunger, which electrically lowers the miniature signal arm on the block instrument at No. 1 box. The train may then proceed, and signalman No. 1 announces its departure by bell to signalman No. 2, who responds by pressing a second plunger, which electrically raises the miniature signal arm in cabin No. 1 to the danger or "protection" position. That this system of working is very simple the inventors have recollected, with the result that the efficiency of the "block" has been increased without in the least affecting the simplicity of the method by which it is controlled. The new appliances will effectually interlock the block telegraph and outdoor signals. The innovation has been made at the request of the chief officers of the company, chiefly for the new underground railway; and a condition was that no more detail should be introduced, as it was undesirable to change the work of the signalmen. The outdoor starting or controlling signal will be constantly locked, unless when permission has been obtained to send on a train to the next section. Signalman No. 1 will give the "Be ready" signal on the bell; signalman No. 2 will then (if clear) lower the miniature signal arm in No. 1 cabin by pressing his electric plunger, which will also release an electric coil on the starting signal at No. 1 section. Signalman No. 1 may then draw his starting signal (which hitherto was electrically locked) and allow the train to proceed, notifying to No. 2, of course, that the train has left, and the latter will press a second plunger which will raise the miniature signal arm in No. 1 box to danger, and at the same time effectually lock the starting signal there. No. 1 is now "locked up"; he cannot bring out another train, for his signal is immovable until No. 2 releases it. No. 2 repeats the bell signals to No. 3, and once the train has passed from No. 2 to No. 3 signals back to send on the second train. But as long as the first train is standing in No. 2 section it is an utter impossibility for the signalman to signal "Line clear" back to section No. 1, for his plunger is electrically locked till the first train passes into No. 3. Outside each starting signal will be a treadle fixed into the web of the rail, which, touched by the engine, electrically relieves the plunger in No. 2 box, and allows the signalman there to signal back "Line clear" to No. 1, provided, of course, No. 2 has first thrown his starting signal to danger. In ordinary block working a signalman may give "Line clear" by mistake, but under the new mode such an error will be impossible, for the train itself will practically control both block and signals.

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THE ELECTRICITY WORKS AT CARDIFF.

General Remarks.

The town of Cardiff, famous for its shipping trade, is situated at the mouth of the River Taff and on the estuary of the Severn. Having an enterprising Corporation, the welfare of the town has been studied and promoted in almost every direction. The principal streets are broad and well kept, and the town enjoys exceptional facilities in regard to railway and steamship accommodation.

The town, which has a population of 150,000, is in a prosperous condition, which has been largely contributed to by the abundance of minerals in the district. It may be said that of the leading local industries the shipping trade stands first, and the docks now cover an extensive area. Next in importance come the iron foundries, tin-plate works, and iron shipbuilding yards. The exports of coal and iron from the port are among the most important in the country. The public buildings are situated in St. Mary-street. A relic of olden times is afforded by Cardiff Castle, now the property of the Marquis of Bute. It was originally established in 1080, but it has been restored, and presents a handsome and attractive appearance.

Preliminary Steps in Electric Lighting.

As long ago as 1890 the Corporation of Cardiff had under consideration the subject of introducing a municipal supply of the electric light, and, as in many other towns, it was some time before any definite decision on the matter was arrived at. About that period Mr. W. H. Massey, M.I.C.E., M.I.E.E. (of the firm of Messrs. Massey and Allpress, 25, Queen Anne's-gate, Westminster, S.W.), was called in as consulting engineer by the Corporation. A sub-committee—comprising Mr. P. W. Carey, Mr. Lascelles Carr, Mr. J. L. Wheatley (town clerk), and Mr. W. Harpur, M.I.C.E. (borough engineer)—was appointed to accompany Mr. Massey on visits of inspection to various central electric light stations in England, France, Belgium, and Germany.

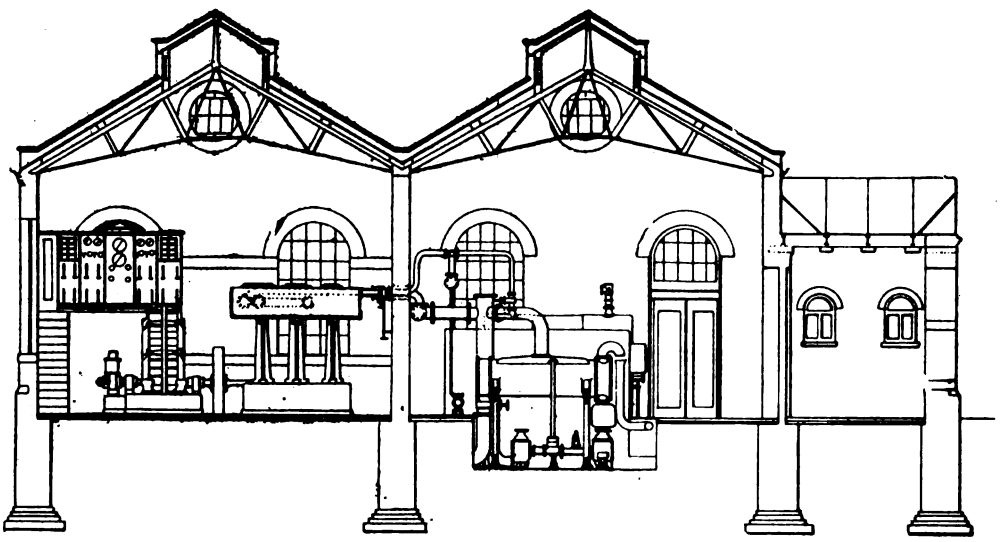
The Corporation obtained a provisional order on July 3, 1891, and it was for the purpose of deciding upon the best method of carrying out the powers thereby conferred upon them that they authorised the committee mentioned to fully investigate different systems of electric supply and to report thereon.

The committee subsequently drew up a preliminary report, which was published in the *Electrical Engineer* on December 11, 1891. The conclusion was that they "had not yet seen anything which they could recommend the Corporation to adopt without modification." Appended to the report was a statement by the borough engineer that the then cost of lighting by gas the streets comprised within the compulsory area stipulated by the provisional order amounted to £650 per annum, and that to light those streets partly by gas and partly by electricity would reach an annual sum of £948.

Subsequently, as will be seen on referring to the *Electrical Engineer* of August 19, 1892, two further reports were drawn up by the committee, who, acting upon the advice of Mr. Massey, recommended the adoption of the high-pressure alternating-current system of generation, with distribution from transformer-chambers on the low-pressure method. A casual glance at the map of Cardiff will show the scattered nature of the district, and this fact, combined with the impossibility of securing, except at a price which was prohibitory, a site for the erection of the station near the centre of the town, fully justified the recommendation of the committee, who suggested that as soon as the question of site was determined the consulting engineer should be instructed to prepare plans and specifications for the carrying out of the undertaking.

The Adopted System.

To the credit of Mr. Massey, be it said that a long time previous to the formation of the sub-committee he had suggested that the Corporation should lay down high-pressure alternating-current plant, and that rectifiers should be introduced for converting the alternating current into direct current for public arc lighting. In fact, he was the first in this country to recommend the employment of rectifiers in connection with central-station work.



Cardiff Electricity Works.—Cross-section of Engine and Dynamo Room and Boiler House.

Ultimately the recommendations of the consulting engineer were adopted by the Corporation, and the central station recently set in operation is the result. The Cardiff station possesses two decidedly novel features. One is the fact that the use of rectifiers was here specified for the first time in this country, and the other is the introduction of vertical triple-expansion condensing engines, fitted with separate cut-off gear for each cylinder.

The control of the work in connection with the generating station has been in the hands of the Electric Lighting Committee of the Corporation, the present members of which are:

LIGHTING AND ELECTRICAL COMMITTEE.

ALDERMAN P. W. CAREY, MAYOR (DEPUTY CHAIRMAN).

COUNCILLOR W. E. VAUGHAN (CHAIRMAN).

ALDERMAN LEWIS.	COUNCILLOR E. W. SHACKELL.
,, T. WINDSOR JACOBS.	,, J. H. CORY.
,, ANDREW FULTON.	,, WM. EVANS.
COUNCILLOR RAMSDALE.	,, B. JOHN.
,, S. A. BRAIN.	,, A. GOOD.
,, T. H. RICHES.	,, G. BENYON HARRIS.

The Corporation eventually decided to erect the station on municipal land on Canton Common in the south-western part of the town. The site adjoins the Great Western Railway at the extreme end of Eldon-road, and a siding from the main line into the works allows of coal being

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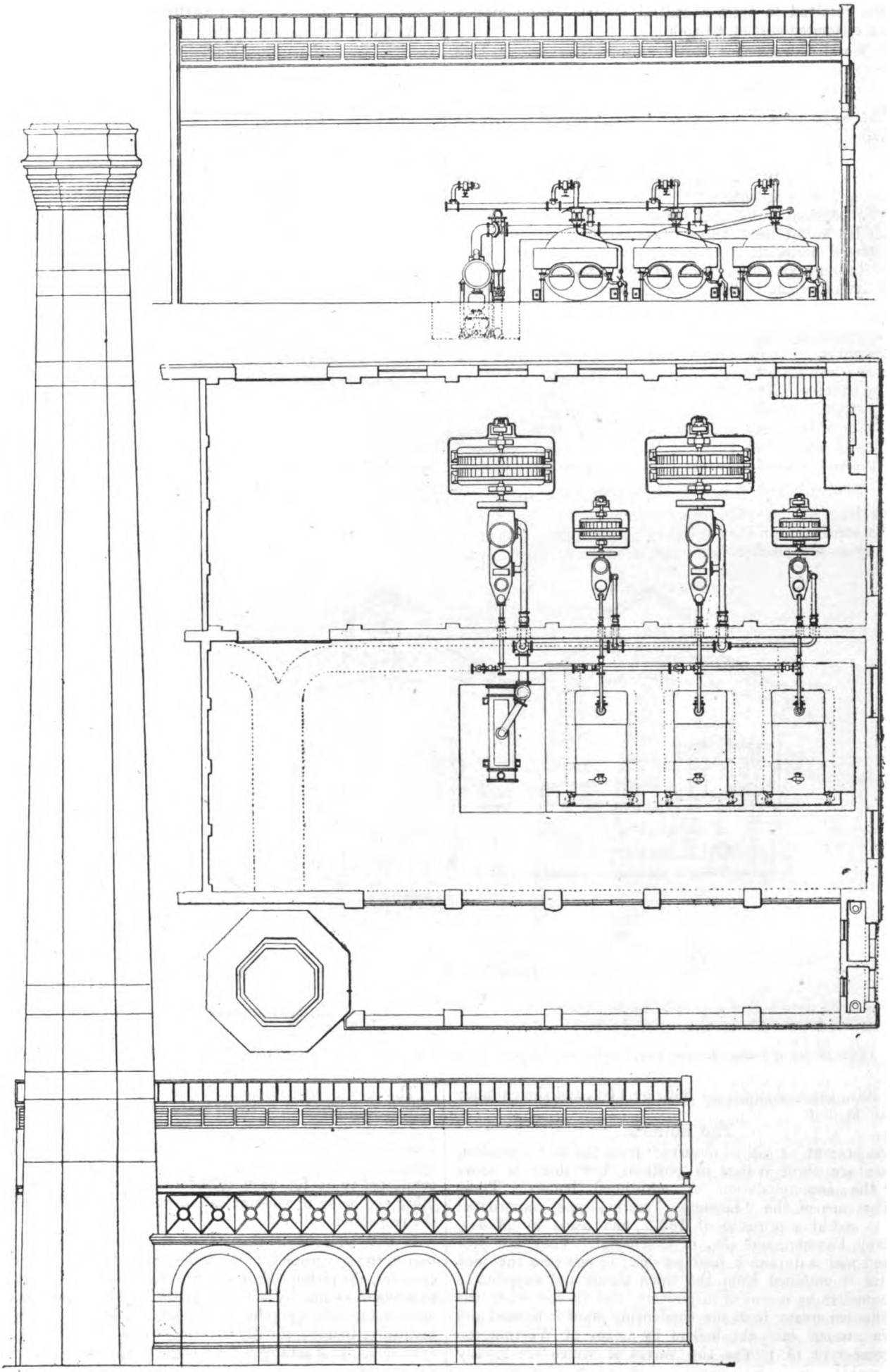

Cardiff Electricity Works.—South Elevation of Station Building, Elevation of Boilers, and Plan showing General Arrangement of Plant.

readily obtained at economical rates. Plans and specifications were accordingly prepared by Mr. Massey, Mr. W. Harpur, M.I.C.E., being responsible for the architectural features of the building, and being joint engineer with Mr. Massey for carrying out the scheme. The land available being admirably arranged for future extensions,

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it was resolved to erect a central electric supply station at an estimated cost of £32,500.

A Local Government Board enquiry having been held into the application of the Corporation to raise money for the purpose of fulfilling the requirements of the provisional order, tenders were invited for the execution of the work, that of Messrs. Thomas and Co., of Cardiff, being accepted for the construction of the buildings, and that of Messrs. Siemens Bros. and Co., Limited, of Queen Anne's-gate, Westminster, S.W., for the supply of the whole of the steam and electrical plant.

The station buildings, which are capable of being extended to at least three times their present size, are illustrated herewith, together with a portion of the plant. The station covers a space of 80 square feet. The engine and dynamo room is 80ft. by 30ft., the boiler-house is 80ft. by 30ft., the coal-stores are 60ft. by 14ft., and the chimney is 150ft. high.

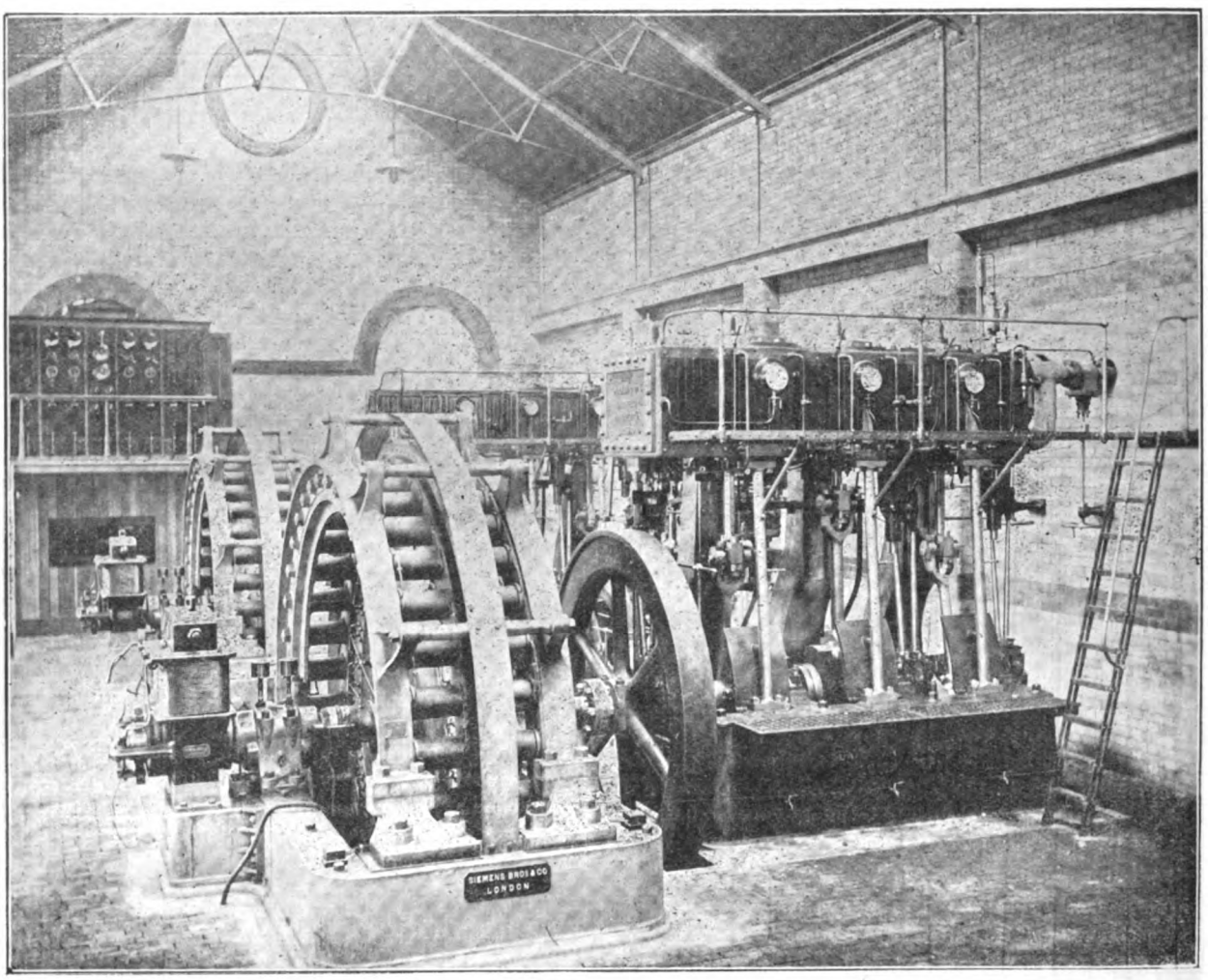
The Boilers.

At present, as will be observed from the end elevation, there are three boilers in position, but there is room for the accommodation of additional boilers. These boilers are of the "Economic" marine type, constructed for a working pressure of 160lb., and made by Messrs. Davey, Paxman, and Co., of Colchester. They are provided with a duplicate feed service; in one case the feed water is obtained from the town mains and supplied to the boilers by means of inspirators, and in the other, the condensed steam from the condensing plant is filtered and then pumped into the boilers by means of Worthington marine type of pumps, the valves of which are readily accessible. A further supply of water is afforded by a tank arranged on the roof of the coal-stores for the collection of rain-water. The main steam pipes and branches, which are carried into the engine-room through the wall of the boiler-house, are all of copper, as is also the exhaust main. The arrangement is shown on the general plan.

The Engines.

As far as we remember, this is the first town for which vertical triple-expansion condensing engines were recommended for central-station work—at all events, in this country. Mr. Massey is a firm believer in this type of engine, which he says ought to be very nearly as economical on light as on full loads.

The novel feature of the engines lies in the fact that they were specified to be equipped with cut-off gear to each of the cylinders, so that on variable loads the work could be evenly distributed between the cylinders. These steam motors were made by Messrs. Davey, Paxman, and Co., of Colchester, who finding that the engines would not be required by the appointed time, took the opportunity of experimenting with the gear, and succeeded in making it to be automatically controlled by the governor.



Cardiff Electricity Works —Internal View, showing line of Siemens Alternators and Exciters, and Davey-Paxman Triple-Expansion Condensing Engines.

The arrangement is somewhat as follows: The governor acts upon a piston in a small horizontal steam-cylinder, one end of the piston-rod being connected at right angles with a horizontal shaft carried along the front of one side of the cylinders. At right angles to this shaft there is rigidly connected to it for each cylinder one end of a rod, the other end being in communication with the cut-off gear for the respective cylinders.

It will be evident that when the load on the engine varies, the governor acts upon the small horizontal steam-cylinder, the piston-rod of which causes the horizontal shaft to move in sympathy with the piston, thus causing the cut-off gear on each cylinder to act simultaneously and automatically, thereby equally dividing the work between the cylinders. This arrangement has so far admirably answered its purpose.

There are altogether four engines. Two of these are vertical triple-expansion condensing engines, each of 270 b.h.p., and running at a speed of 133 revolutions a minute. The other two engines are of the vertical compound type, each of 65 b.h.p., and making 200 revolutions

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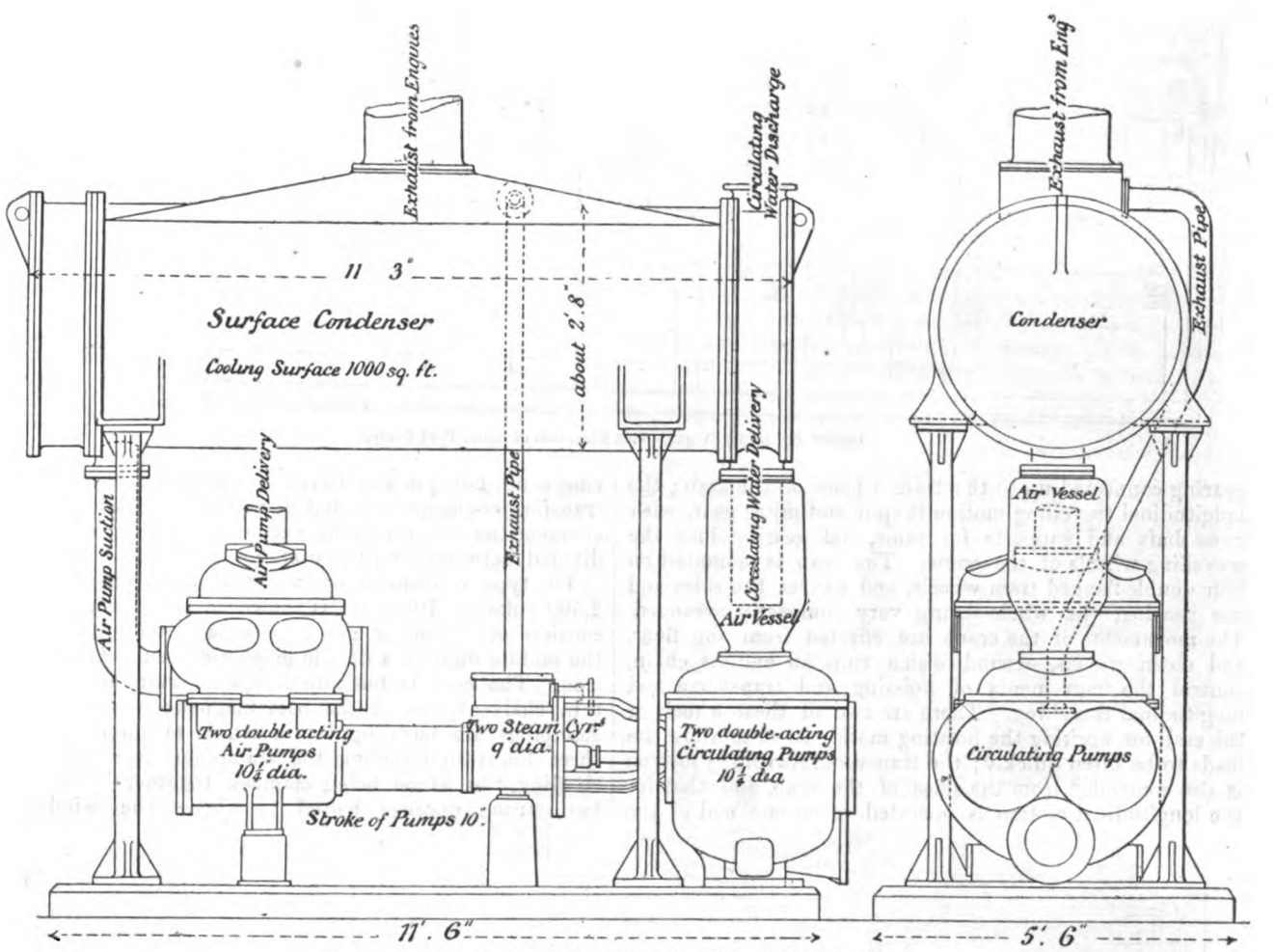
per minute. All these engines are for direct-driving the alternators.

The Condensing Plant.

The exhaust steam from the engines passes along the branch pipes into the copper exhaust main previously mentioned. It is then delivered into the condenser, or, if it be desired for any reason or other to disconnect the latter, the exhaust steam, by means of a valve, is allowed to pass into the atmosphere through the chimney. The condensing plant, of which illustrations are annexed, has been made by Messrs. J. Watt and Co., of Soho Foundry, Birmingham. It comprises a vertical surface condenser, having 1,000ft. of tube service, combined with duplex double-acting air and circulating pumps, the latter being capable of raising 25,000 gallons of water per hour a height of 15ft. The condenser is capable of maintaining a vacuum of 13½lb. per square inch in the exhaust pipes.

corresponding alternators, made by Messrs. Siemens Bros. and Co., Limited, of Westminster, S.W. One of the features of the two large alternators, which each give 72 amperes at 2,500 volts, with a periodicity of 40 per second, is their size; they have revolving disc armatures having a diameter of something like 13ft., which is probably the greatest diameter of any Siemens alternator introduced in this country, although we believe that in Germany larger machines have been installed. The exciters for these alternators, which are provided with water-jacketed bearings, are coupled direct to an extension of the armature shafts, so that each direct-coupled set comprises engine, alternator, and exciter. These two exciters have drum armatures, and each give 100 amperes at 45 volts.

The two smaller alternators, which are direct coupled to the compound engines already mentioned, each furnish 16 amperes at 2,500 volts; their exciters, which are



Cardiff Electricity Works.—End and Front Elevations of Condensing Plant.

The suction of the circulating pumps is connected to a large well or pond arranged on land outside the station building, and the delivery conveying away the water that has been passed through the tubes is in communication with an open trough and channel, leading the hot water back to the well by a circuitous path. The course pursued by the water is such that on reaching the well, where it becomes mixed with the natural supply therein rising, the water is sufficiently cooled to be again used for condensing the exhaust steam.

The air-pump suction is in communication with the condenser, and its delivery is connected to a series of tanks provided with filtering arrangements for removing the oil from the condensed steam. The hot water is then passed into a well, and from thence is supplied to the boilers by Worthington marine type of feed-water pumps, made by the Worthington Pumping Engine Company, of Queen Victoria street, E.C.

The Alternators and Exciters.

As already mentioned, the system of direct driving has been adopted. The four engines are coupled direct to

also operated direct from the armature shaft, each give 65 amperes at 45 volts.

The Switchboard Arrangements.

The switchboard, which is erected on a gallery at one end of the engine and dynamo room, as illustrated in the internal view of the station, is so arranged that any one or more of the four alternators can be connected either separately or together to any one or more of four feeder mains. At the present moment, however, only two feeders, to which reference will again be made, have been laid down. The switchboard, supplied by Messrs. Siemens Bros. and Co., comprises five panels. The first is the "commutator" panel, the second is for the two large alternators, the third for synchronising purposes, the fourth for the two smaller alternators, and the fifth is a spare commutator board for additional machines and the two further feeders.

The alternator panels are provided with double-pole fuses, main and field switches, and voltmeters and ammeters. The object of the commutator panel is to connect any alternator to either feeder. This is accomplished by means of plugs. The return is to the omnibus bar of a

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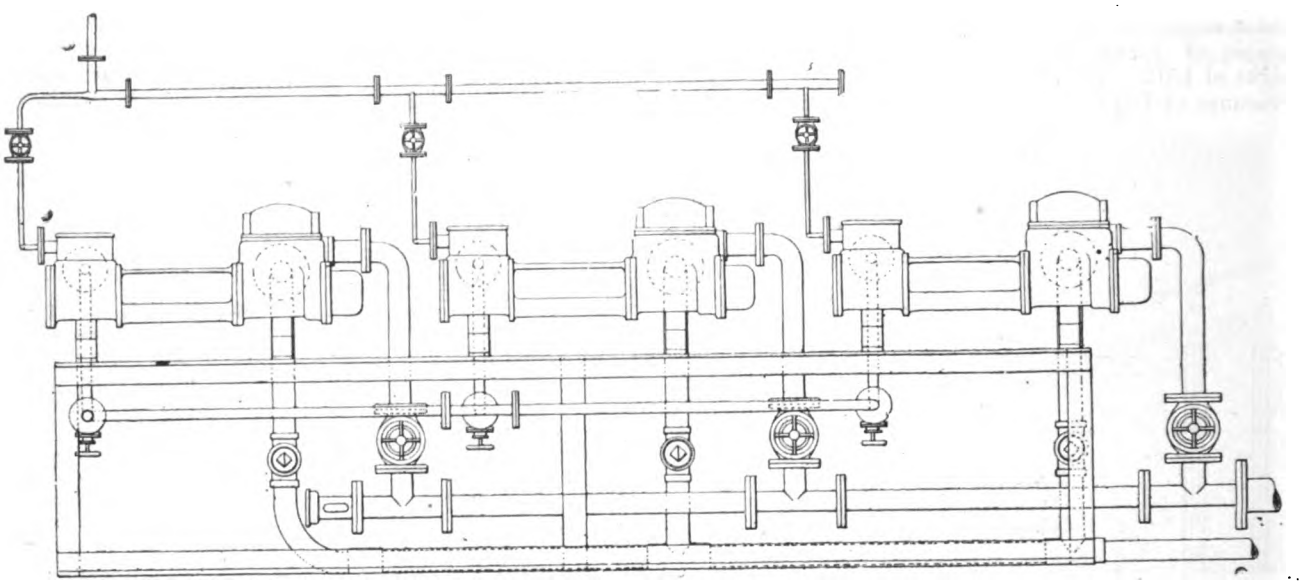
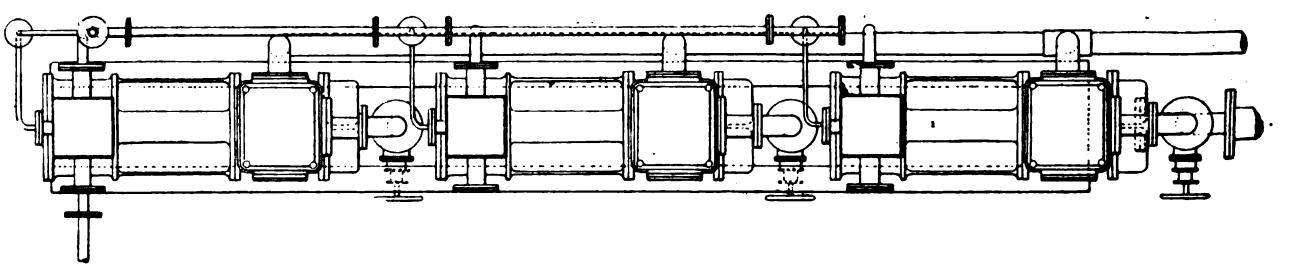
"return board" near the floor, this bar being put to earth.

An overhead travelling crane, having a capacity of 10 tons, is arranged in the engine-room. This crane, which has been made by Mr. Thomas Smith, of Old Foundry, Rodley, near Leeds, has a span of 29ft. The hoisting gearing is single and double purchase, so as to suit varying loads, and the chain and the drum are made to suit the height of lift. The crane, which is similar to that shown in the illustration, is provided with a powerful friction brake and a safety catch, so as to prevent the load running down suddenly. The transverse travelling motion is spur



Cardiff Electricity Works.—Side Elevation of Boiler Feed Pumps.

gearing connected up to the tram wheels of the crab; the longitudinal travelling motion is spur and mitre gear, with cross-shaft and supports for same, and gearing into the travelling wheels of the crane. The crab is mounted on four double-flanged tram wheels, and carries the sides and the gearing, the whole being very compactly arranged. The movements of the crane are effected from the floor, and chain wheels, around which runs an endless chain, control the movements of hoisting and transverse and longitudinal travelling. There are two of these wheels of the crab for working the hoisting motion so as to allow the loads to be lifted quickly; the transverse travelling motion is also controlled from the sides of the crab, and that for the longitudinal motion is operated from one end of the



Cardiff Electricity Works.—Plan of Boiler Feed Pumps.

beams. The transverse beams are of English steel rolled joists and steel channel end carriages, with brackets and caps for the axles, which are of steel, keyed to the four double-flanged travelling wheels.

The Feeder and Distributing Mains.

As already mentioned, there are two high-pressure feeder mains. These are of the Silvertown concentric type, made by the India Rubber, Gutta Percha, and Telegraph Works Company, of Silvertown, E. These concentric feeders have a specially thick insulation, the conductors being respectively equal to $^{7}/_{16}$, $^{19}/_{16}$, and $^{19}/_{14}$, insulated pure, then vulcanising indiarubber, next sheathed with return conductor of tinned copper wires, further insulated pure and vulcanising indiarubber, and the whole vulcanised together, braided, and extra taped over all. They are laid in the ground in two 3in. iron spigot and socket pipes, and two additional pipes have been put down to receive other feeders as occasion arises.

The feeders are brought into the centre of the town to six transformer stations arranged under the pavement, a branch being taken into the basement of the Town Hall for the street-lighting. These transformer-chambers consist of cast-iron boxes 3ft. square and 6ft. deep, each containing a 40-kilowatt Siemens transformer. From each transformer-chamber a pair of $^{37}/_{14}$ Silvertown "Y" type of single low-pressure mains, placed direct in the ground, is carried in either direction. These distributing mains do not form a ring main, but junction-boxes are provided between each transformer-chamber, so that in case of a breakdown in any chamber the latter may be cut out and the load equally divided between the two outer transformers.

The type of transformer adopted, which converts from 2,500 volts to 105 volts, is shown in the illustration. It consists of a primary and a secondary winding enclosing the middle limb of a double magnetic circuit of laminated iron. The core is built up of special stampings of very thin charcoal iron of the best magnetic quality. These stampings are built up into a double magnetic circuit of three limbs by inserting the stampings into the finished winding, the whole being clamped together by means of two strong castings bolted together. The winding is arranged on a substantial bobbin, the body of which is made entirely of insulating material and the cheeks of wood. The material being of a specially tough character, it will retain its mechanical and insulating properties at the highest temperature to which the transformer can rise when running continuously at full load. In the high-pressure coil a layer of the same material is inserted between successive layers of wires. The winding consists of turns of high-conductivity copper wire, either double-cotton covered or taped. The high-pressure terminals are insulated from the wooden cheek of the bobbin by means of ebonite, whilst the low-pressure terminals are mounted on the wood.

With a view to prevent the accumulation of explosive gases in the transformer and junction boxes, the wise plan has been adopted of connecting these with ventilating pipes

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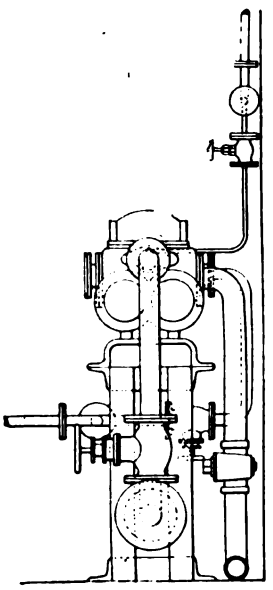
carried up the sides of the nearest buildings. This is believed to be the first occasion of the practical adoption of this method of ventilation in this country.

Public Lighting.

So many complaints have been made regarding the public illumination of some of the main thoroughfares, as, for instance, St. Mary-street, High-street, Castle-street, Duke-street, Queen-street, etc., that a few words of explanation are due, not only for the consulting engineer,



Cardiff Electricity Works.—End Elevation of Boiler Feed Pumps

but also for the contractors. It is all very well for those persons who have no knowledge of the true state of affairs to throw upon an apparatus or individuals the blame for any inefficient street illumination that may occur with arc lamps whether energised from high-pressure direct-current machines, alternators, or rectifiers. But when the correct position is ascertained, and the responsibility for such defective lighting has been located, sympathy should be expressed with those who have been wrongly complained of. The former has been and the latter should be the case at Cardiff. As a matter of fact, the lighting of the streets, which it will be remembered was begun two or three weeks ago, was ordered by the Corporation to be commenced before the arrangements for this branch of the service had been completed at the central station, and, of course, the result was only what might have been expected. Mr. Massey, who had not sanctioned the switching on of the arc lamps, pointed out to the Corporation the adverse opinions that would be entertained by a continuation of the public illumination until everything was finished at the generating station. The Corporation wisely adopted this advice, and the experimental street-lighting was discontinued.

As, however, the whole of the arrangements at the central station and at the rectifier sub-station at the Town Hall are now practically completed, a fresh start with the arc lamps is on the point of being made, and we have no doubt as to the result. In fact, so confident are the Corporation on the subject of public arc lighting, that considerable extensions have already been decided upon.

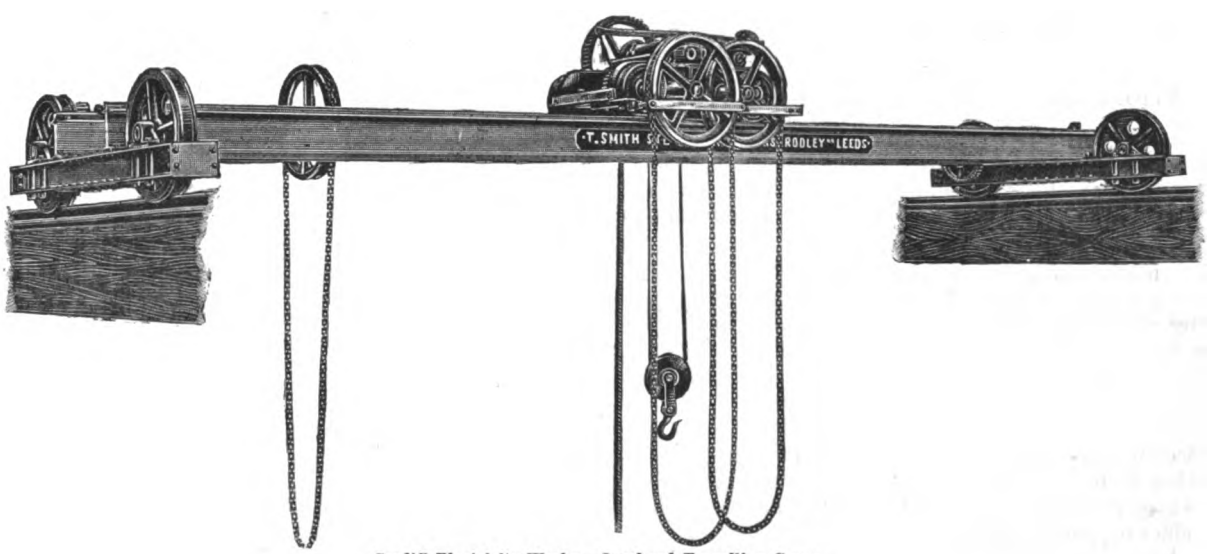
The arc lamps, which are of Siemens make, are arranged on iron standards made by Messrs. MacFarlane and Co., of Glasgow, the height from the street-level to the centre of the arc being 22ft. The lamps are provided with lanterns glazed with cathedral glass, similar to those in the City of London. Wherever possible, the standards have been erected on refuges in the centre of the thoroughfares, but where the streets are too narrow for this the lamps are arranged on the side of the footpaths.

The arc lamp pillars are made of cast iron and in a characteristic design, the ornamentations and mouldings being beautifully realised in a chase and effective style. A door, bearing the Cardiff coat of arms, is provided in the base so as to give access to the conductors and switches. The pillars are fixed into the ground by a tail-piece 3ft. 6in. long.

The Rectifiers.

It is, of course, understood, generally speaking, that an alternating current is produced in a direct-current machine, and that by the use of a commutator the current is "re-dressed," and becomes a continuous current. Now, in the case of the Cardiff central station, it may be said that an alternating current is produced at the works, and that the commutator, instead of being put there, is installed at the Town Hall, a mile and a quarter distant, and that at the latter place the process of commutation is effected. In fact, a rectifier, or motor commutator, as some prefer to call this type of converter, consists of a small synchronous motor driving two commutators.

The rectifiers, of which two have been arranged in a temporary sub-station in the basement of the Town Hall (with a third now being installed as a reserve), are of the Ferranti type, made by Messrs. S. Z. de Ferranti, Limited, of Charterhouse-square, E.C. These rectifiers together are capable of energising 48 12-ampere arc lamps in series,



Cardiff Electricity Works.—Overhead Travelling Crane.

each apparatus supplying two circuits of 12 lamps each. The lamps are arranged on alternate circuits, so that in case of a breakdown of one circuit every other lamp is still able to maintain a supply of light, although the main object in view is to keep the E.M.F. down to 600 volts.

The rectifiers, or motor commutators, each consist of a small self-starting, single-phase synchronous motor, having a low-pressure commutator for commuting the current required to excite its own field magnets. The motor armature shaft is supported in four long bearings, which are fitted with ring oiling gear. At each end of the arma-

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ture shaft a high-pressure commutator is fitted, each of which rectifies the current for one arc light transformer and for one circuit. The high-pressure commutator brushes are held in a concentric frame, which can be rotated to the best position of commutation. A double-pole reversing and cut-off switch for changing over and breaking the connections from the arc light transformer is arranged in each circuit, whilst a special water-break switch is fitted in the primary of each arc light transformer for the purpose of switching on the lamps gradually, and thus preventing a flickering on the incandescent lighting, which might happen if a circuit of 12 lamps were switched suddenly on the small machine.

The motors are run off two small transformers, transforming from 2,500 to 100 volts, and they are enclosed in heavy cast-iron cases, and are fitted with double-pole high-pressure and low-pressure fuses. There are four Ferranti constant-current arc light transformers, each of 10 units capacity, and constructed for giving a fixed current of 12 amperes on the secondary, the high-pressure side of the converter being fed direct with 2,500 volts.

Private Lighting.

Partly owing to unforeseen delays that have occurred in the completion of the station, and partly because of the approaching termination of the year, the Cardiff people have manifested considerable apathy in becoming users of the electric light. At present, however, the tendency is improving, and the largest load on the station has been between 600 and 700 40-watt lamps, whilst further applications for a supply are now being constantly received.

The price of gas, which is furnished by a company, is 2s. 10d. per thousand. At this rate Cardiff shopkeepers, hotel proprietors, and householders should find it advantageous to substitute the electric light for gas, seeing that by a judicious use of switches in turning out lamps not required, the cost of the former can be practically brought down to that of the latter, whilst at the same time the electric light is far superior.

It will be seen from the foregoing description that the Cardiff Corporation have embarked upon an undertaking possessing some novel features, the working out of which in practice will be watched with considerable interest by electrical engineers. The station has been well designed, and the Corporation, the consulting engineer, and the contractors are to be congratulated on the result. It only remains for us to wish prosperity to the station.

REGULATIONS FOR THE SUPPLY OF CURRENT BY THE CARDIFF CORPORATION.

The Cardiff Corporation issued in September a pamphlet giving particulars for the guidance of intending users of the electric light. The following are extracts from the *brochure*:

"The supply mains will be brought into the consumer's premises and up to a pair of cut-outs, which will be provided by the Corporation, and will be placed at a point chosen by the borough engineer; and this work will be carried out free of cost to the consumer, provided that the length of such branch mains does not exceed 60ft., but for any greater distance special terms will be arranged. The price for current by meter will be 6d. per Board of Trade unit—that is, 6d. per 1,000 watt-hours—so that a 40-watt lamp, which will give a light of 10 to 14 candles according to the efficiency of the particular make of the lamp, may be run for $\frac{1000}{40} = 25$ hours for 6d.—say a farthing per lamp per hour. This is about 50 per cent. more than gas lighting by the ordinary 5ft. burner, if the cost be compared lamp per lamp and hour per hour; but by the judicious use of switches which enable consumers to turn out lamps when not absolutely required, the cost of electric light can in an average dwelling-house be brought down to less than the amount previously paid for gas."

The pamphlet, whilst suggesting that consumers should enter into agreements for the supply of electrical energy for a period of at least three years, leaves it open to them in the form of agreement to state what period of years they are willing to become clients of the electricity works. The conditions of supply are briefly as follow.

"The Corporation shall provide, free of cost, a main cut-out and two terminals for supplying the electrical energy to the consumer's premises, and also a suitable meter for measuring the energy supplied. The apparatus thus provided by the Corporation shall be placed in a convenient position on the consumer's premises, accessible at all reasonable times to the servants of the Corporation, and no alteration shall be made in such position except by agreement, and at the cost of the party requiring the change. The apparatus thus provided by the Corporation shall remain their property, and the consumer shall pay a rental for the same, according to the following scale, on the periodical days hereinafter appointed for payment of the energy supplied.

"Meter: For every 100 lights, 8 c.p., or proportion of same, £1 per annum. Cut-outs and terminals: For 8-c.p. to 16-c.p. lamps, up to 25 lights, 5s. per annum; above 25 and up to 50 lights, 10s.; exceeding 50 and up to 100 lights, 15s.; above 100 and up to 150 lights, £1; exceeding 150 and up to 200 lights, £1. 5s.

"The Corporation will make the necessary connections with the service wires and meter and main cut-out at their own cost provided the run of branch mains does not exceed 60ft., but the cost of connecting to the internal wiring shall be borne by the consumer."

PRACTICAL NOTES ON DYNAMO CALCULATION.*

BY ALFRED E. WIENER.

(Continued from page 639.)

33. *Actual Field Density of Dynamo.*—According to the definition given in Section 31, the actual field density of a dynamo is the total useful flux cutting the armature conductors, divided by the area of the actual magnetic field—thus

$$\mathfrak{B} = \frac{\Phi}{A_f} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (93)$$

where $\mathfrak{B}$ = field density in lines of force per square inch;
Φ = useful flux, in webers, from formula (91) or (92) respectively; and
A_f = actual field area, in square inches—*i.e.*, area occupied by the effective armature conductors.

This actual field density (93) is, in general, slightly different from the original field density, selected from Table IV., Section 4, and used for the determination of the length of armature conductor, for the reason that, in practice, the length of the polar arc is not fixed with relation to exactly obtaining the assumed field density, but is dimensioned according to a construction rule having reference to the ratio of the distance between pole corners to the length of gap spaces (see Section 34).

It would be an easy matter to obtain the length of the polar arc and the percentage of its embrace from the assumed field density, for supposing that in a machine with smooth armature the length of the pole-pieces is equal to that of the armature core, we would simply have to make the sum of the lengths to the polar arcs of half the number of poles $= \frac{\Phi}{\mathfrak{B} \times l_a}$, or the percentage of the polar arc,

$$\beta = \frac{\Phi}{\mathfrak{B} \times l_a \times d_f \times \frac{\pi}{2}} \quad . \quad . \quad . \quad (94)$$

in which

β = percentage of polar arc, or quotient of sum of all polar arcs by circumference of mean field circle;
Φ = useful flux, in webers, from (91) or (92);
$\mathfrak{B}$ = assumed field density, in lines per square inch, from Table IV.;
l_a = length of armature core, in inches, formula (12); and
d_f = mean diameter of magnetic field, in inches, which is given by the core diameter of the armature, by the height of its winding space, and by the clearance between the armature winding and the pole-pieces: $d_f = d_a + h_a + k_{12}$ (see Section 34).

* From the *Electrical World* (New York).

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But since the polar embrace so determined may not be within the limits of practical design in accordance with the construction rule referred to, it is advisable not to follow the process indicated by formula (94), but to fix the distance between the pole corners, and thereby the percentage, $\mathfrak{B}$, by that rule, and to calculate the actual field density corresponding to the same by formula (96) or (100) respectively.

This latter method is in no way objectionable, as the new actual value of $\mathfrak{B}$ only enters the calculation of the magnetomotive force, and the change does not affect any of the previous calculations concerning the dimensions and the winding data of the armature. For, according to formula (90), the same E.M.F. will be generated by a certain number of conductors moving at a constant speed as long as the total useful flux remains the same; the E.M.F. generated by a certain armature therefore remains constant as long as the product of field density and field area is kept at the same value, and it matters not whether this product is made up of the original field density and an area corresponding to the polar embrace found from formula (94), or of a larger actual density and a correspondingly reduced field area.

(*a*) *Smooth Armatures.* — In smooth-core armatures, Fig. 46, the area, A_f, occupied by the effective conductors, is obtained from

$$A_f = d_f \times \frac{\pi}{2} \times \beta' \times l_f \quad . \quad . \quad . \quad (95)$$

the actual field density, therefore, by inserting (95) into (93), can be found

$$\mathfrak{B} = \frac{\Phi}{d_f \times \frac{\pi}{2} \times \beta' \times l_f} \quad . \quad . \quad . \quad . \quad (96)$$

where $\mathfrak{B}$ = actual field density of dynamo, in lines of force per square inch;
Φ = total useful flux of machine, in webers, from formula (91), or (92);
d_f = mean diameter of magnetic field, in inches;
β' = ratio of effective field circumference, obtained from the percentage of polar embrace, β, by means of Table XXXII., Section 20;
l_f = mean length of magnetic field, in inches;
$l_f = \frac{1}{2}(l_a + l_p)$; l_a = length of armature core in inches;
l_p = length of pole-pieces in inches.

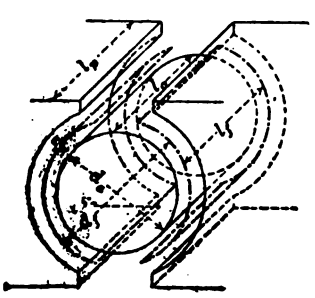

FIG. 46

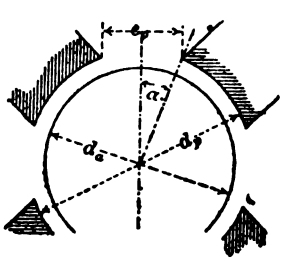

FIG. 47.

(*b*) *Toothed and Perforated Armatures* —For toothed and perforated armatures the area, A_f, occupied in the magnetic field by the effective armature conductors cannot be directly calculated from the dimensions of the armature core, since the path area of the actually useful flux cutting the conductors depends upon too many conditions as to be formulated satisfactorily, and it is therefore advisable to compute the actual field density, $\mathfrak{B}$, directly from the electrical data of the armature.

According to Chapter 1, the E.M.F. generated per foot of effective armature wire moving at a velocity of 1ft. per second in a field of the density of one line per square inch is $\frac{72 \times 10^{-8}}{b}$ volt, if there are b bifurcations of the current in the armature.

For the total effective length of L_e feet of conductor moving at the speed of S feet per second in a field of density $\mathfrak{B}$, therefore the E.M.F. generated is

$$E = \frac{72 \times 10^{-8}}{b} \times L_e \times S \times \mathfrak{B} \quad . \quad . \quad (97)$$

from which follows the field density,

$$\mathfrak{B} = \frac{b \times E \times 10^8}{72 \times L_e \times S} \quad . \quad . \quad . \quad . \quad (98)$$

In equation (98) the length, L_e, of effective armature conductor depends upon the polar embrace, which, in turn, is determined by the ratio of the distance between pole corners to the length of the air-spaces; and can be expressed in terms of the total active length of wire by

$$L_e = L_a \times \beta \quad . \quad . \quad . \quad . \quad . \quad (99)$$

Inserting (99) into (98) we obtain the actual field density:

$$\mathfrak{B} = \frac{b \times E \times 10^8}{72 \times \beta \times L_a \times S} \quad . \quad . \quad . \quad (100)$$

where $\mathfrak{B}$ = actual field density of dynamo, in lines of force per square inch;
b = number of bifurcations of current in armature;
E = total E.M.F. to be generated in armature, in volts;
β = percentage of polar arc (see Chapter 34);
L_a = length of active armature conductor, in feet, formula (3), or (101);
S = conductor speed, in feet per second, formula (5).

Since, in a newly-designed armature, on account of rounding off the number of conductors to a readily divisible number, and the length of the armature to a round dimension, the actual length, L_a, of the armature conductor, in general, is somewhat different from that found by formula (3)—as a rule, a little greater a value is taken; it is preferable to deduce the accurate value of L_a from the data of the finished armature:

$$L_a = K \times \frac{l_a}{12} = \frac{o \times u}{p} \times \frac{l_a}{12} \quad . \quad . \quad (101)$$

where K = total number of conductors on armature;
l_a = length of armature core, in inches;
o = number of wires per layer;
u = „ „ layers of armature wire;
p = „ „ wires stranded in parallel.
} see Chap. 9.

Formula (100) for the actual field density of toothed and perforated armatures can also be used for smooth cores, and may be applied to check the result obtained from (96).

For the application to smooth armatures, however, the polar embrace, β, in formula (100), is to be replaced by the corresponding value of the effective field circumference, β', obtained from the former by means of Table XXXII., Chapter 20.

If it is desired to know the real field area in toothed and perforated armatures, an expression for A_f can be obtained by combining formulæ (93) and (100)—thus:

$$A_f = \frac{\Phi}{\mathfrak{B}} = \frac{72 \times \beta \times L_a \times S \times \Phi}{b \times E \times 10^8} \quad . \quad (102)$$

This formula, which gives the mean effective area actually traversed by the useful lines cutting the armature conductors, is very useful for the investigation of the magnetic field of toothed and perforated armatures.

34. *Percentage of Polar Arc.*—The ratio of polar embrace, to which frequent reference has been had in Section 33, is determined as follows:

(*a*) *Distance Between Pole Corners.*—The mean distance between the pole corners, e_p (Fig. 47), is decided upon according to the rule alluded to in Chapter 33—viz., the rule of making that distance from 1·25 to 8 times the length of the two gap spaces, according to the kind and size of the armature and to the number of poles (see Table XLVII.).

Denoting this ratio of the distance between the pole corners to the length of the gaps by k_{11}, this rule can be expressed by the formula:

$$e_p = k_{11} \times (d_p - d_a) \quad . \quad . \quad . \quad (103)$$

where d_p = diameter of pole-pieces, in inches;
d_a = diameter of armature core, in inches; for toothed and perforated armatures d_a is the diameter at the bottom of the slots.

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The value for k_{11} for various cases may be chosen within the following limits.

TABLE XLVII.—Ratio of Distance Between Pole Corners to Length of Gap Spaces for Various Kinds and Sizes of Armatures.

Capacity in kilowatts.	Value of ratio, k_{11}.					
	Smooth armature.				Toothed or perforated armature.	
	Bipolar.		Multipolar.			
	Drum.	Ring.	Drum.	Ring.	Bipolar.	Multipolar.
·1	1·5	2·5	1·5	2·5	1·25	1·25
·25	1·75	3	1·75	2·75	1·5	1·3
·5	2	3·5	2	3	1·75	1·4
1	2·25	4	2·25	3 25	2	1·5
2·5	2·5	4·5	2·75	3·5	2·25	1·6
5	3	5	3	3·75	2·5	1·7
10	3·5	5·5	3·25	4	2·75	1·8
25	4	6	3·5	4·25	3	1·9
50	4·5	6·5	3·75	4·5	3 25	2
100	5	7	4	4·75	3·5	2·1
200	5·5	7·5	4·25	5	3·75	2 2
300	6	8	4·5	5·25	4	2·3
400	—	—	4·75	5·5	—	2·4
600	—	—	5	5·75	—	2·5
800	—	—	—	6	—	2 6
1,000	—	—	—	6·5	—	2 7
1,200	—	—	—	7	—	2·8
1,500	—	—	—	7·5	—	2·9
2,000	—	—	—	8	—	3

Whenever k_{11} can be made larger than given in the above table without reducing the percentage of the polar embrace below its practical limit it is advisable to do so, and, in fact, this ratio in some modern machines has values as high as $k_{11} = 12$.

(To be continued.)

CARRIAGE AND HARNESS LIGHTING.

Some time ago we referred to the electric lighting of one of the German Emperor's carriages, and to the fact that for the convenience of the coachman in driving along dark thoroughfares electric lamps were arranged on portions of the harness. It now appears that a German firm (Messrs. Wensky and Steinbrink, of 225, Friedrichstrasse, Berlin) is making a speciality of this particular application of electricity, and that various carriages and harness may be seen electrically lighted in that city. Fig. 1 shows the arrangement of lamps placed at the side of the horse's head; Fig. 2 a lamp fixed on the breast-piece; and Fig. 3 two lamps arranged on the collar. The conductors, which are arranged along the harness, are contained in indiarubber tubes which are sewn into the leather so as to be protected from rain and damage.

The lamps are energised from an accumulator of from four to six cells, arranged in a box weighing from 18 to 25 kilogrammes. The cells are ebonite boxes filled with a gelatinous mass, but no acid fluid is used. The battery, the outside dimensions of which are from 30cm. to 40cm. in length by 18cm. to 20cm. high, is placed under the coachman's box. The arrangement adopted by the German Emperor for his four-in-hand drawing a victoria is shown in Fig. 3.

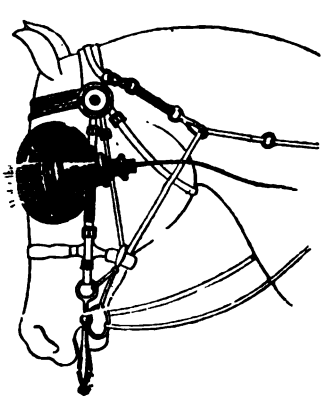

FIG. 1.

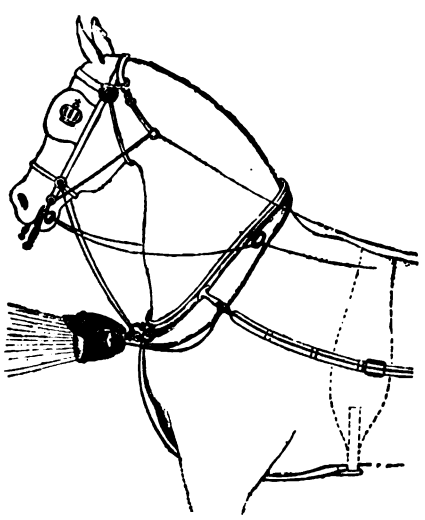

FIG. 2.

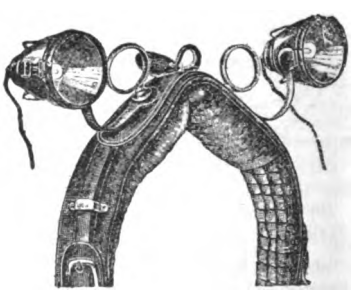

FIG. 3.

ELECTROMAGNETIC SYSTEM OF TRACTION.

The New York *Electrical Engineer* of Nov. 28 contains an illustrated description of a system of traction introduced by the Electromagnetic Traction Company, of Corcoran-building, Washington, D.C. It appears that this method is now being worked in daily service upon a branch of the Eckington and Soldiers' Home Railroad, about one mile in length, situated on North Capitol-street, Washington. It is said to fully comply with the three main requirements of an electric railway—viz., minimum first cost of construction, maximum economy in working, both of power and maintenance, and absolute safety to both passengers and general public. The car has suspended from the underside of its truck two iron bars, the same length as the car, hung upon light springs and adjustable by means of screws, known respectively as the energising and collecting bars. Beneath one of the seats of the car is a small storage battery, consisting of six cells, arranged to give a current at a pressure of about eight volts, and connected to the energising bar. In the centre of the track are placed, at intervals of about 15ft., hermetically sealed cast-iron boxes, upon the lids of which are two raised surfaces, known as the energising and collecting plates respectively, corresponding with the bars suspended from the car, which slide lightly upon them. Securely attached to the under-side of the lid of each cast-iron box is a simple electromagnet wound with fine copper wire, one end of which is connected to the energising plate. The free poles of the magnet hang down vertically, and work in connection with an armature attached to a bridge-piece. Upon this are two carbon faces, directly above each of which is a corresponding carbon face fixed to the slate bed of the magnet. One of the fixed carbon faces is directly connected to the main cable, which conveys the 500-volt current from the generators at the power-house. This runs in an iron pipe through all the boxes, and the other carbon face to the collecting plate upon the box lid. The operation of the car then becomes as follows: The battery discharges its low-pressure current along the energising bar through the corresponding plate upon the box lid to the electromagnet, which upon becoming energised instantly attracts the armature and bridge-piece, thus bringing all four carbon faces into close contact and completing the circuit, which allows the current to flow from the main cable up through the collecting plate to its corresponding bar upon the car and thence to the motors. This applies only to single track.

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Where there is a double track the arrangement is somewhat modified, and in the new roads now under construction upon this system another novel feature has been introduced in the shape of a metallic return, which is effected by simply adding a third or return circuit bar to the car, and connecting a third contact plate with a return cable, laid in the same trench with the main cable. For double track the construction is as follows: The cast-iron boxes, at the same distance apart as in the case of the single track, are placed between the tracks and the electro-magnets, for both tracks are placed in the same box. The collecting, energising, and return contact plates are then set in the centre of the track in the same manner as for single track, with the exception that they are set upon blocks of either terra-cotta or granite, instead of upon the lid of the cast-iron box. All the connections are made in a cast-iron watertight dish underneath the blocks, and taken to the cast-iron box between the tracks in an iron pipe.

INSTITUTION OF ELECTRICAL ENGINEERS, Dec. 13.

The annual general meeting of the above institution was held last night, Mr. Alexander Siemens in the chair, when, after scrutineers had been appointed for the balloting list of the new council and office bearers, and for new applications for membership, the **Secretary** read the annual report, from which it appeared that during the year there had been added 14 foreign members, 13 members, 145 associates, and 123 students, making a total of 295 additions. There had been lost by death four foreign members, one member, three associates, and one student. There had also been a few resignations. The Salomons scholarship had been awarded to Mr. Edward E. Holmby, a student of the Finsbury Technical College. The Institution premium of £10 had been awarded to Mr. H. D. Wilkinson for his paper on "Electric Tramways in the United States and Canada," other papers having been ineligible owing to the authors being members of council. The three-guinea prize for students had been awarded to Mr. J. C. Harris for his paper on "Secondary Batteries," and two others were commended.

It was gratifying to note that the quality of the papers read at the students' meetings had greatly improved. It had been arranged to control the Willans Memorial Fund jointly between the Institution of Electrical Engineers and the Institution of Mechanical Engineers. It would be awarded by the council of the respective institutions once every three years. The first award would be made in December, 1897, and by the Council of the Institution of Electrical Engineers. Contributions had hitherto been made to the expenses of the president's conversazione, and it was now intended that the Institution should defray the whole expense. With respect to the building fund, £3,000 of the general investment fund had been transferred to the building fund, and it was hoped that the latter would increase. The Board of Trade were consulting the Council about various matters, such as light railways. The finances of the society were satisfactory, there being £1,010 in hand on account of the general investment fund. There had been added to the library 56 books, besides periodical literature.

Mr. A. Siemens moved the adoption of the report, which he said showed that considerable progress had been made.

Mr. S. Z. de Ferranti seconded the motion, which was adopted unanimously.

Prof. Hughes moved a vote of thanks to the Institution of Civil Engineers for the loan of the hall, and mentioned that the Institution in question had all along lent them a helping hand, and had assisted them in their methods of procedure. They had been both kind and liberal.

Mr. Raworth seconded the motion, which was carried with applause.

Sir Henry Mance moved a vote of thanks to local honorary secretaries and treasurers, and this having been seconded by **Mr. Aylmer**, was also carried.

Mr. R. E. Crompton moved a vote of thanks to Sir David Salomons for his services as honorary treasurer. His initiative in the matter of the building fund would at no long data put the Institution in possession of a building of their own.

Mr. Shoolbred seconded the motion, which was cordially adopted.

Sir David Salomons, in returning thanks, said he was not a member when the Institution was originally formed, but he joined shortly afterwards, when there were 200 members. On January 1 last there were 2,316 members on the books, and the number now probably was 2,500. They had drawn into their net the greatest men of this land, as well as those of other countries. At one time the surplus of the Institution was £200, which an accountant would put down to furniture in hand, but now the annual surplus was £1,000. He hoped that every year a good sum would be put down to the building fund. It had been said that foreigners were thrifty, and he trusted, in respect to the provident fund which they had started, that members in times of prosperity would contribute to it so as to help their poorer members.

Mr. R. Gray moved a vote of thanks to the honorary auditors, Messrs. Danvers and Stroh, and this was agreed to.

Mr. Mordey proposed the "toast"—correcting himself to "vote of thanks"—to Messrs. Wilson, Bristows, and Carpmael, the honorary solicitors, which, having been agreed to, a member of the firm responded suitably.

The following candidates were then balloted for:

Member.—Thomas Barton, the Electric Works, Blackburn.

Associate.—F. C. Dixon, care of Messrs. Martin and Co., Jackson House, Calcutta.

Students.—Stanley Beeton, "Heathfield," Haverstock-hill, N.W.; Arthur Holroyd Sears, Finsbury Technical College, Finsbury, E.C.; Henry William Kennedy Irvine, Henry Herbert Stanley Marsh, Roland Sydney Robertson, and Richard Norman Vyvyan, Faraday House, Charing Cross-road, W.C.

The discussion was then resumed on the three papers on electric traction which were read at previous meetings this session.

A Member stated that the papers read showed that little improvement was required as respected overhead details on electric lines, but with regard to bonding, there was a deficiency. He drew attention to the rail bond which was described and illustrated in our issue of the 23rd ult., page 600. In the past the railway bond seemed to have been a rather unhealthy item in the history of traction.

Mr. F. B. Lea was pleased at the opportunity which had been given of considering the question of electric rack railways. In the first place, Dr. Preller might have given particulars as to the economy of electricity as compared with steam on such lines. As electricians they were glad to note electrical economies, but it was inadvisable to claim too much. Besides, it was difficult to find two lines which could justly be compared. He would like to know what was the cost for motor repairs on the Barmen line, which was on the step-rack system, for jarring and jolting would have a bad effect, the jolting being caused not by roughness of the road but by the change of load as the teeth engaged and disengaged. Dr. Preller had confined his attention to those rack railways, which were for the same purpose as the famous Duke of York—they first went up a hill and then went down again. The field on the Continent, however, was not so much for independent lines as described, as for systems in mountainous districts where there were levels and ups and downs. When steam was used for such purposes, the locomotives had a double set of cylinders, and such a system was very economical. Electric locomotives could also be made for such combination work. It was to be hoped that great extensions would be made in this country in connection with electric traction now that the light railway question was coming to the fore.

Mr. J. H. McGraw, of New York, stated that he was glad to see what had been done in this country in regard to electric and cable traction. Although considerable work on those lines had been accomplished in the United States, he felt confident that both England and the Continent would soon be abreast of what had been done in the former country, and perhaps in many cases exceed them. Rapid transit was one of the most important industries in America, and he extended a hearty invitation to the members of the institution to visit that country, where every facility would be afforded them in the way of inspection and information.

Major-General Webber hoped that in a year or two some of the members would be able to respond to the invitation given by the last speaker, and that the information suggested would be available to them. Referring to the recent conference held at the Board of Trade, and which the president of the Institution and himself had jointly attended, he mentioned that in Belgium, Denmark, and Spain light railways had been constructed which enabled produce to be brought from the point of production to the places of consumption, and, notably, to the English market. In this connection they ought to go one better in this country. The traffic on such lines, which should act as feeders to the main lines, was not such as would, on the face of it, recoup electrical engineers for erecting a generating station with two or four trains daily. A solution of the problem might, however, be found in traction by storage. If engineers would only turn their attention to the subject, there would be a development of traction by storage.

Prof. Sylvanus Thompson gave a comparison between the electric tramway work in the United States of a few years ago and of the present. Then this class of tramway acted as one or more social factors, and removed the local traffic from the main lines to the benefit of the latter's through traffic, instances of which he cited at Pittsburg and New Jersey. In fact, the Pennsylvania Railway Company had facilitated this diversion with advantageous results to itself. A common gauge should be adopted in this country so that light railway cars could be also operated on main lines.

Mr. W. J. Carruthers-Wain, the president of the Tramways Institute, observed that the failure of storage-battery traction had been due to a variety of causes, some of which he enumerated. After alluding to the success of the overhead system at Walsall, the speaker concluded by referring to forthcoming tests of the Thercy-Oblasser battery on the Birmingham lines.

Mr. S. Z. de Ferranti, after referring to the causes of the backwardness of electric traction in this country, suggested that it was to the interest of the whole of the electrical branches to unitedly promote electric traction.

After some remarks from **Mr. Sharp** concerning varying loads on the line at the generating station, in which he described a flywheel which he thought would tend to greater efficiency, and from **Mr. Darras**, in regard to the gearing of motors, the authors of the three papers on traction replied, this bringing the meeting to a close.

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MUNICIPAL REPAYMENT OF LOANS.

Perhaps the most important question to any municipal body when discussing the question of electric lighting is that relating to the repayment of loans. A conflict of opinion has arisen upon this question, and in this matter the electrical industry has so far not seemed to trouble itself. On the one hand, high authorities say that a loan for electric lighting purposes may well be repaid over a long period of years, while others say not so, and the Treasury, together with the London County Council, have adopted the latter view. An estimate has been framed as to the life of various portions of the apparatus used. Averaging these, the final conclusion of the County Council is to adopt two periods for the repayment of loans obtained to defray the initial cost of electric lighting. Thus the loans for outlay upon land, buildings, culverts, bare copper mains, and patent royalties can be repaid in fifty years, while twenty years is the limit for all other purposes. In hearing or reading such conclusions as these, it is necessary to rub the eyes in order to be certain if the world is awake. Mr. W. H. Preece, in some remarks made at Hampstead to municipal engineers, evidently did not agree with these views. He contended that from the nature of things it was absolutely necessary to keep an electric light plant at the highest pitch of efficiency, and, therefore, the question of depreciation hardly came in. Ten years hence the plant must be as efficient as to-day. Why then depreciate? If there is no necessity for a municipality to depreciate, why restrict the time of payment to so short a period as twenty years. The most temporary of all electric plant is to be found in the meters, and these are expected to last five years. Now, taking that one item alone, we cannot expect the meters to follow the example of the "one-hoss shay," and everyone to last for exactly five years and then tumble to pieces. The actual state of the case—that is, the actual practical state of the meters—at the end of every five years will be that all will be efficient. There may be repairs and even renewals month in and month out, but, on the whole, efficiency will be maintained. Now, what a municipality really has to do if the capital for meters was to be repaid at the end of five years, and the facts are correctly stated that the meter has a life of five years only, will be to maintain efficiency out of revenue, and at the same time repay the initial capital. Suppose meters initially cost one thousand pounds; in five years, according to this estimate, one thousand pounds must be spent upon them to keep them efficient, and at the end of five years they are known to be efficient. This seems very like heavily handicapping the ratepayers unnecessarily. There is no valid reason that we can see why the initial outlay should not even in this case be spread over, say, twenty-five years without averaging with the outlay on hand. Of course, there is another way of treating these accounts. All renewals and all repairs, except the most trifling ones, can be placed to capital account, so that capital account is never closed with the municipality, just as it is never closed with the company. In both

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cases the capital account would then be unvaried, for new capital would be annually created equivalent to the old capital paid off. The good of this cannot well be seen. Why are many municipalities so chary of undertaking work which would benefit the community, except from the knowledge that the initiators of such movements throw a heavier burden upon their constituents than ought to be so thrown. In almost every case of municipal activity the same argument holds good. If they lay out public parks, the burden of so doing is thrown upon the present and the immediate future ratepayers; but the park won't run away or grow less, or be less beneficial to the community. We incline to the opinion that there is no reason why the repayment of loans for electric lighting purposes should not be spread over a period of fifty years. We would not make it longer, because the future is uncertain. Tallow has given place to gas, gas is to give place to electricity, and it may be—we know not when or how—that electricity will give place to some other form of illuminant. We think, however, that electricity is good for fifty years.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

HYSTERESIS.

SIR,—I should esteem it a great favour if you would kindly allow me a corner in your widely-read journal to put a question to which perhaps one of your numerous readers will be good enough to reply.

In Dr. Fleming's "The Alternate-Current Transformer," vol. i., three forms of hysteresis are mentioned—viz., magnetic, static, and viscous.

What I should be glad to know is whether "magnetic" hysteresis and "static" hysteresis are one and the same thing? Dr. Fleming apparently uses both terms to express the "lagging behind" of the magnetisation, and gives the formula $E = -\int I\, d\, H$ for the energy spent per unit volume in performing the cycle. On page 65 he calls it "magnetic" hysteresis, and on page 69 refers to "this static hysteresis."

I find in Prof. S. P. Thompson's "Dynamo-Electric Machinery" no mention whatever is made of "static" hysteresis.—Yours, etc.,

STUDENT.

THE CONTROL OF TRANSFORMING LOSSES ON THE BEDFORD ELECTRIC SUPPLY SYSTEM.

SIR,—In your excellently detailed description of the Bedford electric lighting scheme, just arrived at a successful issue, you describe one detail in which I take considerable and particular interest. I refer to the switching gear for changing over the load at the sub-stations from large to small transformers, or *vice versâ*, as the conditions require. It is satisfactory to see that the engineers of the scheme were bold enough to adopt some such system of controlling the transforming losses, in view of the general neglect of the problem by other designers of electrical supply schemes. But looking at their essay in this particular direction as impartially as I can, I cannot help regarding it as just a pity they adopted the method they did, seeing that there was a better and simpler method available. For with due humility I would submit that my method of controlling transforming losses as set forth in my patent No. 7,266/93, would have better served their purpose, and proved a simpler, cheaper, and generally more reliable means of effecting the desired reduction of the transformer loss at light loads. In support of this I will first describe the way I should have applied my system to the case, and then contrast it with the method actually used.

Generally described, my system consists of the use of a distributing network of three-wire mains fed by sub-stations in which the transforming plant is arranged as follows Two comparatively small transformers feed the two sides of the three-wire system. These are always in action. Another much larger transformer or group is put across the outer conductors of the three-wire mains. This is to take the heavy load, and is the part of the plant that is put out of action during light load. On the primary side the transformers are fed from the generating station thus: the large transformer is connected to a pair of primary mains, and the two smaller transformers are put in series across the same mains. Their junction is also connected to a third main from the station of smaller section than the other two.

At the central station the alternator armature is divided into two equal sections in series when at full load, and the before-mentioned third main would then be connected to the junction of the two sections when in series, the first pair of mains being connected to the terminals of the series. All connections at the sub station end are permanent, through whatever fuses and hand switches may be required.

If the alternator gives 2,000 volts, there will, of course, be 1,000 volts between the third, or neutral, primary main and either of the two first, or outer, mains. The large transformer will convert from 2,000 to, say, 200 volts; the two smaller ones from 1,000 to 100.

With this arrangement and a suitable switch at the central station by which one of the outer primary mains can be thrown over on to the same terminal as its fellow, and at the same time the two sections of the alternator be thrown into parallel connection with each other, and across the third or neutral main terminal and the one carrying the two outer mains, the system is complete.

By making the change over described, or *vice versâ*, the large transformer at the sub-station will be put completely out of action, or the reverse, without breaking circuit either on the primary or secondary sides of the transformers.

No automatic switch whatever is required for this operation, though, of course, if desirable, the central-station switch may be made to operate automatically.

In the particular case of the Bedford sub-station, if the conditions were such as to permit a very accurate balancing of the low-pressure network, I should use in each sub-station, arranged as previously described, one transformer of 24,000 watts capacity and two of 3,000 watts capacity. If it were not possible to guard reasonably against a want of balance sufficient to blow the fuses of or endanger either of the small transformers, I should either make them larger, and reduce the dimension of the large transformer to correspond, or I should use a device as follows:

From the centre point of the secondary of the large transformer I should bring out a connection, and join it through a magnetic cut-out to the neutral main of the low-pressure system. The cut-out when open would be designed to short-circuit the outer mains of the secondary system through a coil, that would operate to close the cut-out when the current flows through it (the coil). By this means, which there is not space to describe in detail here, the centre connection of the large transformer is duly coupled to the neutral main when the transformer is active, and severed when it is out of action. As it is a dead short-circuit that actuates the cut-out both ways, it can hardly fail to act instantly the change over is made at the central station.

The points of contrast between my method and that adopted at Bedford are therefore:

In my system there are no idle mains at any time, and no idle transformers at full load, as there is in the Bedford scheme. Less transformer plant and a smaller extra primary main are therefore required.

In my system there are no automatic switches in the sub-station, and therefore not under supervision, as at Bedford. At the worst there may be a simple double cut-out controlling a single connection which carries a small fraction only of the load.

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In the Bedford method there is no need for separate armature sections in the alternator, as in mine, but this is a very small matter.

It seems to me that from the financial point of view, as well as from the working aspect, my system has a very decided advantage. T. WHITCHER.

REVIEWS.

The Electroplater's Handbook: A Practical Manual for Amateurs and Young Students in Electro-Metallurgy. Second edition, enlarged. Whittaker and Co. Price 3s.

We like Mr. Bonney's book, and the fact that it has entered a second edition shows that others like it too. Almost all his paragraphs are simple descriptions that cannot fail to be easily understood by the reader. The book is admittedly a compilation, but it is a compilation differing from the ordinary run of such books, in that the author knows something of his subject, which many pure bookmakers do not. Again, the author restricts himself to the consideration of such things as are pretty generally agreed, and when he mentions something not immediately proven by his own experience he gives the name of his authority. This is as it should be. If we might venture to suggest a modification when another edition is called for, it would be to largely curtail Chapter III. All that need be given about dynamos is how they fulfil the requirements for plating work. History and descriptions of various makes of dynamos can be relegated to other books.

CITY AND GUILDS OF LONDON INSTITUTE.

LECTURE XIV.—GENERAL DESCRIPTIVE KNOWLEDGE OF MAGNETS AND ELECTROMAGNETS. — BEST METHOD OF WINDING ELECTROMAGNET COILS FOR VARIOUS SERVICES.

(Specially contributed.)

The Earth's Magnetism.—We have seen that a small magnet free to move in a vertical plane takes up a position which is really due to the direction of the earth's lines of force. Let N S, Fig. 1, represent the earth, and F F a line

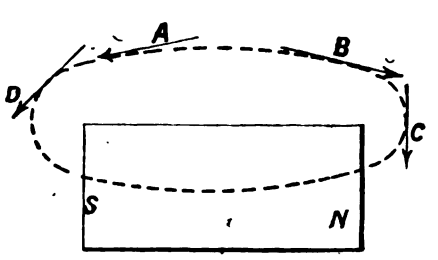

FIG. 1.

of force, and A B C D magnets. These magnets in their different positions place themselves tangential to the line of force, hence in the different positions will point in different directions, according to the curvature of the lines of force. We can easily see, then, that a magnet placed

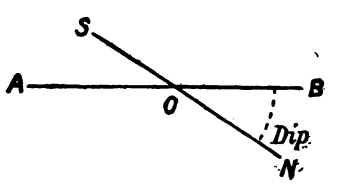

FIG. 2.

anywhere except at the magnetic equator is not parallel to the earth's surface, *nor does either of its poles point directly towards either of the earth's poles*. The angle which the magnetic axis of such a needle makes with the horizontal line at that point is called the *angle of dip*, or of *inclination*. Thus, if A B, Fig. 2, is the horizontal line, and S N the direction of the magnetic axis of the magnet at the point O, then N O B is the angle of inclination or of dip.

The earth's lines of force are not symmetrical around it, hence the angle of dip varies somewhat in the same latitudes. The material construction of the earth's crust at any particular place influences the lines of force. Again, and for the same reason, the earth's magnetic equator is an irregular line, and not exactly midway between the poles. I have said that the earth's magnetic poles are not coincident with the geographical poles; therefore the lines of force are not parallel with the geographical meridian of longitude. We have seen that when a magnet is free to move vertically it has an angle of dip; when free to move horizontally, as in this case of the compass needle, its axis comes to rest in a direction pointing in the direction of the magnetic north and south poles. If A B, Fig. 3,

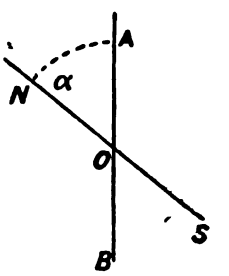

FIG. 3.

represent the geographical meridian at any place, O, and C D the magnetic meridian at that place, the angle A O D is called the angle of declination. Once more, the

Angle of inclination or angle of dip at any place is the angle between the direction of the magnetic axis of a magnet free to move vertically and the horizontal line at that place.

Angle of declination is the angle between the geographical meridian and the magnetic meridian at any place.

The magnetic equator is an irregular line around the earth when a magnet has no angle of dip.

The earth's magnetic poles are not fixed. Thus the north pole fluctuates from one side of the geographical north pole to the other. At the present time it is now about 18deg. or 19deg. W.

The magnetic meridian is the vertical plane in which the axis of the magnet comes to rest, and the two horizontal directions in this plane are respectively the magnetic north and south.

The value of this property of a small magnet placing itself in the magnetic meridian pointing in the direction of the north and south magnetic poles is of incalculable value to sailors. Such a magnet, either single or in a group of magnets like Lord Kelvin's, forms the mariner's compass, by means of which the sailor finds his way across oceans, where there can be no watermark to guide his course.

Winding Electromagnets.—I shall not endeavour to describe the various types of electromagnets, because till within the last few years the makers of electromagnets proceeded by rule of thumb more than upon any principles of the subject. The advanced student in this direction must of necessity consult Prof. Silvanus P. Thompson's large book, in which he will find the history, the principles governing the design of electromagnets, and the design, set forth at considerable length in an admirable manner. The two great purposes for which electromagnets are used to which I shall refer are (1) the attraction of an armature, and (2) to generate a current of electricity. Now, for either of these purposes we require a dense field at the point of action, and not only do we want a dense field, but we want that field in a medium, such as air, through which the armature to be pulled or the wire to be moved can pass. Compared with iron, air has great resistance to the passage of lines of force, and, therefore, for economy's sake we

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want as little air space in our magnetic circuit as possible. We have to consider:

1. How to get our lines of force (magneto-motive force).
2. The media through which the lines pass (resistance).
3. The number of lines.

The lines of force are obtained by means of a current through a conductor. The field around any given length of conductor—say, an inch or foot—carrying a constant current—is constant, provided the medium through which the lines go is constant. Assume the field to consist of so many lines of force in a given area. If I double the current in the conductor the number of lines is doubled, other things remaining the same; or if I halve the current, the number of lines of force is halved. The number, then, is directly proportional to the current, resistance remaining the same.

Further, if I halve the resistance of the magnetic circuit the number of lines is doubled with current constant, so that the number is inversely proportional to the resistance.

Ampere-Turns.—All this is similar to the conductive circuit, which we have already investigated. There we had a unit of pressure, or E.M.F.—the volt—and here we will take as our unit a conductor carrying an ampere of current and making one complete turn or circle, or a ring conductor carrying an ampere of current. To this unit the name **ampere-turn** has been given. Of course, you quite understand that the same effect is obtained whether you use an ampere-turn or 10 turns each carrying one-tenth of an ampere.

Magnetic Saturation.—There is one point to which your attention must be given. It is that no media has yet been discovered through which you can pass an unlimited number of lines of force; that means, simply, the density of field is limited. An ampere-turn gives us a certain number of lines in a given circuit; the addition of another ampere-turn, as I have said, will double the lines in this particular circuit. And so you can go on, up to a point, adding ampere-turns and getting a corresponding increase of lines; but when this point is reached, you do not by adding ampere-turns get a corresponding addition of lines. When the point is reached and the resistance medium no longer admits the generation of lines of force—or only to a very limited extent—we say the medium is saturated. Thus with good wrought iron we get saturation when about 125,000 lines to the square inch pass through; with cast iron, 70,000 lines per square inch is about the limit of saturation.

This shows it is no good adding ampere-turns after the field is saturated. Up to the point of saturation there are two ways of increasing the density of field:

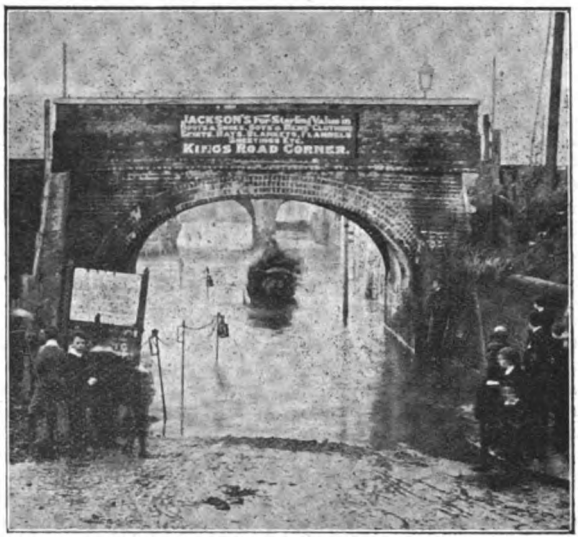
1. By adding ampere-turns.
2. By decreasing the sectional area of the field.

Suppose a pull is required upon an armature, and a uniform field of six square inches is used, with ampere-turns to give a total of 125,000 lines. We have just seen that this number of lines is the limit for a square inch of good wrought iron. But if the whole magnetic circuit is of such iron, then by decreasing the section from six square inches to one square inch, we should increase the resistance of the circuit six times, and thus require six times the ampere-turns to get the required magneto-motive force. Therefore, the question of weight, cost of materials, and cost of construction play an important part in the design of electromagnets. As Prof. S. P. Thompson says, "We now see how in designing electromagnets the length of the iron core is really determined: it must be long enough to allow of the winding upon it of the wire which, without overheating, will carry the ampere-turns of exciting current which will suffice to force the requisite number of magnetic lines" across the resistances in the useful path.

Transmission of Power in Germany.—At Pforzheim, where a central electricity station was started a short time ago, a strong demand has sprung up for current for power purposes, on account of the cheapness of this method. Applications have been received for 500 motors for working polishing brushes in *bijouterie* works.

LAYING MAINS UNDER DIFFICULTIES.

The photograph which we reproduce herewith is one showing how the streets at Reading have been flooded, and



what troubles had to be put up with in laying the mains by the Callender Company.

ON THE COMMERCIAL POSSIBILITIES OF ACCUMULATORS FOR TRAMCAR TRACTION, CONSIDERED AS A MUNICIPAL UNDERTAKING.*

BY ALFRED H. GIBBINGS, MEMBER.

Introductory Remarks.

During the past 12 months I have had occasion to consider the question of electric traction in each of the many forms in which it is placed before the public in general, and municipalities in particular, by the interested advocates of the respective systems. The fact is, the Corporation of Hull had it in contemplation to apply for an Act of Parliament empowering them to acquire and work the tramway system of their own borough. I was, therefore, requested by my committee to place before them a report as to what had already been done in this country in the direction of electric traction, so that at least as far as this form of traction was concerned they would be in a position to consider each of the different methods on its own merits. In my final report to the committee I submitted that, in my judgment, accumulators would offer greater advantages to the town than either of the other forms. The technical journals, however, in which this recommendation was published did not, I am sorry to say, include the whole of my report to the Corporation. The consequence was (as might, indeed, have been anticipated) that several criticisms were passed questioning the commercial and financial results of the method I recommended, whereas, in fact, these results were the determining factors in the conclusion to which I ultimately arrived.

When the subject of electric traction is seriously approached by electrical engineers, corporations, and companies, the usual course of procedure and investigation is to consider the relative intrinsic merits of the different systems, apart from the very important question of the conditions under which the method is to be employed. Each of the three forms of electric traction—namely, the underground channel or conduit system, overhead wires or trolley system, and accumulators—has its own very able exponents in the technical Press and elsewhere, but, unfortunately, the majority of the writers are themselves interested in the system which they advocate, and for this reason such papers cannot be considered to have the same value as if the authors had been entirely disinterested experts. I am safe, perhaps, in admitting that the overhead wire or trolley system has proved a greater practical and financial success than either of the others. This statement, however, refers to cases in which a special plant has been put down to generate energy for the specific purpose of working whichever system has been adopted, and as far as my knowledge extends every comparison between the three systems in regard

* Paper read before the Northern Society of Electrical Engineers, December 10, 1894.

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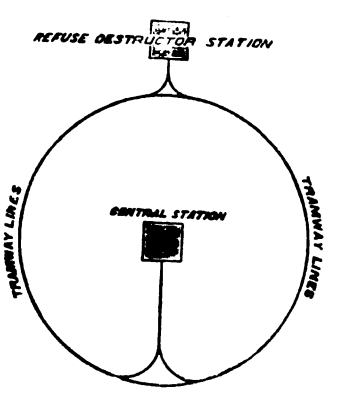
to cost and working efficiency has been made under these special circumstances. I am, however, digressing a little, and will now resume. The recommendation to adopt accumulators which I ultimately submitted to the Corporation of Hull was based upon an entirely new departure, in the working out of which I have been very interested. My object in bring the subject before your notice in this paper is that my reasons and conclusions may be fully discussed, in the hope that a new light may be thrown upon municipal undertakings. I have come to the conclusion that the secret of success lies not so much in the adoption of any particular method of electric traction, however superior, as it does in enlisting and utilising services which other enterprises can be made to contribute. Separately, they may be only just paying their way, but combined, it will probably become possible to make an exceptional success of both. Let me clear the way, in the first place, by removing any misconceptions there may be that the circumstances and conditions of the town of Hull relative to electric traction are unique in their nature. Such is not the case. There are, indeed, dead level roads, and these certainly offer many advantages to accumulator traction which might not apply elsewhere. On the other hand, there are many dock bridges which open and close, and these present a mechanical difficulty which, however, can be surmounted without stopping the running of the cars, as it is very seldom that two of the docks' gates are open at the same time. But in point of fact, these special features do not affect the general question we are considering.

The basis on which I now propose to consider the subject of my paper has for its essential feature the possibilities in economical management and working which are within the power of municipal corporations. Municipal corporations are, in this respect, widely different from private or public companies, inasmuch as they are responsible, not for one business alone, but for many and varied undertakings. A public company restricted to the narrow limits of its single enterprise will, of course, select a system which is likely to show the lowest working costs, and such a selection will be to the best interests of the shareholders. But municipal corporations should have wider views. They have many businesses to conduct in the interests of the ratepayers. The system therefore to be selected by a municipal corporation is that which has the greatest tendency to enhance the value and increase the profits of other departments of the corporation. The cost of working, considered from this point of view, though, perhaps, actually heavy and large, may be relatively small.

I will now proceed to a short general analysis of the combination of refuse destruction, electric tramway service, and electric lighting on the low-tension system. For the purposes of illustrating the general arrangement I beg to draw your attention to the accompanying diagram. The large circle of lines represents the tramcar route, with the destructor station on the confines of the town, and the electric lighting station in the centre.



It is now a generally admitted fact that, given modern improvements for the generation of steam, some power can be obtained from refuse destruction. The publication of Mr. Charles Jones's book on refuse destructors has thrown light upon a subject which has hitherto been neglected by engineers, while the popular articles by Mr. Thomas Thomlinson have brought new possibilities before the electrical engineer. To sum up the whole of the evidence contained in Mr. Jones's work, I find that out of 50 destructors at work, destroying from 3½ tons to 10 tons per cell, the power obtained varies from 5 h.p. to 7 h.p. per cell. This power has been generated under conditions for raising steam which have had to be, and will always have to be, modified and made compatible with the complete destruction of the refuse from a sanitary point of view. The question therefore arises, What is the best use to which this power may be put? Hitherto it has found its solution for the most part in the working of mortar-mills and stone-breakers, or as a subsidiary power to an electric lighting station, possibly producing sufficient power for day-load purposes. These applications, however, while their advantages are not denied, do not use one half of the available power for the simple reason that most destructors are in operation the whole of the 24 hours and the hot gases are at night perforce turned into a by-pass flue, and so far wasted. Under every scheme which is at present being tried there is as much power lost as utilised, but in the scheme to which I wish to draw your attention this evening the whole available power is laid under contribution day and night without intermission as far, of course, as the usual engineering considerations will allow.

Now, this is a very important point, upon which I wish to lay particular stress. The difference, therefore, between my proposition and the use to which the power has already been applied, or, in other words, between my scheme and the schemes for utilising the power for the day load of electric lighting stations, may be stated as the difference between horse-power and horse-power hours. The available horse-power with a variable demand is practically an unknown quantity, whereas the utilisation of the available horse-power continuously over a stated and prearranged number of hours is a definite quantity, and one upon which calculations can be made. The suggested probable economy in the first case is a very doubtful matter, but under definite conditions the problem is resolved into calculating the usual losses which always occur through the transmission and transformation of power. Where the power is utilised as an auxiliary to electric lighting one other very serious drawback occurs, which I just briefly point out in passing. I refer to the "standing by" of the main boilers and their consequent daily cooling during the time that the destructor boilers are supplying steam. The period of the earning capacity of the former is thereby rendered very short, and the increased economy of working by the combination is practically neutralised by being swallowed up in interest on the capital outlay. In addition, the boilers are deteriorated by being alternately cold and hot.

Application of the Power.—In a paper of this description it is quite unnecessary to deal in a detailed manner with all the applications to which it is possible to put the power derived from the destruction of refuse. The effectiveness of this power depends largely on the quantity and nature of the refuse to be destroyed, and this, again, varies enormously in different towns. But I have already pointed out that, according to the best authorities and our own knowledge of the relative value of fuels as heat-producing agents, it must be admitted that a refuse destructor cannot be depended upon without the extraneous aid of other fuel to provide its maximum power at any given time. I must not be understood to say that an advisable and economical arrangement might not be devised where coal, for instance, might be used as an auxiliary fuel; but taking the refuse destructor on its own capabilities alone, we may safely assume that as a power producer it is limited to this extent—namely, that it yields a mean steady power only; or, in other words, that it cannot be depended upon for sudden emergencies. We must take it for granted, at the outset, I think, that in every case the refuse destructor may be depended upon to provide a certain minimum power. This minimum power must be adequate to meet the demand made upon it, or, in other words, the plant to which it is proposed to apply the power must be so designed and arranged that at no time shall a sudden and unexpected demand be made upon the destructor which it is incapable of meeting.

In the town of Hull, about 250 tons of miscellaneous refuse are destroyed weekly. This is a small quantity compared with that of other provincial towns. A large portion is composed of dry shop refuse, such as paper, straw, wood, and ashes, while it is not an infrequent occurrence to have to destroy whole ship cargoes of condemned fruits, vegetables, and fish. From observations taken I am well within the mark in estimating that with the necessary alterations to the present destructor we could obtain a continuous power of 45 i.h.p. This 45 i.h.p. would give at least 40·5 e.h.p at an efficiency of electrical machinery of only 90 per cent., or a continuous output of 400 amperes at 75 volts, for it must be borne in mind that under the scheme I am unfolding, the electrical machinery would be designed to always work at full load. This arrangement would be amply sufficient to charge batteries of 25 cells, always keeping a certain number of batteries in parallel according to the rate of charge. Of course, the number of batteries and their size would depend upon the size of car to be propelled, and I have already pointed out that the power at the destructor station can be supplied continuously for the 24 hours. This would be equivalent to doubling the capacity of the plant, as the batteries charged during the night would meet the requirements of the tramcars for half the succeeding day. This power would charge a sufficient number of accumulators to run from about one-half to three-quarters of the trams according to whether the service consisted of 12 or more trams in the hour on the different routes. The remaining portion could be conveniently and economically provided for by supplying another charging station with power from the machines at the central electric lighting station, which machines would be available for this purpose during the day or night, excepting only at the time of maximum demand.

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In considering the whole matter I had brought before my notice what had already been done with regard to thermal storage. There may be possibilities in thermal storage which are not yet matters of common knowledge. This, of course, may be especially the case where sudden demands for abnormal power for short periods would be made, as in that case the steady and continuous power generated might be stored. But the only reliable working statistics we have are those connected with a steam tramway in India, where the engines obtain sufficient power for one journey from a reservoir of high-pressure steam. It can easily be seen, however, that the hot climate of that country must conduce very largely to the success of the system, as radiation must be at a much less rate than would be the case in England. Indeed, an English winter might render such a system quite inoperative.

Reverting to the two other alternatives—namely, the overhead cable or trolley system and the underground conduit system, the advantages of which mainly consist in economy of working (plant for plant)—I may mention a few of the disadvantages (and consequent expense) attendant upon these systems which do not occur with the use of accumulators: (1) irregular demands upon the generating plant; (2) greater wear and tear of the machinery; (3) capacity of generating plant must be equal to all possible demand upon it: (4) plant standing idle when cars are not running; (5) stringent requirements of the Board of Trade as to insulation and periodical tests; (6) greater original outlay of capital; (7) impossible to economically use the power which the electric lighting station might contribute during the day; (8) inability of the refuse destructor station to supply the whole of the power required; hence (9) necessity to erect independent central generating station to supply additional power required; (10) for reasons contained in (8) and (9), very little, if any, advantage in point of economical working would arise from the aid of the refuse destructor.

The foregoing list of disadvantages is serious enough, but over and above all these I may point out that the power from a refuse destructor when applied to an overhead or underground system would only complicate what is merely a simple scheme. In fact, it would be more economical to put down one complete generating plant for the tramcars appropriating the destructor power to some other purpose, where, as I have already mentioned, the whole power obtainable, as calculated in horse-power hours, would be turned to more remunerative account. The most serious item to be considered is, after all, that of capital expenditure. A heavy original outlay runs away with so much of the profit in the case of municipalities in providing interest and sinking fund. Now, the capital expenditure, be it observed, for the complete equipment of accumulator cars is usually from 50 per cent. to 75 per cent. only of that required for the overhead cable system, according to the track mileage. If the accumulator system can be arranged and worked so that the entire depreciation of the accumulators can be written off per annum out of lower working costs than are possible with either of the other systems, then it is clear that traction by accumulators would be the most highly remunerative system of any form of traction yet devised.

The Advantages of Accumulators.—I have already pointed out that one of the greatest advantages of accumulators for electric traction purposes lies in the fact that the power of a refuse destructor may be utilised to the full, and that in consequence the cost of generating the power (both with regard to fuel and labour) would be extremely small. But if the scheme ended here the advantages would perhaps scarcely justify the especial prominence I have given to it. It is only as the destructor is brought into combination with the central station electric lighting plant that the matter becomes supremely worthy of consideration. I am of opinion, in the first place, that no town has sufficient refuse to supply of itself the whole power required to run its tramcar service, whether by accumulators or other system. Even supposing that sufficient power could be so obtained, it would necessitate an additional capital outlay on buildings, machinery, etc., so great that it would practically be the same as for an electrical station independently worked. But where merely horse-power is available the necessary plant could readily be accommodated. The chief function and value in that case would consist in its being a "relief" station, which would obviate the running of all cars to one point only for recharging purposes. If there were more than one refuse destructor in a town, each of course could be used to form a relief station according to the number and frequency of the cars. I have so far endeavoured to point out the advantages and uses of accumulators in connection with the utilisation of the power derivable from refuse destruction. I now proceed to consider a far more important matter—namely, the advantages arising from charging accumulators for electric traction by means of the available and otherwise idle plant at a low-tension electric lighting central station. These advantages are based upon the following fact: the cell charging can be stopped at the hour when the heavy lighting load comes on, and the full capacity of the plant can then be used for lighting purposes. This at the first glance may perhaps appear a very small advantage, but its full significance consists in the fact that it provides a day load for the central electric lighting station. I have no need to here describe the *modus operandi*; suffice it to say that low-tension central stations are designed for charging accumulators, and by means of independent connections those machines not running in the day or night time could be employed in charging separate accumulators for the tramcar service. As the electric lighting load came on so the different machines would be transferred from the tramcar plant to the main switchboard and *vice versâ*. The question now is, What does this arrangement actually mean both to the tramcar and the electric lighting enterprises? The tramcar enterprise would benefit in many ways—viz.: (1) less capital would be required, not having to provide independent dynamos and engines; (2) there would be, of course, correspondingly less interest and sinking fund liabilities; (3) such expenditure as would fall under depreciation of plant, repairs, rents, rates and taxes, wages of boiler and engine attendants, etc., would be equitably divided between the electric lighting and the tramcar concerns; (4) the management of the tramcars whilst under the supervision of an official and staff would also be controlled by a separate committee which would act conjointly with the electric lighting committee. It must be quite clear, therefore, that co-operation must very largely reduce the working costs of a tramcar system. The cost per unit, whether we calculate per horse-power hour, per car mile, or on any other basis, must be greater where the whole cost of management and working has to be borne by the tramcar service alone than will be the case where by using the resources of the electric lighting plant handsome profits are made in what I may term "spare time." To what extent this co-operation might be developed it is difficult to say, but the fact that each enterprise would save considerable expense to the other is perfectly obvious.

With regard to the electric lighting concern, the acquisition of a substantial day load is of the utmost possible consequence. For the purposes of this paper it will be better to assume that this department merely charges (as an electric lighting enterprise pure and simple) for the current which it can generate and sell. That is, I do not wish to complicate what I have to say by assuming any arrangement between the electric lighting and tramcar committees with regard to sharing the proportions of the costs under the various items common to both enterprises. It will be sufficient if we assume that: (1) the electric light committee retain their independent position and make a definite charge per unit for all current supplied; (2) that this output is merely considered as a day load.

The endeavour to solve the prob of a day load for the central station has resulted in the suggestion of many different methods, but most of these methods at the best would only make use of a very small proportion of the available power. In common with other central-station engineers I have had the problem before me, and a few months ago I endeavoured to show in a contribution to the *Electrical Review* how far the various methods of charging the public for electricity from a central station tended in the direction of encouraging a day load. In the course of my analysis in that article, under the heading of "The Works Cost," I dealt with the available horse-power of a central station, and I cannot do better than read the paragraph: "Let us assume that the available horse-power of a station is 1,000. Multiplying this by the total number of hours (8,760) in the year, gives 8,760,000 horse-power hours. Assuming, on the other hand, that the full capacity of the plant is used on the average three hours only per day, then the total number of actual horse-power hours = 1,095,000, or one-eighth of the absolute capacity. As an assumption this errs, if anything, on the same side, as very few central stations, in fact, are yet reaching the one-eighth of their full capacity in the year. We must now consider this unused available horse-power side by side with those items of cost which would not practically be increased in the sum by generating seven-eighths available output. The items are as follows: (1) wages, except outdoor staff; (2) salaries; (3) repairs and maintenance; (4) rents, rates, and taxes; (5) sinking fund; (6) interest on capital. It will readily be admitted that these are the expenses which really affect the cost per unit delivered to consumer. Yet these remain, to all intents and purposes, constant; practically neither more or less, even when the plant is being utilised to the full. The result, of course, is that where the output is increased eightfold, the rate of cost per unit delivered, so far as these items are concerned, will be reduced to one-eighth."

The remarks I have now quoted with regard to the methods of charging for current are equally true in reference to the arrangement which we are now considering. As an example, I will give actual figures from the working of the electric lighting station at Hull. These may be absolutely depended upon, as we weigh all coal, all ashes, and measure everything consumed. The units generated and delivered are checked in four ways: (1) by Aron meters in the circuit from the dynamo to the switchboard; (2) by the working out of daily load curves taken from readings on the ammeters; (3) by Edmondson meter in the main omnibus bars between the switchboard and the several feeders; (4) by quarterly comparison of the consumers' meter readings. All these we find agree within

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small percentage. Our lightest weekly output during this summer cost us ·97d. per unit delivered (not generated), including coal at 14s. per ton, and oil, water, waste, and all stores. Our heaviest weekly output during this winter has cost us ·60d. per unit for the same items. Now, with regard to the standing charges just referred to, if we multiply the heaviest weekly output by 52, or, in other words, if we assume the maximum weekly output as the average weekly output, I find that the proportionate cost of the standing charges comes to 1·84d. per unit. Adding both these costs together—that is, the generating cost and the standing charges cost—we get: generating cost, ·60d.; standing charges cost, 1·84d.; total, 2·44d. as the representative total cost per unit for one week, and I have no need to add that I only wish the figures were true for every week in the year. The maximum electrical power used during this model week was 450 for an average of three hours per day, or 9,450 electrical horse-power hours out of a possible 75,600. Now a minimum number of small cars—say, 30, averaging 10 e.h.p. each—would give (neglecting charging losses) 300 e.h.p., which for 90 hours in the week is equivalent to 27,000 electrical horse-power hours, or an increased output of at least three times the usual quantity. As the power required by the tramcars would not vary with the season of the year, but would remain fairly constant, it is possible that this supply would form by far the largest factor of the output for some years. You will at once see my object in giving you these figures. The generating cost, of course, will remain the same—viz., ·60d.—but the standing charges cost will be reduced to one-third, and the gross cost per unit becomes 1·21d. only for all current generated. This figure gives us a very high efficiency; in fact, the very highest efficiency which has ever been obtained from any electric lighting central station in the United Kingdom, or, I venture to say, anywhere in the world. This demonstrates clearly what the co-operation of accumulator cars will do for an electric lighting station, and it may be definitely stated that the combination guarantees a better load factor for every week throughout the year than is obtained by the highest weekly output of the electric lighting alone. It would mean that an enormous profit would accrue to the electric lighting business itself if only 3d. per unit were charged, and the first possibility which is immediately suggested is that of the great reduction which might be effected in the usual price per unit for current. But we must not forget that this possibility is essentially due to the creation of a magnificent day and night load. I am of opinion, therefore, that the standing charges rate should not be divided equally between the tramcar and the electric lighting concerns, but in the inverse ratio of their demand in units throughout the year. In thus charging the users of the electric light with the larger proportion of the standing costs, it would be possible to confer a still greater benefit on the traction enterprise by bringing the whole of its charges to within a 1d. per unit. This price, which includes interest and sinking fund, capital, wages, and power, as far as the generating machinery is concerned, will be found to be a much lower figure than has ever been obtained with any system.

The foregoing arrangement does not necessitate that the traction accumulator cells should be charged at the electric lighting central station. The nearer the charging depôt is to the central station so much the better, in order to avoid loss in transmission and outlay in cables, but it is not an indispensable condition. A special set of cables could readily be laid to any convenient spot. The system of low-tension supply will generally allow and admit of additional cables being easily laid to any point within the area of distribution. You will have observed that the arrangement therein suggested is essentially based upon those facts of which we as engineers are certain. I have endeavoured to entirely eliminate dubious or insufficiently tested possibilities, such as thermal storage, and I have avoided the unnecessary procedure of basing my proof upon comparisons of the working cost per car mile of the different systems, as such figures are generally misleading, and in most cases do not form any proof at all. Admitting and including the heavy depreciation of the accumulator plates, it has been my object to show how accumulator traction can be worked cheaper and more satisfactorily than the other two systems. Hence my ideas are placed before you rather in the abstract than in the concrete. With reference to my figures representing the power obtainable from our refuse destructor, or, for that matter, from any other refuse destructor, providing the requisite quantity of refuse is present, I merely wish to point out that Mr. Jones, of Ealing, estimates for the same number of cells, destroying the same quantity of refuse as at Hull, a continuous power of 50 i.h.p., while I have placed my figures at 45 i.h.p. The refuse at Hull is, in fact, of a drier and more combustible nature than that at Ealing, so that my estimate may be taken as well within the mark. I have had the advantage of seeing the Ealing destructor works, and my assertions therefore may be taken with every degree of assurance.

I have now endeavoured to point out or indicate in this paper a few features in connection with municipal enterprise, which are well worth consideration. I do not for a moment say that the particular instance I have given, and which I have found would be so particularly to our advantage at Hull, is one which in all respects would be found equally advantageous in other towns. But it is the co-operation of departments under municipal control which might be arranged without in any way interfering with the carrying out of the regular or specific work which each department has been created to perform. The tendency, of course, is already in this direction, and many towns are attempting to make some use out of the destruction of their refuse. But there is no reason why such combinations should not be more extensively made, and to this end I have endeavoured to show accumulators, as applied to electric traction, can at the present time be turned to remunerative account.

NEW ELECTRICAL ENGINEERING WORKS.

THOMAS PARKER, LIMITED.

Invitations were issued on Monday by Messrs. Thomas Parker, Limited, of Wolverhampton, for an inspection of their new works, which have just been completed in that town for the manufacture of electrical plant. The works, which were formally opened on Monday by the Mayoress (Mrs. C. T. Mander), have been erected in Wednesfield-road, opposite the goods department of the Midland Railway, and a short distance from the stations of the Great Western and London and North-Western Railway Companies.

The buildings occupy a large site, and are arranged in the most convenient manner possible, whilst the closest attention has been paid to the health of the workpeople. There are erecting, fitting, pattern, and machine shops, and a foundry for brass and iron work. The building at the left of the entrance has been set apart for the erecting, fitting, and machine departments. It has four bays—two of which have a span each of 32ft., and two with a span each of 42ft. 6in., and each of the four measures 150ft. in length—and in connection with each one there are arrangements for travelling cranes. In the first bay there are the main engines for driving the whole of the works, and for testing the machinery before it is sent out. The steam for the engines is supplied by two Babcock and Wilcox boilers. In the second bay there are the larger tools, general erecting and testing machinery. The third bay is used as a machine shop, with lathes, milling machines, drilling machines, and general tools for carrying out work of any size. The fourth bay is for light brasswork, winding armatures, etc. The floor of this large building is of concrete with wood blocks. There is also a railway track, so that it can be connected with the Midland Company's sidings. The machinery is fitted with the latest improvements and every arrangement to secure accuracy and rapidity in working. There are several milling machines, which are now taking the place of the planing machines. Four other large and valuable machines have yet to be laid down. The building is heated with steam from the main boilers by means of radiators. The travelling cranes and machinery are driven by electric motors supplied with current from a dynamo, which will also supply the electric light for the building. The building which will be used for the foundry is 120ft. by 40ft., and will be fitted with a 10-ton electrically-fitted travelling crane. The cupola is a large one placed in a convenient position and has a covered stage, with a hoist for taking up pig iron, coke, etc. The pattern-shop is 80ft. by 40ft., the floor of which is of concrete, over which wood blocks are laid, and heated by steam radiators. Mr. A. P. Brevitt, of Wolverhampton, was the architect, and Mr. Henry Lovatt the builder.

The ceremony of setting the machinery in motion was performed at noon in the presence of a large and representative gathering. Amongst those present were the Mayor (Alderman C. T. Mander), Mr. T. Parker, Mr. T. Graham, Mr. W. Thomas (directors), Mr. T. Bantock, Mr. A. P. Brevitt (architect), Mr. H. Lovatt (builder), Mr. H. G. Powell, Mr. Wilkie (secretary), and Messrs. J. E. Underhill, J. W. Sankey, J. H. Woodward, E. S. G. Rees, C. H. Iles, W. Armistead (the last four named gentlemen being members of the staff). After an inspection of the machinery by most of those present, Mr. Parker called upon the Mayoress to set the machinery in motion, which she did amid cheering from spectators and workpeople. Mr. Parker afterwards presented the Mayoress with a blotter, made from deer-skin leather, of a very delicate-brown colour.

The company having adjourned to the pattern-shop, Mr. T. BANTOCK said that was a very important occasion for Wolverhampton. A successful work of the magnitude and character as that which they saw before them was most important both for those who put their capital into it as well as for the workpeople. He had the greatest pleasure in proposing success to the new undertaking. The health of the new firm was then drunk with enthusiasm.

The MAYOR, as chairman of the company, responded, and

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said he was pleased to see Mr. Bantock present, and to hear him so kindly propose success to the new undertaking. He (the Mayor) fully believed it was going to be a grand success. They had a very able staff, and a most able managing director in Mr. Parker, whose name in the electrical world was a household word. He could assure the public that the concern was honest from start to finish. There had been no promotion money, the concern had not been "watered," and they had the best chance of success. On behalf of the directors he thanked them for the hearty way in which they had drunk success to the undertaking.

Mr. THOMAS PARKER said he was glad to see Mr. Bantock present, and to know that the Mayor was by his side, upon whom he looked as a tower of strength in connection with that undertaking. The site upon which those buildings had been erected was a field in July last. The idea of starting those works was fixed upon by the gentlemen who formed his staff, who about nine years ago came to Wolverhampton as pupils to him (Mr. Parker) at the works of Elwell-Parker, Limited, and had grown with and taken a large part in carrying out the works that made the name of Elwell-Parker known throughout the world. They had been his staff through the term of his agreement and of service with the Electric Construction Company as their engineer and works manager. They made the term of further union to be the initiation of a new concern. They now gave Thomas Parker, Limited, their united services and experience, and had each subscribed largely to its capital. He wished them to receive from the friends of the firm credit for this. The company were now able to take in hand the largest work which was likely to be required. They intended to do the highest class of work at the lowest cost. They had the newest and best machinery, carefully chosen from seven of the best makers, and bought at the lowest possible price. They had plenty of orders in hand. He had the greatest faith in the future of electrical engineering, where the object was sound and legitimate business. This, he was sure, was the one object of the directors. They had been working upon designs and patterns the last five months, and hoped to be able to offer to the public a better class than they had bought hitherto, and improved designs. They had obtained some important patent rights, and he thought the works would be a standing monument to their chairman, the Mayor, during his mayoralty.

Mr. GRAHAM proposed hearty thanks to Mr. A. P. Brevitt, the architect, and Mr. Henry Lovatt, the builder, for the excellent way in which they had carried out their work. Several electrical engineers had seen the works, and they had candidly declared them to be the best of the kind in the United Kingdom.

Mr. BREVITT responded, and the proceedings were brought to a close.

LIGHT RAILWAYS.

On the invitation of the Board of Trade, a conference on the desirability of making light railways for the carriage of produce from the rural districts was held at 8, Richmond-terrace on Thursday last week. Among the bodies represented were the London County Council, the Association of Chambers of Commerce, the Central and Associated Chambers of Agriculture, and the London Chamber of Commerce. The officials present were: Mr. Bryce, President of the Board of Trade; Mr. Gardner, President of the Board of Agriculture; Mr. Shaw Lefevre, President of the Local Government Board; Mr. Burt, M.P., parliamentary secretary of the Board of Trade; Sir Courtenay Boyle, permanent secretary of the Board of Trade; Mr. F. J. S. Hopwood, assistant secretary of the Railway Department; Mr. Garham Roper, private secretary to the President of the Board of Trade; Major Cardew, electrical department; and General Hutchinson, Major Marindin, Major Yorke, and Major Addison, railway and tramway inspectors of the Board of Trade.

Mr. BRYCE, who presided, said he had called the various bodies together to discuss the desirableness of constructing light railways in rural districts and in places where there was no railway connection at the present time. There had been a great depression in agriculture for some time past. When they turned their attention to several foreign countries, notably Belgium and France, they would see the great development which had taken place in the formation of cheap light railways. The question was whether such lines could be made to give satisfaction to those who might construct them. Considering that 50 years had elapsed since most of our great trunk railways had been completed, comparatively little had been done to facilitate locomotion in the less populated districts for the conveyance of produce therefrom. All that the Board of Trade could do, in many respects, was to keep just ahead of public opinion. They were restricted in their policy by statute, and also by usage, which was scarcely less strong. They could not go far in advance, therefore, of public opinion in very many of the matters that were brought before them. They had always to consider the question of safety and of speed. Another side of the question was whether light railways would relieve the congestion of the passenger traffic in urban districts by providing better transportation for workmen going to and coming from their work, and enable many of those large industries now being carried on in cities to be transferred to rural districts. The formation of light railways would, of course, turn on the question of money, and it would be well if some means could be devised to lessen the cost. He believed the cost of constructing a railway, taking into consideration the land and the heavy parliamentary expense, was little less on an average than £10,000 a mile, but there was reason to believe that a light railway would be formed for something like £4,000 and upwards per mile. If light railways were to be formed, many of the local authorities would have to change their attitude, or they could not have the benefit of these lines. An expensive thing would be the cost of the land. The question of gauge must depend on the character of the country to be passed through. In hilly districts a narrow gauge would be desirable. The question of motive power must be left to others to decide. The Board of Trade would not be justified in doing away with their requirements as to the working of a line, for the fencing, the signalling, the block system, level crossings *versus* bridges, station platforms, and the maximum of speed. The doing away with any of those requirements must be the work of the Legislature itself. Whether the light railways should go along roads or across country would be another question to be considered, and there were other matters of political economy which must not be lost sight of. Of course, the solution of many of those questions must depend on the attitude taken by the existing railways. He hoped they would recognise the great value which these proposed new lines would be to them, for they must serve as feeders to their main system.

After some discussion, the Duke of SUTHERLAND proposed the appointment of the following gentlemen, with others, as a committee to enquire into the question at issue: Sir M. Hicks-Beach; Sir B. Samuelson, Sir A. Hickman, Mr. W. Jackson, Mr. Beachcroft, Lord Claud Hamilton, Lord Cathcart, Sir C. Boyle, Mr. Hopwood, Lord Thring, Mr. W. Meik, Mr. H. Hobhouse, Mr. Acworth, Mr. Storey, Mr. Humphreys Owen, Sir B. Baker, Sir A. Rendel, Sir A. Clark, Mr. A. Siemens, Lord E. Fitzmaurice, Mr. Sellon, Mr. Channing, Sir A. Rollit, Colonel Makins, and himself. The resolution was agreed to, the committee to meet at once, so as to be able to present their report before the end of January.

Mr. JACKSON spoke with reference to what had been done in Ireland. It devolved upon him to make the arrangements for the last batch of light railways which had been constructed in that country under Mr. Balfour's Chief Secretaryship. Some of the lines there had been constructed under what is known as the baronial guarantee, and in many cases the charge was felt as a great burden by the ratepayers, who were more or less restive under it. The general impression upon his mind was that whenever the promoters could conveniently make arrangements under which a line to be constructed could be worked in connection with the adjoining or parent company, not only would it result in economy, but in the best interest of a locality. He believed there were many districts in England having an ample water supply in which it would be possible to have electric motors, and they would provide cheap means of conveyance. The gauge on light railways should be the same as the parent gauge, so that trucks coming from a farm could be shunted bodily on to a main line. There were places in Ireland where steam tramways were laid partly along the roads and partly on independent land. There were great disadvantages, however, in having railways or tramways along the roads, and those disadvantages were constantly growing. Sir D. FOX, C.E., was in favour of the question being relegated to the local authority, with consultation with the Board of Trade if necessary. He believed in the development of electricity as a means of bringing about cheap and light railways as proposed. One authority alone should decide as to the gauge to be laid down. After some further discussion, Mr. BRYCE said that many instructive and interesting points had been raised, and he was sure they would be duly considered by the committee.

THE PACIFIC CABLE QUESTION.

The report of the Earl of Jersey to the Marquis of Ripon on the proceedings of the Colonial Conference at Ottawa has now been published as a Blue-book. The following are extracts from the report in reference to the projected Pacific cable, in connection with which five resolutions were passed by the conference:

(1) "That in the opinion of this conference immediate steps should be taken to provide telegraphic communications by cable, free from foreign control, between the Dominion of Canada and Australasia.

(2) "That the Imperial Government be respectfully requested to undertake at the earliest possible moment, and to prosecute

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with all possible speed, a thorough survey of the proposed cable route between Canada and Australia, the expense to be borne in equal proportions by Great Britain, Canada, and the Australasian colonies.

(3) "That it is for the interest of the Empire that in case of the construction of a cable between Canada and Australasia, such a cable should be extended from Australia to the Cape of Good Hope, and that for that purpose arrangements should be made between the Imperial and South African Governments for a survey of the latter route.

(4) "That, in view of the desirability of having a choice of routes for a cable connection between Canada and Australasia, the Home Government be requested to take immediate steps to secure neutral landing ground on some one of the Hawaiian Islands, in order that the cable may remain permanently under British control.

(5) "That the Canadian Government be requested, after the rising of the conference, to make all necessary enquiries and generally to take such steps as may be expedient in order to ascertain the cost of the proposed Pacific cable and promote the establishment of the undertaking in accordance with the views expressed in this conference."

In this connection Lord Jersey remarks:

"I should observe, in passing, that the discontinuance of the surveys was commented upon, and great disappointment was expressed by the delegates that the request of the conference of 1887 had been so imperfectly met. It seemed, therefore, to the conference sufficiently clear that the first step to be taken was a survey of the route, so that the depth and character of the ocean bed should be ascertained, the position of the various islands fixed, and their suitability as landing-stages determined.

"With these considerations before them, the conference passed the second of the above resolutions. Your lordship will observe that, whereas in 1887 her Majesty's Government were asked in effect to undertake the survey at their own cost, the conference proposes that the expense should be borne in equal proportion by Great Britain, Canada, and the Australasian colonies.

"It seems desirable that further consideration should be given to the question whether survey is necessary before actual operations are commenced. At the Colonial Conference of 1887, and in the subsequent correspondence, it was assumed that this was the case. Some doubt was expressed at the Ottawa Conference as to whether the partial surveys already made in the Pacific Ocean were not sufficient to render possible a fairly approximate estimate of the difficulty and cost of the work. This was the view taken by Mr. Lee-Smith, who stated as an illustration that when the cable on the West Coast of Africa was laid no survey was taken, but an allowance made for risks. It appears that since 1887 the scientific resources connected with the laying of submarine cables have been so improved that, given a general knowledge of the depth, a previous survey is not now always required. On this point I will quote from a printed memorandum by Mr. A. Siemens, which was communicated to me after the close of the conference. Mr. A. Siemens is well known as a distinguished member of one of the most important electrical firms in the world, and has very recently been successful in laying the last cable between Great Britain and America."

Then follows the quotation from Mr. A. Siemens's pamphlet, one of the sentences of which runs: "It may, therefore, be taken for granted that any technical obstacles which were apprehended in 1887 have now been overcome, and that the cable can be laid as soon as the financial question has been settled." Continuing, Lord Jersey says: "Her Majesty's Government will, I presume, consult their professional advisers on this point. The question was raised whether it would not be proper for the conference to endeavour to settle the route which the cable should follow. From one point of view it may seem unreasonable to ask that the route should be surveyed without suggesting what that route should be. Several routes touching at different islands in the Pacific were before the conference. As a general indication of their direction I will take two as types. One route would be from Vancouver Island to Fanning Island, Fiji, Norfolk Island to Tweedmouth in Australia. This is a distance of 6,730 miles, and if a branch is made to connect it with New Zealand, 415 miles would have to be added. This route is entirely through British territory. The second route is from Vancouver Island to an island in the Hawaiian group, thence through the Gilbert and Solomon Islands to Bowen in Queensland. This route is about 6,300 miles. But upon the whole it was felt that the balance of convenience was in favour of leaving these questions to stand over for future consideration. They appeared to depend largely on circumstances requiring expert information and advice, and the delegates thought it best to await any views or recommendations which her Majesty's Government, with the valuable professional assistance at their command, may in due course be able to offer.

"In connection with this matter the fourth resolution may be noted. It was the decided wish of the conference that the cable should, if possible, pass entirely through British territory whenever it touches the islands on the route. It was believed that the practical exigencies of the case, from an engineering point of view, might render it desirable that the cable should run from Vancouver to the Sandwich Islands, as this stretch is materially shorter than that to Fanning Island. In that case it would be desirable, if possible, that the exclusive use of one of the Hawaiian Islands should be obtained, in order that the cable might be as far as possible free from foreign control. Necker Island, which lies about 400 miles from Honolulu, has been much mentioned as a possible landing-stage, but it does not appear to be suitable for that purpose. Captain King in his report of last May to the Hawaiian Government stated 'there was no water, no trees, no grass; to support life, supplies would have to be brought to the island, including water, and the station there would be similar to that of a lighthouse.' Possibly some more suitable island might be found on the edge of the Hawaiian Archipelago. The conference was not, of course, in a position to arrive at any conclusion as to whether such an arrangement as that desired was practicable, but there was an impression that the Hawaiian Government was disposed to assist the project so as to secure for themselves the convenience of having cable connection with the rest of the world. The resolution should not as I understand be taken to mean that the conference favours the Sandwich Islands route. Whether that route, or the alternative one to Fanning Island, should be taken is left open. The resolution only expresses the desire that whatever route is adopted the cable should be under British control throughout. I believe that there is no practical difficulty in laying the cable if Necker Island or one of the Sandwich Islands be used as one of the landing-places. The greatest depth is apparently about 3,300 fathoms, and the Eastern Extension Telegraph Company have a cable laid at a greater depth between Java and Port Darwin. The Senegal-Pernambuco cable, also, is laid at a depth of more than 3,000 fathoms.

"It is, of course, necessary to look forward to the question of the probable receipts and expenditure when the line is in working order, and much correspondence from opposing points of view and interest has passed. I regret that I cannot place before your lordship a reliable statement as to the probable cost, expenses, and receipts. The figures mentioned at the conference must, from the nature of the case be problematical, and be taken subject to correction and variation. The cost of a single cable from Vancouver to Australia may be roughly put down at £2,000,000. Mr. Sandford Fleming, in his memorandum, calculated that the earnings of the cable would be, at 2s. per word across the Pacific (this would reduce charges between Australia and England to 3s. 3d. in place of 4s. 9d. as at present), £99,465 in 1898, and that there would be a progressive annual increase till in 1904 they would amount to £153,023. The interest at 3 per cent. would be £60,000, the cost of working he put at £60,000, and the renewal fund at £32,000. Thus in seven years from starting there would be a balance of receipts and expenditure. If this statement should prove correct, the liability of the guaranteeing Governments would rapidly diminish, and the undertaking would become self-supporting. The general opinion of the conference was that if the enterprise is undertaken with proper safeguards, it would entail little or no loss to the contributing or guaranteeing Governments. Of its value to commercial enterprise there was but one opinion. The delegates, some of whom have had business experience of a very practical kind, considered that, having regard to the usual difficulties of diverting trade and to the established advantages and conveniences of existing channels, it would be impossible greatly to enlarge the dimensions of traffic across the Pacific until a cable has been constructed. Telegraphic communication is now an indispensable condition of commercial intercourse, and if that communication is impracticable, or if the rates are excessive, commerce cannot thrive. It was believed that if the direct cable were constructed a great impetus would be given to the trans-Pacific trade, and that, therefore, the cable would not merely compete with the Eastern lines in respect of existing trade, but would reap the benefit of a new traffic.

"Adverting to the opinion that a duplicate cable is essential to the proper working of the communication, I must add that it would add very largely to the initial cost, and that its consideration can well be left till the present scheme has assumed a more definite shape. Great stress was laid upon the value of the line for Imperial purposes, but the question of the strategical value of the line must be decided by experts. Diverse opinions appear to have been expressed by various authorities, and I am not qualified to join in the controversy. I will only remark that I cannot understand how two different routes, one eastern, the other western, joining Great Britain and her Australasian colonies, can fail at critical moments to be more useful than one; and that it is a not unreasonable proposition that a cable passing solely through British territory and waters comparatively secure from attack, must give greater strategical advantages than lines which pass through European or Egyptian territories, with their constant liability to warlike complications. Considerable divergence of view was manifested at the conference as to whether it was desirable that the cable should be laid by the contributing Governments as a national undertaking, or by a private company with a Government subsidy or guarantee. In favour of the first alternative it may be urged *inter alia* that certain expenses, such as those of promotion, are avoided by State ownership, and that the danger of amalgamation with other companies to the disadvantage of the public is precluded; and in favour of the second, that a company would do the work and carry on the business more economically than a Government body. The difficulty of a State control under the joint ownership of several responsible Governments cannot be disregarded.

"It may be said that it would not be just for the Governments to subsidise a new and competing line. The enterprise of the Eastern Extension Telegraph Company has conferred great benefits on Australasia, to which Mr. Lee-Smith bore testimony. Whilst, however, admitting and admiring that enterprise, it cannot be conceded that it entitles the company to the cable monopoly of Australasia. The new route is not proposed from mere motives of competition, in which case her Majesty's Government would probably decline to take part, but from the conviction that commercial and Imperial interests demand its construction. The British Government pay subsidies for cables to Bermuda, the Seychelles, Mauritius, and to certain British settle-

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ments and possessions in Africa. These places, it is true, were entirely without telegraphic communication before the subsidies were given, but not one affords a parallel case to that of the vast continent of Australia. The subsidy and guarantee paid by five Australasian colonies to the Eastern Extension Telegraph Company amounted in 1892-3 to £53,363."

Lord Jersey concludes by stating that further negotiations must take place on the subject of the guarantee or subsidy, after the questions of route, survey, and probable cost have been settled. He, however, repeats that an alternate line of communication with Australasia and the Pacific should have strategic as well as commercial advantages.

BEDFORD ELECTRICITY WORKS.

The electricity works at Bedford, which we described in our issue of the 30th ult., were formally opened on Thursday afternoon of last week. The ceremony of switching on the light was performed by the Mayoress, who was accompanied by his Worship (Mr. George Wells, J.P.). There were also present Alderman Young, Councillors Richards, Jarvis, Turner, Sell, and Mr. T. S. Porter (clerk). The various parts of the apparatus and machinery were explained to the Mayoress and the gentlemen present by Mr. F. H. Medhurst (consulting engineer to the Corporation) and by his staff of assistants. The Mayoress then switched on the light to four 100-c.p. lamps in the roof of the station.

Mr. Councillor Richards (chairman of the Electric Lighting Committee) said that the inhabitants of the town were getting anxious to have the benefit of the electric light, and that the committee therefore felt it their duty before waiting to put any finishing touches to the station and machinery to let the people have the light at the earliest possible moment. The station was not a show place, but a place where the work was done. It was built for working purposes, and therefore those who visited it anticipating they would see a show place would be disappointed, but they hoped to get a lot of work out of that station for the benefit of the ratepayers of the borough of Bedford. That was not the place for speaking, and he could not help thinking if they had the noise of those engines in the Council-chamber they would have had a good deal less talk on the electric lighting question. But it had not been all talk, for there had been a lot of hard work done in the last four months, and he could say that they had beaten the record in installing the electric light. It had been done in this town in a shorter time than anywhere else. That it would be a success the committee felt sure. The only fear they had at the present time was that the machinery would not be strong enough to supply the number of customers who had applied for the light. That spoke well for the opinion of the town, and was an answer to their opponents who had feared it would be a failure. The committee said it would be a success because of the manner in which the town had taken the matter up, and helped the Corporation by showing in that way that they appreciated their services.

The Mayoress then switched on the current to the town mains.

Councillor Sell proposed a vote of thanks to the Mayoress, remarking that it was fit she should do it, as the Mayor had most constantly stuck to his guns with this question.

Alderman Young seconded, and the vote was carried by acclamation. The proceedings then terminated.

LEGAL INTELLIGENCE.

GORDON V. SCOTTISH HOUSE-TO-HOUSE ELECTRICITY COMPANY, LIMITED.

This case came on last Friday for trial before Mr. Justice Lawrance, without a jury, in the Queen's Bench Division of the High Court of Justice. The plaintiffs claimed a sum of £5,000 under an agreement with the defendants dated October 4, 1892. The defendants admitted the contract, but raised a number of defences. The plaintiffs, Messrs. Gordon, were electrical engineers in London, and they entered into an arrangement with the defendants, who had a contract to light the town of Coatbridge, to do the work. The plaintiffs performed some part of their contract, but the defendants did not, and hence the plaintiffs claimed £5,000, which they alleged to be forfeited by breach of contract. Counsel then formally proved the plaintiffs' case in detail.

Mr. Crump, Q.C., for the defence, said the facts were as follows: There was a provisional order granted for lighting Coatbridge with electricity, and several gentlemen formed themselves into a syndicate for the purpose of raising the necessary funds to float and finance a company and carry out the contract to light Coatbridge. The defendant company was then in a state of suspended animation, and it was desired to resuscitate it and put the shares on the market. Accordingly, an agreement was entered into to underwrite a number of shares, and in this manner the syndicate was brought into communication with the present plaintiffs. Messrs. Gordon agreed to find one-third of the capital if the syndicate could find the other two-thirds. This the plaintiffs did not do, and consequently the £5,000 was not supplied. No work had ever been done by the plaintiffs, and as a fact the British Electric Company had carried out the whole of the contract since, as in January, 1893, the plaintiffs went into liquidation. The whole arrangement was subject to underwriting by certain persons, and as they failed to do so, he submitted the plaintiffs were not entitled to recover.

Mr. Justice Lawrance held that the defendants were not liable to pay the £5,000, and he accordingly entered judgment for them with costs.

PRIESTMAN BROS. v. STARBRICK.

On Tuesday, in the Queen's Bench Division, this case was heard before Justices Wills and Wright. It was an appeal by Messrs. Priestman Bros., of Kingston-upon-Hull, from the decision of the magistrate at Hull, who had held that a deed of apprenticeship was disadvantageous to an apprentice, and therefore void.

Mr. M. Lush appeared for the appellants, while Mr. L. Smith represented the respondent.

Mr. Lush said in 1889 the respondent was apprenticed with the appellants to be taught the trade of an instrument maker. There was a clause in the indentures providing that after the apprentice had attained the age of 18 years he should work overtime when required to do so, and should receive pay for such overtime at the rate of time and a half. On April 27 last respondent was informed that he would have to work overtime from five to nine in the evening to finish a spraymaker upon which he was engaged. He refused, and proceedings in the police court followed. It was proved that for the overtime the respondent would have been entitled to 7½d., whereas a journeyman engaged for the same period would have charged about 3s. The magistrate was of opinion that the clause of the indenture with reference to overtime was disadvantageous to the respondent, and that there was a want of neutrality in the deed, and that it was void. He (the learned counsel) submitted that the decision of the learned magistrate was wrong.

Mr. Justice Wills said he was of opinion that the clause in the indenture went beyond what was fair to the respondent, and therefore the decision of the magistrate would be upheld.

Leave to appeal was granted.

GRAHAM v. SITWELL.

On Wednesday, in the Westminster County Court, his Honour Judge Lumley Smith, Q.C., had before him the case of Graham *v.* Sitwell, in which the plaintiffs, Messrs. Graham and Riddle, a firm of electric light fitting dealers, sued the defendant, Sir George Sitwell to recover a balance of account of £6 in respect of electric light fittings supplied to his order. It appeared, from the evidence of the plaintiffs, that the defendant was in the habit of giving orders for goods from time to time and paying for them in the ordinary course, but he objected to pay for these particular goods on the ground that, although he gave the order for them, he did so on behalf of his mother, and was, therefore not personally liable to pay.

A **Member of the Firm** was called, and said he did not remember the defendant saying anything about the goods being for his mother, or that she would pay for them.

For the defence **Sir George Sitwell** was called, and swore positively that when he gave the order for these goods he told the plaintiffs they were for his mother and that she would pay for them. In spite of that, however, they insisted upon sending in accounts to him, but from the first he had repudiated his liability, and had the plaintiffs sent in the account to the proper quarter they would have been paid the money.

His **Honour**, after hearing the evidence, said he had come to the conclusion that he ought to non-suit the plaintiffs, as they had evidently got hold of the wrong person, but they could always bring a fresh action against the proper person.

COMPANIES' MEETINGS.

GENERAL ELECTRIC POWER AND TRACTION COMPANY, LIMITED.

An extraordinary meeting of this Company was held on Tuesday at the Cannon-street Hotel to consider the confirmation of the resolution passed at the extraordinary general meeting on the 21st ult. for winding up the Company voluntarily under the provisions of the Companies Acts, Mr. James Pender occupying the chair.

The **Chairman** proposed the resolution and **Mr. Immisch** seconded it.

Mr. Page Hopps thought the shareholders were entitled to a little further information regarding their position and assets before they were asked finally to wind up. They had shares in the Acme and Immisch Company and the Immisch Launch Company, and he would like to know what would be done with these shares. He did not understand how any complication could arise—as appeared to be thought at the last meeting—regarding the rights of the preference and ordinary shareholders.

The **Chairman** stated that as far as he was aware the preference shareholders had a first claim on any assets which might exist.

Mr. Garcke observed that the position of the two classes of shareholders was clearly defined, and the liquidators would have no difficulty in dealing with the matter. No arrangement whatever had been made as to selling the preference shares held by them in the Acme and Immisch Company and the Immisch Launch Company.

The motion was then carried with one dissentient, and a further

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resolution was afterwards passed appointing Mr. E. Wilding (the accountant) and Mr. William Bulloch (the secretary) liquidators of the Company, and fixing their remuneration at £150.

WESTMINSTER ELECTRIC SUPPLY CORPORATION, LIMITED.

Two extraordinary meetings of shareholders in this Corporation was held yesterday (Thursday) morning. The first, which was of holders of founders' shares, confirmed the following resolutions which were passed at an extraordinary meeting held on the 28th ult.: "That out of the newly-created share capital of £100,000, £40,000 in 8,000 shares of £5 each be forthwith issued at a premium of £1 per share, and in the first instance allotted to shareholders on the register on November 14, 1894, in the approximate ratio of one to every complete eight shares then held, and that the Board be empowered to allot any balance of the 8,000 shares not alloted to the shareholders, to members of the staff of the Corporation, or to such other persons as they may think fit on the same terms. That the amount due on the shares be payable as follows: £1 (premium) on January 3, 1895; £2 on January 15, 1895; and £3 on July 1, 1895, and that the new shares rank for dividend (on amount of capital paid) from January 1, 1895. That the balance of 12,000 shares be retained, and that the Board be authorised to issue them as required, they being first offered to the shareholders on the register at the time of such issue, and on such terms as the Board may consider desirable."

The second assembly, which was of the shareholders, confirmed the following resolutions which were passed at an extraordinary general meeting held on the 28th ult.: "That out of the newly-created share capital of £100,000, £40,000 in 8,000 shares of £5 each be forthwith issued at a premium of £1 per share, and in the first instance allotted to shareholders on the register on November 14, 1894, in the approximate ratio of one to every complete eight shares then held, and that the Board be empowered to allot any balance of the 8,000 shares not alloted to the shareholders, to members of the staff of the Corporation, or to such other persons as they may think fit on the same terms. That the amount due on the shares be payable as follows: £1 (premium) on January 3, 1895; £2 on January 15, 1895; and £3 on July 1, 1895, and that the new shares rank for dividend (on amount of capital paid) from January 1, 1895. That the balance of 12,000 shares be retained, and that the Board be authorised to issue them as required, they being first offered to the shareholders on the register at the time of such issue, and on such terms as the Board may consider desirable."

WOODHOUSE AND RAWSON UNITED, LIMITED.

The debenture-holders of Woodhouse and Rawson United, Limited, met on Tuesday at Winchester House to hear a statement of the progress made in the realisation of the assets. Mr. F. D. Leslie, the receiver and manager, presided.

The **Chairman**, in the course of his remarks, said: I propose to give you a report which I have prepared, giving as clearly as possible the result of the liquidation of the assets that have up to the present been actually realised, and the estimated result of those assets which still have to be liquidated. In doing this I shall take the estimates of value based on the different groups of assets by the directors in their statement of affairs, and show you, when possible, by comparative figures, where and how the differences have arisen. I was appointed receiver and manager for the debenture-holders on March 10, 1893, and on the same date I took possession of the books, documents, papers, and assets of the Company. It took me a considerable time to thoroughly acquaint myself with the nature of the assets, and, indeed to find out where some of them were, also to obtain a full grasp of the situation. The books of the Company—in a large concern like this they were something like 200—were in anything but a complete condition, and, in fact, had not been posted since December, 1892. It consequently took many months to bring them up to the date of my appointment as receiver and manager. Of course, it was absolutely necessary that this should be done, as until this was finished I could not ascertain what were the assets of the Company, especially the book debts, or the position of the branches generally. You may be aware that this Company had agencies and branches situated in the United Kingdom to the number of 13, also at various places on the Continent, at Johannesburg and other parts of South Africa, and in Australia. Now, as these branches not only traded with the head office, but traded amongst themselves, you will see it was necessary that not only the books at the head office, but also the books at the various branches, should be written up before I could ascertain and trace the assets that ought to be at the various branches. Whilst this was being done, amongst many other things, two important matters required my immediate and constant consideration: First, the completion of the contracts entered into by the Company and only partly carried through at the date of my appointment. Of course, on account of these contracts, various sums of money had been received, but there were still considerable sums outstanding representing work already done under the contracts, and which, had the whole contract not been completed, would have been forfeited. I am glad to say that all these contracts have been completed, and no such forfeiture has occurred. Second, I had to consider which of the branches should be carried on, either with a view to the contingency of the reconstruction of the Company, and their forming with what goodwill might attach to them a valuable part of the assets to be dealt with in such reconstruction, and also to ascertain which branches were of such a nature that to carry them on at all would only involve further and serious loss. Having decided in which of these two categories the various branches must be placed, I had to take immediate steps to close down those in the second category, the carrying on of which would only have resulted in further loss. Much time was taken up in dealing with these matters, and in this connection I may say—although, perhaps, it is almost unnecessary—that in a large concern like this no serious steps could be taken without applying to the Registrar for authority to take such steps. This necessarily caused delay, as you know the Court will not make any order without the fullest information being laid before it; but at the same time it will, no doubt, be satisfactory to you to know that I have, in every case of any moment, taken such directions before acting. All the before-mentioned matters took up such an amount of time that at the end of the first six months of my trading as receiver and manager I was not in a position to take out a trading and profit and loss account; in fact, I could not do so, as I had not received, and could not receive, from the foreign branches their returns. I, therefore, decided to take out a trading and profit and loss account at the end of my first year's trading, being as at March 9, 1894. In taking out this account, and before I give you the result, I must say that the stocks on March 10, 1893, were overvalued. Upon the trading at the head offices and the branches (and, perhaps, at the present moment I need not go into the details, but may rather deal with the result as a whole), there appears a loss of £3,872, the greater part of which is accounted for by the fact that the turn-over was nothing like large enough to bear the standing charges, consisting of rates, taxes, rents, wages, salaries, etc., although in this connection I may say that immediately after my appointment, and during the whole of the time I have had the management of this business, I have given my attention to in every way cutting down the expenses. I reported to the Court and received directions to take steps to close down the head office and branches, the result of which is that at the present moment I have closed down all the branches, with the exception of the head office, Manchester, Kidsgrove Works, Birmingham, Chiswick, South Africa, and Australia, and have ceased trading altogether. I am now negotiating for the sale of the assets at the head office, also for those at the Manchester, Kidsgrove, Birmingham, Chiswick, South Africa, and Australian branches. The Official Receiver, as you are aware, issued a statement of affairs under date of December 12, 1893, setting forth therein the valuation of the various assets as estimated and certified by the directors. I have found it practically impossible to give you a detailed comparative statement of the realisation of the general assets, as in many cases sales have been effected, including items appearing in the statement of affairs under several headings, the whole being sold as a lump sum. Moreover, as the stocks mentioned in the statement of affairs at £76,396 have, of course, been depleted, it would be impossible and unfair to compare the realisation of the remnant of those stocks with the estimate of the stock on March 10, 1893. I think that I can, with the exception of the items "stock-in-trade" and "trade fixtures and fittings," give reliable figures, which items I, however, think may be fairly estimated at £20,215. The cash at bankers and in hand appearing in the directors' statement of affairs is substantially correct. The investments in shares, etc., amount to £31,768. The item appearing in the statement of affairs for property—£36,847—includes the sum of £13,500 for goodwill at the head office and different branches, and the sum of £21,950 for patents. The item for goodwill will realise nothing, but for certain of the patents I have received an offer of £2,000, others are included in the offer of £8,500 for the Manchester and London businesses, the remaining patents being valued at £1,150. The book debts were estimated to be of the value of £37,519, but I estimate a deficiency on the whole item of £24,521. The next item is bills receivable, which, according to the statement, are estimated to produce £3,662. Of this amount £1,616 has been received, and the balance of £2,046 is valueless. I now come to an item of £13,599, which is the estimated surplus from the securities in the hands of the creditors fully secured. Of this item not more than £2,500 will be received, inasmuch as it was estimated that the surplus from the sale of the Kidsgrove works would show an excess of £5,000, but it will only show £2,500, and even part of this is for stock, etc., not included in the mortgage or in the above estimated surplus; whilst from the Cadby Hall sale it was anticipated that a surplus of £7,000 would result, and this property has been disposed of by the mortgagees for £10,500, the amount of their mortgage money and interest. I may say with reference to this property that I instructed a well-known firm of land agents and valuers in the West-end of London to value the property on my behalf, and they valued it at the sum of £6,000. I thereupon allowed the mortgagees to enter and take possession. The item for unpaid calls was estimated to produce £7,647. Up to now I have succeeded in recovering £7,073, and anticipate that £100 will be realised from the remainder. After detailing certain negotiations he had entered into for the disposal of the remaining assets of the Company, the Chairman proceeded: You will gather from the report which I have read to you that the realisation of these assets has fallen far below the too sanguine estimate placed upon them by the directors in their statement of affairs. You will see that as all the assets at the present moment are not realised it is practically impossible for me to give anything like a reliable estimate of what may be expected by the debenture holders in the shape of a dividend, but my estimate is that, subject to the costs of the realisation, there will be a sum of £32,000 available for distribution amongst the debenture-holders, of which I estimate £3,600 will be due to the

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5½ per cent. debenture-holders, £18,400 will due to the 6 per cent. debenture-holders, and £10,000 to the 10 per cent. "secured" debenture stock. It is apparent upon the face of it, from the statements that I have made to you, that in no case can the debenture-holders receive a full return for their investment, and although it would, of course, have afforded me greater satisfaction to have been able to give you some more or less reliable figures to day from which I could arrive at an idea of what dividend I shall sooner or later be in a position to pay you, you will see that under these circumstances all I can possibly do is to lay before you—which I think you will see I have endeavoured to do—a full account of the present position of the assets existing when I took possession of what is practically your property, and also lay before you a statement showing the steps I have taken in your behalf and in the protection of your interests.

Some discussion having ensued, the **Chairman**, in reply to the Receiver of the British Electric Lighting Company, said the amount of debenture stock outstanding on the respective issues was as follows: on the 6 per cent. debentures, £65,500; on the 5½ per cent. debenture stock, £118,187; on the 10 per cent, £19,905; but he did not anticipate more than £13,600 of the last named would rank.

The proceedings closed with a vote of thanks to Mr. Leslie.

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Blyth.—The Cowpen District Local Board (Blyth, Northumberland) invite tenders for the lighting, by electricity or otherwise, of the lighting area within their district by the 20th inst.

Madrid.—Tenders are invited by December 20 by the Ministère d'Outre Mer, Madrid, and by the General Government of Havana, for the construction of a telephone system in the island of Santa Clara.

Portsmouth.—The Town Council invite tenders for the purchase of certain electrical plant at the Town Hall, Portsmouth The plant has only been used about four years, and is now being sold in consequence of the Town Hall being now connected with the central electric light station. Full particulars of the articles to be sold, with forms of tender, can be obtained on application to Mr. Alexander Hellard, town clerk. A price must be given for each separate article, and the forms of tender, duly filled up, must be delivered by 22nd inst. The Town Council do not bind themselves to accept the highest or any tender, and reserve the right to accept any item or items of a tender.

Walsall.—Tenders are invited for alterations to buildings at the Wolverhampton-street gasworks, including the construction of boiler-house, dynamo-house, offices, and other works for an electricity generating station, for the Corporation, in accordance with the plans and specifications prepared by the borough surveyor, which may be seen at his office, Bridge-street, Walsall, where forms of tender and bills of quantities may be obtained Tenders, endorsed "Tender for Electricity Generating Station," to be sent to Mr. John R. Cooper, town clerk. Walsall, by 24th inst. The Corporation will not accept the tender of any firm or person paying less than the standard rate of wages current in the district.

Edmonton.—Tenders are invited for the supply, delivery, and fixing of a system of electric call bells and telephones, for fire brigade and Local Board purposes, for the Edmonton Local Board. Forms of tender and full particulars may be obtained of Mr. G. Eedes-Eachus, engineer to the Board, Town Hall, Edmonton. Sealed tenders (which must be upon the Board's form), endorsed "Tender for Electric Call Bells and Telephones," to be delivered at the office of Mr. Wm. Francis Payne, clerk, Town Hall, Edmonton, by 12 noon on 21st inst. Any person whose tender may be accepted will be required to enter into a proper contract, with bond and sureties to be approved by the Board, such contract and bond to be prepared, executed, and completed in every respect at the expense of the contractor.

Hanley.—The Corporation of Hanley are prepared to receive tenders for the supply and erection of the following plant: Contract No. 10—extension of engine-house plant, including 200-kilowatt alternator, 25-kilowatt alternator, and 20-kilowatt exciter, each separately driven by a compound steam-engine, with all necessary steam and exhaust pipes, valves, switchboard, and appurtenances; Contract No. 11—extension of condensing plant, consisting of circulating pump, air-pump, boiler pump, surface condenser, with all necessary pipes and appurtenances. The drawings can be inspected, and specifications, prepared by Mr. G. H. Cottam, Corporation electrical engineer, together with general conditions and forms of tender, can be obtained at the offices of Mr. Joseph Lobley, Town Hall, Hanley, on payment of 5s. Tenders are to be delivered to Mr. Arthur Challinor, town clerk, on or before January 5, 1895. The Corporation do not bind themselves to accept the lowest or any tender.

RESULTS OF TENDERS.

Tunbridge Wells.—The tender of Messrs. MacFarlane and Co. has been accepted by the Town Council for the supply of arc lamp standards at the rate of £9. 8s. per standard.

London.—The London County Council have affixed their seal to agreements (in duplicate) with the Post Office in respect of the maintenance, at an annual cost of £13 in each case, of telephonic communication between the Kennington fire-engine station and the Vauxhall Cross street station, and between the Rotherhithe fire-engine station and the Bermondsey street station.

Cheltenham.—The following tenders for steam and exhaust pipes have been opened by the Electric Lighting Committee of the Town Council: Messrs. Such and Larter, Cheltenham, wrought iron £73, cast iron £31; Messrs. Thomas Piggott and Co., Birmingham, wrought £35, cast £60; Messrs. Sharpe and Co., Lancaster, wrought (no price), cast £47; Mr. James Pollard, Burnley, wrought (no price), cast £47; Messrs. Edwin Lewis and Sons, Wolverhampton, wrought £125, cast (no price); Staveley Coal and Iron Company, Chesterfield, wrought £10. 10s. per ton; "Silvesters," Newcastle, Staffordshire, wrought £38, cast £30. 10s. The committee resolved to accept the tenders of Messrs. Thos. Piggott and Co. for steam-pipes, and of Messrs. Such and Larter for cast-iron exhaust-pipes.

BUSINESS NOTES.

Ealing.—The mains are to be extended.

Salford.—The price for current to be charged by the Council is 7d. per unit.

Belfast.—It is expected that the electric light will be ready for use next month.

Glasgow.—The Merchants' House Buildings are to be lighted electrically. Messrs. Anderson and Munro have obtained the wiring contract.

Jersey.—A scheme is on foot for establishing an electric llghting company in the island.

Wolverhampton.—A new theatre, the Grand, has been opened. It is lighted electrically.

Western and Brazilian Telegraph Company.—For the past week the receipts were £3,084.

Bristol.—The Roman Catholic church in Victoria-street is to have the electric light installed.

Warminster.—The Local Board are considering the question of the erection of a central electric light station.

Bangor (Wales)—A committee of the City Council are to enquire into the subject of introducing the electric light.

Llanelly.—The Local Board are making enquiries as to the probable demand by private consumers for current.

West Australia.—The Coolgardie Electric Lighting Company has issued a revised prospectus. They want £7,000.

Aston.—The Local Board consider that for the present it is undesirable to go in for the electric light for the district.

New Hirst.—The New Hirst branch of the Ashington Co-operative Society which has just been opened is lighted electrically.

Rathmines.—A committee of the Commissioners is to report on the advisability of introducing the electric light into the township.

Wells.—A special committee has been appointed by the Town Council to enquire into the subject of introducing the electric light.

Guildford.—The Urban Sanitary Authority have instructed a committee to go into the general matter of the best means of lighting the streets.

Pontefract.—A committee of the Corporation are enquiring into the question of constructing an electric tramway between Pontefract and Featherston.

London.—Extensive alterations have been made in the premises of the Royal Geographical Society, Savile-row. The electric light has been introduced throughout.

Scarborough.—The Lamps Sub-Committee of the Town Council have been instructed to obtain tenders for the lighting of certain streets in the borough by electricity.

Fermoy.—Mr. Tomlinson, engineer to the Bray Electric Lighting Company, has submitted to the Fermoy Town Commissioners a scheme for the introduction of the electric light.

Cheltenham.—Alderman Norman has been appointed chairman of the Electric Lighting Committee. The committee are about to order transformers, meters, and service conductors.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 9th inst. amounted to £855, as compared with £606 in the corresponding week of last year.

Eccles.—Alderman Kendall and Mr. Oldfield have been re-elected chairman and vice-chairman respectively of the Town Hall, Tramways, and Electric Lighting Committee of the Town Council.

Manchester.—The new parcels' offices of the Lancashire and Yorkshire Railway in Strangeways are lighted by electricity. It is being urged that the electric light should be extended to Stretford-road.

Aluminium Soldering Company, Limited.—This Company has been registered with a capital of £10,000 to acquire, develop, and turn to account certain patents for inventions relating to soldering aluminium.

Bell's Asbestos Eastern Agency, Limited.—This Company has been registered with a capital of £10,000 to enter into an agreement with Bell's Asbestos Company, Limited, and to deal in asbestos and asbestos goods.

Taunton.—The Town Council have decided to refund the sum of £25 to the relatives of the late Warren Upham, of Brixham, who was recently killed at the electric light works, being a portion of the premium paid by him.

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Newcastle Tramways.—There has been a warm discussion in the Town Council, where some members favoured the adoption of electric traction on the tramways. The majority, however, supported the old principle of cable lines.

Lowcock, Hill, and Co., Limited.—This Company has been registered with a capital of £15,000 to acquire as a going concern the business of electrical engineers, etc., as hitherto carried on by Lowcock, Hill, and Co. at Manchester.

Brechin.—An arc lamp has been erected in St. Ninian's-square and was lighted for the first time last week. The lamp was erected by the Scottish House-to-House Electric Supply Company. The wiring was undertaken by Mr. Lowden, Dundee.

Fareham.—A Local Government Board enquiry has been held into the application of the Local Board for sanction to borrow £7,000 for electric lighting purposes including the purchase of the Fareham Electric Light Company's undertaking.

Chiswick.—The Local Board have approved of the plan for a new electric light station submitted by Messrs. Bourne and Grant. The Works Committee of the Local Board report that the works at the electric light station are progressing favourably.

Dover.—Another heated discussion has taken place in the Town Council on the subject of whether the streets should be lighted by gas or electricity. Eventually a resolution that the gas company have the contract for another year was carried.

Globe Telegraph and Trust Company.—The directors of the Globe Telegraph and Trust Company, Limited, have declared an interim dividend of 3s. per share on the preference shares, less income tax, and of 1s. 6d. on the ordinary shares, free of income tax.

Fulgur Electric Lighting Company, Limited.—This Company has been registered with a capital of £7 to acquire from Le Fulgur Société Anonyme d'Eclairage Electrique the patent for an apparatus for primary batteries for Great Britain and Ireland, No. 9,689 of 1891.

Oldham.—It has been reported to the Town Council that the Electric Light Committee had made enquiries as to persons willing to take the supply in various streets of the town, but the committee do not consider the demand to justify the extensions of the mains.

National Electric Engineering Company, Limited.—This Company has been registered with a capital of £5,000 to acquire and carry on the business of electrical engineers, as hitherto carried on by A. C. Cockburn and D. C. Bate, at 2, Holborn-place, W.C., and elsewhere.

New Office.—Messrs. Weyman and Hitchcock, Limited, makers of the "Trusty" engines for oil or gas, have opened an office at 11, Queen Victoria-street, E.C. This firm have recently moved into large works at Cheltenham, which are equal to an output of some 500 or more engines per annum.

Brighton.—The Town Council have adopted the report, which we printed in our last issue, recommending the borrowing of £42,000 for an extension of the electric lighting system. Councillor Berry has mentioned that the balance on the electric light works will be something like £1,000 this year.

Eastern Extension Telegraph Company.—This Company announce an interim dividend of 2s. 6d. per share for the quarter ending September 30. The 5 per cent. Australian Government subsidy debentures, due on January 1 next, will be paid on and after that date at Messrs. Barclay, Bevan, and Co.'s bank.

Glasgow.—The treasurer to the Town Council has reported that the collection of electric lighting rents on 28th November last were £3,185. 13s. 10d. for 1894-5, as compared with £2,118. 0s. 7d. for 1893-4, an increase of £1,067. 13s. 3d. The Lord Provost states that the demand for the electric light continues to increase.

Country House-Lighting.—Judging from the number of country houses Messrs. Drake and Gorham have in hand at the present time, it would seem that this class of work is far from being exhausted. Among other work, they are carrying out the lighting of Speldhurst for Mr. E. Jansen, where they are putting down a petroleum engine, dynamo, and a battery of D.P. cells.

City and South London Railway.—The receipts of the Company for the week ended December 9 were £941, against £913 for the corresponding week of 1893, or an increase of £28. The total receipts for the current period of the present half-year amount to £20,517, as against £19,188 in the corresponding period of 1893, an increase of £1,329.

Hanley.—The Town Council have decided to apply to the Local Government Board for a consent order for the creation and issue of £39,310 Hanley Corporation 3 per cent. redeemable stock for the purpose of raising loans required for wiring and fittings for the electric lighting of the public buildings, works of sewerage and sewage disposal, etc.

Aluminium and General Foundry Syndicate, Limited.—This Company has been registered with a capital of £10,300 to enter into an agreement for the purchase of the inventions and secret processes of Rudolph Van Wart for manufacturing aluminium alloys and of solder, and also of the business carried on by him at 36, Percival-street, Clerkenwell, E.C.

Sheffield.—It has been decided that the new hospital in West-street shall be lighted by electricity. Many other important consumers have been joined to the supply mains during the past few weeks, and the resources of the company to supply the demand are greatly strained. It is hoped that the company's new machinery for supplying an additional 10,000 lights will be running by the end of this year.

Halifax.—The work in connection with the Corporation electric light station is progressing under the superintendence of Mr. Wilmshurst, the electrical engineer. Last week the small engine was running daily, and the two large engines have been got into working order. The mains have been tested, and Trinity-road Baptist Chapel has already been illuminated with electric light supplied from the works.

Bell's Asbestos Company.—The half-yearly interest on the 5 per cent. mortgage debenture bonds of Bell's Asbestos Company, Limited, will be paid by warrant on and after 1st prox., also the bonds drawn on the 7th inst. for payment on the same date, at the Manchester and Liverpool District Banking Company, Limited, 75, Cornhill, E.C. The transfer-books will be closed from the 18th to 31st inst.

Harrow.—The Local Board called a public meeting last week to consider the question of electric lighting. Among those present were Mr. W. C. Hawtayne, the consulting engineer, and Mr. R. E. Crompton, the tender of whose company has been provisionally accepted by the Board. Although a motion and amendments were put to the meeting, it does not appear from the local reports that any definite decision was arrived at.

British Light Railways, Limited.—This Company has been registered with a capital of £110 in 20 £5 shares and 10 £1 shares, to construct, purchase, lease, or otherwise acquire any light railways, tramways, or tramroads in the United Kingdom, and to equip, maintain, and work the same by horse, steam, electricity, or other mechanical power; to manufacture and deal in locomotive and other engines, dynamos, and apparatus, etc.

Grasmere.—The Clerk to the Local Board has received from the Windermere Electric Light Company maps showing the line of proposed cable. Mr. Simpson said the whole matter had been left over for the new District Council. When did the time for opposing the company expire? The Clerk thought on December 24. The Surveyor thought not till January 15. It was directed that the clerk communicate with Mr. Gatey, and call a special meeting if necessary.

R. Waygood and Co., Limited.—This Company has been registered, with a capital of £60,000, to acquire and take over as a going concern the business of constructors of and dealers in lifting machinery, and of hydraulic, electrical, and general engineers and contractors, and otherwise, heretofore carried on at Robert's place, Falmouth-road, Great Dover-street, London, S.E., and at other places in the United Kingdom, under the style or form of R. Waygood and Co.

Morley.—A meeting of the Town Council has been held, when Mr. Robert Hammond, consulting electrical engineer, adverting to his offer *re* the lighting of the Town Hall, wrote that his feeling was that under the terms of the competition if the Corporation employed him to carry out the town scheme the £100 premium paid to him would merge into his fee for superintending the work. Under those circumstances he would superintend without fee what might prove to be the first instalment of the work—viz., the lighting of the Town Hall. Councillor Johnson proposed, and Councillor Foster seconded, that the letter be referred to the Town Hall Committee, which was agreed to.

Bath.—Mr. C. Chivers, at a meeting of the Town Council, asked what steps were being taken with regard to the provisional order for which the electric light company had given notice that they were applying to the Board of Trade. He had been told by those conversant with such matters that unless the Corporation stated their intention of taking the light into their own hands the company would be sure to get the provisional order they were seeking. Mr. Moore and other members hoped the Electric Light Committee were fully alive to the situation, as they wished the Corporation to take over the lighting themselves. Alderman Sturge informed the members that the committee had not forgotten or overlooked the question.

Cardiff.—A supply of current to the arc lamps in the streets was turned on at Cardiff on Monday. At the meeting of the Council in the afternoon several members called attention to the delay in lighting the town by electricity. Councillor Vaughan (chairman of the Lighting and Electrical Committee) and the Mayor explained that the Corporation had not yet taken over the system, and that experiments were still being carried on. It was the intention of the committee to extend the mains for the electric light. The committee before doing anything wished to lay specifications and costs before the Council, and if the expenditure were sanctioned the committee would be only too glad to go on with the work of extension.

Bowness.—At the last meeting of the Local Board the Chairman said they would all have seen the notice of the Windermere Electric Supply Company advertised in the newspapers, seeking for permission to lay their cables on the public roads of this district, and also on a number of private roads. The Clerk stated that, according to the rules of the Board of Trade, they (the company) could do nothing for three months. Mr. Holland said there was plenty of time to consider the plans. Mr. Westlake thought it would be as well to commence the lighting question. The clerk, after being requested, read Mr. Fowke's letter, and also his (the clerk's) reply. The Chairman then stated they would push the matter as far as they could, after which the subject dropped.

Stafford.—The Electric Lighting Committee of the Town Council recommended an insurance of the men against accident in conjunction with the insurance scheme of the Gas Committee. Alderman W. H. Peach, in moving the adoption of the report, said the chimney at the works had been completed, and the accumulator-house had been roofed. The principals were now about to be erected in the engine and dynamo house. By a joint system of insurance with the Gas Committee the premiums

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payable for the insurance of the men under the Employers' Liability Act were much lighter. He was pleased to report that the County Council had determined to light the technical instruction buildings by electricity. Alderman Silvester seconded the adoption of the report, which was adopted.

Dewsbury.—Alderman Fox at a meeting of the Town Council opposed a recommendation of the Lighting and Water Committee to expend in wages for workmen at the central lighting station £468 per annum, and ultimately, by the casting vote of the chairman, it was decided to refer the matter back to the committee. On Monday the electric lighting works belonging to the Dewsbury Corporation, which have been erected on the site of the old gasworks in Bradford road, under the superintendence of Mr. W. H. Preece, of London, were formally opened in the presence of the Mayor and members of the Corporation and other public bodies. Alderman Robinson, the chairman of the Gas and Lighting Committee, performed the ceremony of switching the electric current into the distributing mains. Later on a number of shops in the town were lighted from the central station.

Hastings.—The Roads Committee reported to the Town Council last week that they had received from the Hastings and St. Leonards-on-Sea Electric Light Company notice of the intention of the company to construct a transformer-chamber under the public pavement at London-road, St. Leonards, and recommended that the plan be approved. The committee had also received from the company a communication forwarding plan of a service main intended to be laid by them under the pavement in Queen's-road, consisting of a 3in. cast-iron pipe of 9ft. lengths with clip joints, and four brick connection-boxes with pavement frames and covers, such main to be laid about 18in. from the kerb at an average depth of 18in. The committee recommended that the plan be disapproved, the same not showing fully the mode and position in which the proposed works were intended to be executed, and the manner in which it was intended to interfere with the street. The report was adopted by the Town Council.

Elmore's German and Austro-Hungarian Metal Company.—The profit and loss account shows a loss for the year ended December 31, 1893, of £12,076. The directors state that the loss on trading is made up to a considerable extent by the reduction made in the values taken of the various descriptions of copper in stock, it having been deemed desirable by the German managers and auditors that these should be written down to almost their raw material value. It is also partly made up by the loss incurred on the sale of 10 tons of stock tubes, which had to be sold at the raw copper value, instead of the market value of such sized tubes. Subject to these reservations, the actual loss on trading did not exceed £600. The largeness of the profit and loss account is partly accounted for by the fact that, according to the German company law, it was necessary to write off the establishment expenses, as shown in the last account, amounting to £4,471, as loss, and the depreciation on the various accounts comes to the sum of £3,300.

Lancaster.—In proposing the adoption of the minutes of the Gas Committee at a meeting of the Town Council, the Chairman (Alderman Hatch) remarked that the comparative statement of gas consumed during the past quarter was very much better than at the corresponding period of last year, and although they had not yet felt the pressure of the electric light, the committee were exceedingly loyal to their consumers, and would endeavour to do the best they could for them by reducing the price of gas at the earliest opportunity. Not only were they trying to do this, but they were going to endeavour to meet the wants of the poorer inhabitants by the adoption of the penny-in-the-slot meter. Probably at their next meeting this system would be adopted, and the matter would come before the Council in due course. Whether the Electric Lighting Committee would start anything of the kind he did not know, but they would endeavour to set them a good example. As soon as the Electric Light Committee could afford to pay anything reasonable in the shape of a contribution towards the rates, the Gas Committee would not be backward in attempting to follow them.

Airdrie.—Provost Arthur has moved at a meeting of the Airdrie Town Council for the appointment of a committee, to act along with a similar committee for the burgh of Coatbridge, to consider the formation of a joint trust for the purpose of laying down a line of tramways from Drumpellier in the west of Coatbridge to Clarkson in the east of Airdrie, and to work the same in the interest of the two burghs. The proposed line would be about four and a half miles long. The Provost said that such a scheme by a private company had frequently been talked about, but he strongly favoured the concern being in the hands of the Corporations, as both burghs had already suffered by the gas and water supplies being in the hands of private companies. He had no doubt that the scheme, which had the approval of the provost and others in Coatbridge, would be a remunerative investment, and a great convenience to the public. Whether the motive power would be by cable or by electricity could be dealt with in committee by the proposed trust, along with the getting of the necessary powers. Bailie Conner seconded the proposal, which was unanimously adopted, and a committee was appointed in terms of the motion.

Aberdeen.—The members of the Gas and Electric Lighting Committee of the Town Council have made their annual inspection of the gasworks and electric supply station. The Lord Provost stated that he hoped that Councillor Johnston, the convener of the committee, would have a successful addition to the plant at the electrical station, and that he might soon be able to reduce the price of the electric light to 4d. per unit. Mr. Murray (the electrical engineer) said he could assure them that it had been a great pleasure to him to see the great success of the electric lighting in Aberdeen. It had been more successful in Aberdeen than in any other city. It had never yet met with any mishap, and of very few schemes of the kind could that be said. So far as he knew, their consumers were very well pleased with the service. He only hoped that the committee would soon extend the system to the West-end, as he had every confidence—judging from the success of the past—that it would be speedily taken up. Lord Provost Stewart supplemented the remarks of Mr. Murray by stating that he knew there were a great many people in the West-end who were ready to take in the light the moment the system was extended.

Prescot.—Considerable commotion has been caused at Prescot by the action of the Local Government Board auditor, Mr. George Haslehurst, in surcharging four members of the Local Board to the extent of £360 in connection with the electric lighting of the township. The Prescot Wire Company had entered into a contract with the Local Board to light the town with electricity instead of gas, as formerly supplied by the gas company. Mr. J. D. Banks, solicitor, had complained of the inefficient nature of the new light, and further drew the attention of the authorities in London to the fact that there was no penalty clause in the contract, which rendered it invalid. Some of the members of the Board have espoused the cause of electricity and others gas, and the controversy has waxed hot locally. Acting on several minutes in the Board's records that they did not consider the lighting efficient, the auditor has surcharged four members—Messrs. Edward Dyson, James Berry, Joseph Preston, and Thomas Pennington—to the extent of £360, as they had signed cheques for payments to the company to cover periods when the light was unsatisfactory. The clerk is preparing a petition to the Local Government Board to ask them to remit the surcharges.

Accrington.—Mr. Riley at a meeting of the Town Council asked if it was intended to do anything with respect to the electric light this year. It was now over a year since a site was purchased for a central station, and he had been expecting to see a meeting called for the purpose of going on with the work. He was afraid the thing was going to be shelved again, for what reason he could not say. Neighbouring towns were introducing the light, and it was giving every satisfaction He thought Accrington ought to keep abreast with the times They either ought to decide once and for all to introduce the electric light, or let someone else come in and do it for them. The Mayor: Would you propose a meeting of the Legal and Parliamentary Committee being called? Mr. Riley: Yes; I should like a meeting. The Mayor: I will do so. Mr. E. Higham said the last time the matter was brought up the Council decided against the light being introduced, and he did not think the committee would be prepared to move unless they were requested by the Council. They brought a very definite resolution to the Council, and the Council put it entirely on one side. Mr. J. S. Higham: They referred it back for reconsideration by the committee, and they have not reconsidered it. Mr. Ratcliffe: We have bought the gasworks since then.

Leeds.—A special meeting of the Leeds City Council has been held, the Mayor (Alderman Gilston) presiding. Mr. Moody, in the absence of Alderman Firth, moved a resolution declaring it expedient that the Corporation should in the next session of Parliament promote a Bill authorising the construction of additional tramways in and near the city, and for other purposes; and, further, charging the expenses of promoting the Bill "on the city fund and city rate, or such other public funds or rates as the Council may deem advisable." This was, he said, a purely formal resolution, carrying out the decision arrived at by the Council last month. The motion having been seconded. Mr. Battle moved an amendment providing that the costs incurred in passing the Bill should be charged to the tramways account. The Town Clerk pointed out that the resolution as worded would give the Council power to determine that the expenses should come out of the tramways account. After further discussion, in the course of which the Town Clerk, in reply to Mr. Goodson, said that whilst there was no doubt the tramways account was a public fund, it might be advisable to incorporate the amendment in the resolution in order that there should be no doubt on the point, the amendment was accepted, and the resolution adopted.

Appointments Vacant.—There is required at the Manchester Corporation electric works an assistant to take charge of an eight-hour shift. He must have had technical education and passed through usual routine of pupilage; essential to have had central-station experience of boilers, engines, dynamos, secondary batteries, and switching gear. Salary £2. 10s. per week. Applications to be made in writing, with copies of testimonials, and forwarded to the Gas Department, Town Hall, Manchester, by 15th inst, addressed to the Chairman of the Gas Committee, and endorsed "Application for Assistant Electrician."—The Blackburn Corporation are about to appoint a properly qualified mechanical and electrical engineer to take full charge of the electricity works. Applicants must have an extensive experience in the construction and erection of engines and dynamos, and the working of a central station on a low-pressure system. Age not less than 26, nor more than 40 years; salary £200 per annum. Applications, endorsed "Superintendent Engineer," stating age and experience, accompanied by copies of not more than four testimonials, to be sent to Mr. Robert E. Fox, town clerk, Town Hall, Blackburn, in sealed envelope, by 15th inst. Canvassing will disqualify.—The Worcester Town Council want an electrical engineer to take charge of the electric lighting works. The salary is £250.

Liverpool.—At a meeting of the Health Committee of the Town Council the town clerk read a letter from Mr. H. P. Boulnois, city

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engineer, who is engaged in London on corporate business, in reply to a letter which appeared in the newspapers from Mr. H. H. Hall, managing director of the Hall Electrical Company, Limited, complaining of the "unreasonable delay in obtaining the Health Committee's permits for service lines." The engineer, in his communication, said there was no foundation in fact of alleged undue delay taking place in granting permission for laying electric cables or services. Upon receipt at his office of plans and applications they were examined, and all the necessary enquiries were made, his report being sent in to the Health Committee generally within 14 days. Of course, between the final meeting of the Health Committee in October and the first meeting in November a longer period would elapse before the committee's approval could be obtained; but in case of urgency, provided there were no special objections to the proposed lines, he would grant provisional permission. The Town Clerk added that in his opinion the last few lines of Mr. Hall's letter contained a very serious libel, and it would be for the committee to consider whether they would take any steps in the matter. Mr. J. Houlding pointed out that the writer of the letter was only one out of the 600,000 people in Liverpool. What was the use of taking notice of every letter which appeared in the newspapers? The Chairman said the whole subject could be considered at a more opportune time by the committee.

Weston-super-Mare.—In our last issue we gave Mr. Francis H. Medhurst's report to the Local Board on the subject of refuse destructors and electric lighting. In this connection it may be mentioned that the Electric Lighting Committee's minutes of a meeting held on the 5th inst. are as follows: "In presenting to the Board the result of our careful consideration of the report of the electrical engineer on the question of electrical supply to this town, this committee desires to express its high appreciation of the ease and ability which Mr. Medhurst has exercised in its preparation, and recommends that his account be paid forthwith. In leaving to our successors the further consideration of this important question, we should like to state that the conclusions he has arrived at commend themselves strongly to our judgment. We believe the system of electric lighting could be established with small risk of loss even at the commencement, and with good hope of ultimate profit and saving to the ratepayers, to say nothing of the great advantage it would be to the town. The proposal of agreement with the Horsfall Company, containing provisions which would require careful consideration and probable alteration, commends itself to us as a very good basis for negotiations with them, and we strongly recommend it to our successors as forming a satisfactory solution of the problems of the disposal of the refuse and utilisation of the power generated by its combustion." At a special Board meeting subsequently held it was—upon the proposition of Mr. Pethick, seconded by Mr. Phillips—resolved *nem. con.* that the minutes of the Electric Lighting Committee be confirmed.

Tunbridge Wells.—The chairman of the Lighting Committee for the present year is Councillor Ashby Wood. The committee have decided to sink a well for the supply of water to the electric lighting station, and Mr. Prince has been authorised to proceed with the work provided the cost does not exceed £60. It has been decided to employ a clerk of works to superintend the laying down of the electrical machinery and plant at a salary of £3 per week. The tender of Messrs. MacFarlane and Co. for the supply of arc lamp-posts has been accepted, their tender being £9. 8s. per post. The offer of the gas company to lay a gas service from the Quarry-road to the central station, with a branch to the adjoining stables, for £32. 10s., has been accepted. The proceedings of the committee having been confirmed at a meeting of the Town Council last week, Councillor Putland asked what it was intend to lay the gas service to the central station for? Councillor Wood said they proposed to have a gas-engine to do the work in the daytime, and they required gas for the purpose of working it. The proceedings of the committee were then adopted. The Lighting Committee reported at the same meeting that they had had under consideration the question of the arrangements to be made with the gas company for the lighting of portions of the town after the electric lighting works are established. The committee thought it desirable that the contract with the gas company should be revised. The contract is determinable by six months' notice. The electric lighting of portions of the town will, it is expected be in operation before June 24 next, and the committee, therefore, recommended the Council to authorise them to determine the present contract with the gas company, and to make arrangements with them for a fresh contract, subject to the approval of the Council. A motion for the adoption of the report was agreed to.

Larne.—At an adjourned meeting of Larne Town Commissioners the following letter relative to the removal of an arc lamp-post at the corner of Inver and Bank roads was read: "To Mr. William Baxter, town clerk. Dear Sir,—Messrs J. E. H. Gordon and Co. have informed us that, owing to the improvements made at the corner of Inver and Bank roads, the post bearing the arc lamp has been considered an obstruction by your Commissioners and by the county surveyor; that the county surveyor has written them to have the post removed or otherwise he would institute proceedings. Messrs. Gordon further state that they laid these facts before your Board, and on the 22nd ult. wrote you fully on the subject, pointing out that they would be bound to comply with the requirement of the county surveyor and remove the lamp-post, but that without the authority of your Board they could not put it in any other position, and that accordingly the corner would be left in darkness until your Board saw fit to direct a new position for the lamp. Notwithstanding this latter, we are informed that your Board have passed a resolution to the effect that our clients and the county surveyor should be left to settle the matter between themselves. Now, we beg to give you notice that when Messrs. Gordon are compelled to remove the lamp-post by the county surveyor they will not undertake the responsibility of placing it in any other position until your Board directs where it is to go. Accordingly, the corner will be left in complete darkness, and Messrs. Gordon will not admit any liability, seeing that the fault entirely lies with your Board. It is a very trifling matter, and our clients are anxious that there should be no litigation on the subject. Accordingly, you will kindly direct your Lighting Committee to give the necessary directions.—Yours faithfully, M'NEILL AND WILLIAMS, solicitors, Larne." The letter was marked read.

Smithfield Club Show.—Messrs. Robey and Co., of Lincoln, make a prominent exhibit at Stand No. 1 at this show, which closes to-day, at the Agricultural Hall, Islington, N. One engine shown is a horizontal engine fitted with their automatic triple-expansion gear. This engine is of substantial construction, suitable for doing heavy work, and is at the same time provided with expansion gear for securing the greatest economy in fuel and perfect governing under varying loads. On an estate it can be set to do thrashing, sawing, and other work in the day time with the greatest economy, and at night can be employed for driving a dynamo for electrical illumination. A compound Robey engine and locomotive boiler combined, fitted with an automatic governor and link expansion gear, is also on view. This class of engine is suitable for driving electric light plant, mills, factories, and other machinery where perfectly steady running is required. In addition to the above, Messrs. Robey exhibit specimens of their medium and long stroke horizontal fixed engines, fitted with automatic governor and link expansion gear, portable engines, and wrought angle-iron framed thrashing and finishing machines, steel-framed stone-breakers, centrifugal pumps, and high-speed vertical engines. This type of vertical engine is specially suitable for driving dynamos and other high-speed machinery either by belt or by being coupled direct. All the wearing parts have very large surfaces, and as the crank runs in a bath of lubricating mixture it, together with all the bearings, is automatically lubricated, so that long runs can be secured without needing to stop the engine. Among other exhibits may be mentioned a horizontal fixed oil-engine, which has internal automatic ignition, and is able to develop the greatest power for the size of cylinder. The governors control the engines with great efficiency and regularity, and the engines work with great steadiness, and can be used for electric lighting.

Acton.—The Local Board received a letter from Mr. J. Clifton Robinson, the manager of the London United Tramways Company, asking the Board to receive himself and Mr. Winslow, the manager of the Leeds electric tramway, in support of the company's petition for the consent of the Board to their provisional order to authorise the reconstruction of the line between Shepherd's Bush and Acton and the introduction of the overhead trolley system of electric traction. Mr. Amherst said he thought the Board should defer the settlement of the question until after the election of district councillors. The Chairman, in reply to a question, said that the company proposed to carry the tramway as far as Acton-hill. Mr. Bradford observed that the Board had previously received a strong deputation of tradesmen and others in opposition to a proposal to carry the tramway through the town. Several members expressed opinions adverse to the settlement of the matter prior to the election, and Messrs. Robinson and Winslow, on being introduced into the Board-room, were informed that as that was the last meeting of the Board but one, the Board felt that the questions of overhead wires and a continuation of the tramway should be left for the District Council to decide when elected. Mr. Robinson said that if the Board had any fear of dangers arising from the overhead system of electric traction, Mr. Winslow, who had had great experience of that system, would be pleased to answer questions on the subject. The Chairman replied that as the Board would not decide the question discussion would be out of place, but if Mr. Winslow could attend before the District Council they would be very glad to see him, he was sure. The deputation then withdrew. The Chairman, referring to a remark made by Mr. Bridger Athawes in a letter published in a local paper, said that the Acton Board were invited to visit Havre to see the working of the electric tramway there, but they distinctly declined the invitation.

Keswick.—The clerk read to the Local Board, at a meeting last week, the minutes of a special meeting of the Board at which it was resolved to instruct Mr. I. Lowthian, solicitor, to report upon certain proposals of the Keswick Electric Lighting Company as contained in a letter read at the meeting. The Chairman mentioned that Mr. Lowthian had drawn up a report, which was as follows: "I have examined the Electric Lighting Acts, 1882 and 1888, and the Board of Trade rules with reference to a proposed application by the Keswick Electric Light Company to the Board of Trade for a license and provisional order under the above Acts The company have hitherto distributed their light principally by above-ground wires and on sufferance, and now wish to obtain a legal status, with right to lay mains under the streets and other privileges and duties, as set forth in the printed forms of license and provisional order, the latter being the more elaborate form. The method of proceeding would be by memorial to the Board of Trade, stating the description and capital of the company and other particulars, and requesting to be relieved from the obligation of supplying light during the whole 24 hours—*i.e.*, during daylight; and proceedings can be commenced to obtain the license at any time, and as to the provisional order, in July next, followed up by

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advertisements limiting the time for objections. The consent of the local authority to the application is a preliminary, and the most convenient method for putting the facts before the authority seems to be to submit to them the draft memorial when it is ready; and in the meantime enquiry could be made as to the needs of probable customers of the company who might otherwise be put to trouble and expense in opposing. A piecemeal or partial consent, to be followed by another consent, does not appear to be contemplated by the law. The consent must be given by a resolution passed at a meeting of the local authority held after previous notice of the same, and of the purpose thereof, has been given in the manner in which notices of the meetings of such local authority are usually given. Since writing the above Mr. Jos. Broatch, the company's solicitor, has handed me a draft notice of the intended application for a provisional order to submit to the authority, which draft, though not so full as the draft memorial and order would be, gives a further instalment of information. It appears that the company wish to proceed with certain works this winter, and if so, the authority would have to consider whether they would consent to that course without the license or order being first obtained, or security given by the company to obtain one of them without delay." Mr. Lowthian then read the terms of the provisional order. Mr. Hogarth asked if the Board were in order in entertaining the application. The Chairman said sufficient notice had been given as far as he was aware. Mr. Broatch (the clerk), who is solicitor to the electric light company, said the Board of Trade would insist upon proper notices being given even if they got the consent. They would have to give notice by July 1. They wanted the consent of the Board to enable them to get on with their work. After considerable discussion, the Local Board decided that the matter should stand over for the Urban Council to deal with.

Southport.—The following minutes of the Electricity Committee were read at a meeting of the Town Council on Tuesday: "November 20.—Resolved, that it be referred to the Works and Plant Sub-Committee to consider the desirability or otherwise of providing electricity for motive power and street-lighting, and the best means of increasing our present supply for private consumers, and that they be empowered to take such measures (including the taking of expert opinion) as they may deem necessary or advisable to enable them to present a complete report to this committee. December 4.—The engineer reported that the plant at Crowlands was capable of supplying current to 5,200 8-c p. lamps; that 3,198 lamps had been connected to the mains; that 2,146 lamps were at present unconnected; and that applications had been received for an additional 620 lamps. Resolved, that new applicants for current be informed that save under exceptional circumstances the committee cannot for the present connect their premises to the mains, and that a circular letter be issued stating that the committee propose to at once put down additional plant to meet the demand, and inviting intending consumers to make immediate application, and informing them that they will be connected in rotation according to the dates of their application. Resolved, that the town clerk be instructed to communicate with the Local Government Board with respect to the proposed extension of the works." Councillor Hesford, in moving the adoption of the minutes, said that they were perfecting and completing the system as rapidly as they could. They would see that the Board of Trade had consented to the further delaying of the statutory opening of the electricity works for three months from the 27th ult. That meant that on March 27 next they must be in a position, unless a further period of delay was granted, to place the current on the main for the whole 24 hours of the day. Up to the present time they had as good a report of the electric works as the Gas Committee had to lay before them. The number of lamps and the amount of current were increasing, and applicants were far in excess of the power of supplying the electric light. Their machinery was supposed to be capable of supplying about 4,200 lights. They had applications for 6,000. And in face of this the committee had decided that the new applicants for the current could not at present be supplied, except in certain exceptional cases, and these were the churches and chapels, which they wanted to take the light on the Sunday, so that they could have a Sunday load. At present they were connecting shops and places of business chiefly. They would see that they had Prof. Kennedy at their works, and so far as they knew they would not require broader or wider buildings for the purpose of extension. They must remember that the slightest disarrangement of their delicate machinery might place them in the position of asking some of their customers to be cut off. As to the finances, they stood, so far as their estimates were concerned, in strong contrast to the Improvement Committee. They had, however, powers for £28,000. Of this they had expended about £14,000—just about half—and so far as they could see they would not exceed the whole sum allowed. He believed there was some truth in the statement that the Corporation had not touched the fringe of prospective applications for the light. Councillor Todd seconded, and the motion was carried.

Worcester.—The Electricity Committee of the Town Council reported having elected Mr. G. H. Williamson as chairman for the ensuing year. They recommended the fixing of an electric arc lamp at each side of the Guildhall gates at a cost of £47. 10s. Mr. Williamson moved the adoption of the recommendation, and upon Mr. Rushton enquiring how many more extras they would get, Mr. Williamson replied that at every meeting of the Council they would bring up as many extras as they possibly could, consistent with the development of the scheme. The recommendation was adopted. The committee submitted a special report recommending the appointment of an electrical engineer, versed also in the management of machinery driven by steam and water power, to take entire charge of the installation at Powick and in the city, and to be directly responsible to the Council and the committee. They also recommended that the salary should be fixed at £250 per annum, and that the committee should be empowered to define the duties, advertise for applicants, and recommend three for the Council to select one of them. Mr. Williamson moved the adoption of the recommendation. He urged that they could all see the absolute need of having a competent electrical engineer, on whom they could thoroughly depend. Mr. Millington seconded, remarking that the subject of the electric light was of such importance as to demand the undivided attention of a competent person. In reply to Mr. Bozward, Mr. Williamson said the Council were under an agreement with the Brush Company to take over the works on January 11. Mr. Barnett stated that when Mr. Caink's salary was increased the Council were led to understand that he would take over the responsibility of the electric light works. This proposed appointment seemed to be sprung upon them. Mr. Williamson pointed out that Mr. Preece recommended the appointment of two officers—one at £200 and the other at £180 a year—so that the proposal of the committee was less costly. He believed that within two years the committee would be able to tell the Council that the business was thoroughly established and paying them well. Mr. Hughes supported Mr. Barnett's suggestion as to Mr. Caink's electrical knowledge being put forward as an argument for his appointment as city engineer, and said he did not think the Council should be hurried into the appointment of a fresh officer. The Sheriff said that the statement of the city engineer's duties included the control and responsibility for the due working of the electricity works. The committee had decided that a much better arrangement would be to have another engineer, and it would be open to any member to suggest a re-arrangement with regard to Mr. Caink's salary. Mr. Winwood enquired whether Mr. Preece's services would end when the Council took over the works? Mr. Williamson replied that he hoped so. It was impossible for the city engineer to carry out the whole of the work in addition to his ordinary duties, so as to make the £60,000 fruitful. Alderman Day urged that if they did not give the committee the authority they asked for, possibly in two months everything would be in utter chaos at the electricity works. The surveyor was responsible for the works in a way, but only as far as general supervision was concerned, and it was absolutely necessary he should have an efficient staff. In reply to Mr. Charge, the Mayor said the increases of capital outlay had not been made without due notice being given. Nothing would please him better, if they could see their way to making a decent return of interest, than to go in for another £10,000 or £15,000 increase of capital. If they could get a good return for their money, the more they put out the better it was for everybody. The resolution was passed.

Canterbury.—The town clerk read the following letter from the Brush Electric Lighting Company relating to the number of ordinary gas lamps which would be replaced by the arc lamps: "49, Queen Victoria-street, London, November 24, 1894—Dear Sir,—Electric Lighting of Streets—I have gone carefully into this question with Mr. Baker, your surveyor, and forward you by this post the Ordnance maps of the city of Canterbury, on which I have marked the position of the proposed arc lamps, and shown by an enclosing blue line the number of gas lamps which each arc lamp would replace. Unfortunately, owing to the narrowness and crookedness of your streets I find that the average number of gas lamps so replaced to be under three for each arc lamp, although in some parts of the city where the streets are straight and fairly wide one arc lamp sometimes replaces as many as five gas lamps, including one large Sugg or Bray lamp. The total number of arc lamps shown upon the plan is 47, which are distributed over the following streets: St. Dunstan's (commencing at London-road), Westgate-street, St Peter's-street, High-street, Parade, St. George's-street, St. George's place, Chantry-lane, part of Longport-street, Church-street, Monastery-street, Lady Wooton's Green, Lower Bridge-street, Broad-street, Church-street (No. 2), Palace-street, Guildhall-street, Sun-street, Mercery-lane, and Burgate-street, which between them take up 36 arc lamps, replacing in all 99 gas lamps. In the district on the other side of High-street, I have marked the position of 11 arc lamps along St. Margaret's-street, Castle-street, Rhodaus Town, Upper Bridge-street, and Dane John. These 11 arc lamps replace 30 gas lamps. By reference to the map it will also be seen that a few more arc lamps in the space between Dane John and Castle-street, and six or at most seven lamps in the space between Burgate-street and St. George's-street, practically replaces the whole of the gas lamps within these areas, and if desired I will mark the best position of these arc lamps upon the maps if they are returned to me for that purpose, although for the present my instructions from Mr. Baker are that only the lighting of the streets enumerated above is to be estimated. The price we would propose charging for arc lamp burning all night long every night in the year is £30 each, or if the lights be extinguished at midnight we would make the price £25 each per annum, provided a 14 years' contract is entered into between the Corporation and the company. The minimum number of lights which we would be prepared to supply and maintain would be 33, placed as shown in the positions marked on the map, or at such adjacent points as may be selected by the Council. Taking the total number of gas lamps therefore which would thus be replaced as 129, their average illuminating power as being about 12 candles, and the price to the Corporation for each gas lamp as being £3. 13s. 6d. per lamp from sunset to sunrise the whole year round, the cost of gas

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lighting thus replaced would be £474. 1s. 6d. plus the additional cost of the large Sugg or Bray burners, say £30, making the total probably about £500, while the cost of current for the 47 arc lamps replacing them would be £1,410—or about 26 times the volume of light for less than three times the outlay for gas lighting. Were a larger area taken, the expense of arc lighting would appear more favourable in comparison, as in other parts of the city the average number of gas lamps which could be replaced by each arc lamp would be greater. I trust the information which I now place before you will enable your Council to favourably consider the question of entering into a contract with the Canterbury Electricity Supply Company, and thus secure the introduction of electric lighting into your city. I append a list giving the number of each arc lamp as marked upon the plan, and the gas-burners which each would replace.—Yours truly (for the Canterbury Electricity Supply Company, Limited), A. J. LAWSON." The Town Council have resolved to consider the letter six months hence, the mover of this resolution giving as a reason that the electric light would be cheaper by-and-by.

PROVISIONAL PATENTS, 1894.

DECEMBER 3.

23398. **Improvements connected with electric batteries.** Robert McLauchlan McDonald and Alexander McDonald, 70, Wellington-street, Glasgow.

23441. **Improvements in and connected with galvanic batteries.** John Crisp Fuller and George Fuller, 33, Chancery-lane, London. (Complete specification.)

23440. **Improvements in or relating to targets and electrical indicators therefor.** Alfred Mantel-Rieter and Emanuel Meyer, 323. High Holborn, London. (Complete specification.)

23472. **Improvements in telephony and apparatus connected therewith.** Charles Adams-Randall, 1, The Avenue, Bedford-park, London.

DECEMBER 4.

23480. **A combined mat and electric alarum contact.** James John Pye, 27, Martin's-lane, Cannon-street, London.

23486. **Improvements in or relating to secondary batteries or accumulators.** Francis Louis Berners and Frederick Griffin, 69, Fore-street, London.

23294. **Electric alternate-current quasi-polarised relays, indicators, and cut-outs.** Silvanus Phillips Thompson, Morland, Chislett-road, West Hampstead, London.

23505. **Improvements in electric light fittings.** James McFarlane, 154, St. Vincent-street, Glasgow.

23510. **Burglar-proof electric fastener and combination lock.** Alexander Dalziel, 41, Stanhope-street, Glasgow.

23525. **Improvements in or applicable to electric switches.** Charles Phillipp Ehmann, 70, Deansgate, Manchester.

23529. **Improvements in connections for electric lighting and power.** George Lyon and Henry Bevis, 73, St. Stephen's-road, Upton Park, London.

23553. **Improvements in apparatus for the electrical treatment of beer or other liquid or material.** Louis Wagner and John Marr, 115, Cannon-street, London. (Complete specification.)

23565. **Improvements in apparatus for transmitting and controlling work for an electrometer.** Arthur Bergtheil and Robert Alfred Marples, 1, Queen Victoria-street, London.

DECEMBER 5.

23661. **Improvements relating to electric telegraph automatic transmitting and receiving instruments.** Joseph William Wilmot, 24, Southampton-buildings, Chancery-lane, London.

23668. **Improvements in electric impedance or choking coils.** William James Davy, 40, Chancery-lane, London.

23669. **Improvements in or connected with the electro-deposition of zinc upon iron.** The Cowper-Coles Galvanising Syndicate, Limited, and Sherard Osborn Cowper-Coles, 47, Lincoln's-inn-fields, London.

23679. **Process for the manufacture of metallic articles by electro-deposition.** La Société des Cuivres de France, 53, Chancery-lane, London. (Date applied for under Patents, etc., Act 1883, Sec. 103, May 22, 1894, being date of application in France.)

23680. **A process of an apparatus for making compressed electrolytic copper, applicable also to other metals capable of being deposited by electrolysis.** Alexander Melville Clark, 53, Chancery-lane, London. (La Société des Cuivres de France, France.)

23685. **An improvement in brackets for telegraph poles.** Siemens Bros. and Co., Limited, and George William Perry, 28, Southampton-buildings, Chancery-lane, London.

23688. **An improved charging material for galvanic elements.** Gustav Platner, 37, Chancery-lane, London. (Complete specification.)

DECEMBER 6.

23697. **Improvements in the construction of electrodes.** Arnold Beaumont Woakes, 78, Harley-street, London.

23745. **Improvements in electricity meters.** Georg August Julius Telge, 31, Southampton-buildings, Chancery-lane, London. (Complete specification.)

23748. **Improvements in or connected with dynamo-electric machinery.** Francis Murray Newton and Tom Hawkins, Norfolk House, Norfolk-street, London.

DECEMBER 7.

23825. **Improvements in electric arc lamps.** James Brockie, 33, Chancery-lane, London.

23854. **Improvements in systems of electrical distribution.** Reginald Wood, 28, Southampton buildings, Chancery-lane, London.

23858. **Improvements in the construction of instruments for measuring electric currents.** Francis Henry Nalder, Charles William Scott Crawley, and Alfred Soames, 24, Southampton-buildings, Chancery-lane, London.

DECEMBER 8.

23866. **Automatic electrical fog signal.** Tom Thompson, 3, Chester-terrace, Lady Pit-lane, Leeds.

23936. **Improvements in electrical fire and burglar alarms.** John Ronald Shearer, 28, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1893.

21958. **Electric lighting apparatus for bicycles, etc.** Lake. (Mayr.)

1894.

690. **Electric railway signalling apparatus.** Hampson.

916. **Electrical measuring instruments.** Harrison.

923. **Electric fuses.** Deakin.

1115. **Electrical circuits.** Essinger and Harden.

2800. **Incandescent electric lamp fittings.** Soleau.

3080. **Fixing electric call bells.** Theerman and others.

12972. **Electric arc lamps.** Doubrava and Donat.

17313. **Electric motors.** Losch and others.

19191. **Galvanic batteries.** F. and N. von Alimonda.

19517. **Indicating the lamp hours of electric lamps.** Wende.

19742. **Electrical switches.** Theermann.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5½-6
Bournemouth Electric Company	—	—
Brush Company, Ordinary	3	2⅞-2⅞
—— Nom. Cum., 6 per cent. Pref.	2	2⅛-2¼
—— 4½ Debenture Stock	100	111-114
Charing Cross and Strand	5	4¼-5¼
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	13¾-14½
—— 6 per cent. Cumulative Pref.	10	14⅜-15½
—— 5 per cent. Debenture Stock	115	132-135
City and South London Railway, Consolidated Ordinary	100	41-43
—— 4 per cent. Debenture Stock	100	124-126
—— 5 per cent. Pref. Shares	10	13¾-14½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2⅞-3⅛
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	96-101
Electric Construction, Limited	2	½-½
—— 6 per cent. Debentures	—	93-97
—— 7 per cent. Cumulative Pref.	2	1½-2
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1½-1⅝
Elmore's French Company	2	½-½
Elmore's Wire Company	2	½-1⅛
Fowler-Waring Cables	5	½-1½
W. T. Henley's Telegraph Works, Ordinary	10	8½-9½
House-to-House Company, Ordinary	5	2½-2⅝
—— 7 per cent. Preference	5	6½-6⅝
India Rubber and Gutta Percha Works	10	25½-26½
—— 4½ per cent. Debentures	100	102-104
International Okonite, Ordinary	—	—
Kensington and Knightsbridge	5	4½-4⅝
—— 6 per cent. Pref.	—	6½-6⅝
Liverpool Electric Supply, Ordinary	5	7⅛-7⅜
—— Pref.	—	—
Liverpool Overhead Railway	10	8½-8⅝
—— Pref.	10	12-13½
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric	5	½-1⅛
Metropolitan Electric Supply	10	9¾-10½
—— 5 per cent. Reg. Debentures, 1-10,000 in Bonds of £10, £20, and £40	—	—
National Telephone, Ordinary	5	5½-5⅝
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-16
—— 5 per cent. Nom. Cum. Third Pref.	5	5½-6
—— 4½ per cent. Deb. Stock	—	110-113
Notting Hill Company	10	7-7½
Oriental and Electric Company, £1 shares	1	1-1⅛
—— £5 Shares	—	7-7½
—— £4½ shares	—	5½-6½
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7⅜-8½
—— 7 per cent. Pref.	5	8½-9
Swan United	—	—
Telegraph Construction and Maintenance	12	41-43
—— 5 per cent. Bonds	100	106-109
Westminster Electric Supply, Ordinary	5	7⅛-7⅜
Yorkshire House-to-House	4½	4⅛-4½

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NOTES.

Electric Lighting in Switzerland.—A project is on foot for the erection of a central electric light station in Schwanden.

Electric Light Legislation in India.—An Electric Lighting Bill is being drafted, and will be introduced early in the Calcutta season.

Electric Light in Siam.—It is expected that the principal thoroughfares of Bangkok will be lighted with electricity almost immediately.

Electric Traction in Italy.—Mr. Cattori, an Italian engineer, proposes to construct, in conjunction with Messrs. Armstrong, an electric tramway in Rome.

Telephony in Ceylon.—Experiments have been made in telephoning along the telegraph wires between Trincomalee and Colombo, and have proved successful.

Bordeaux Exhibition.—The council of the London Chamber of Commerce have nominated an influential committee to consider the subject of British representation at this exhibition.

Gohna-Hurdwar Telegraph Line.—Orders have not yet been issued for dismantling this line, which will remain until the local government consider that the necessity for it no longer exists.

Berliner Telephone Patent Declared Void.—The United States Circuit Court in Boston gave its decision on Monday in the suit against the Bell Telephone Company. It declared the Berliner patent, valued at £500,000, void.

"Electric Power."—Our American contemporary will change its form on the 1st prox. It has hitherto been published monthly in the usual style of American technical papers, but it will henceforward be of the character and shape of a monthly magazine.

A New Kind of Tax.—Baron Sonnino, the Italian Minister of the Treasury, has made his financial statement in the Chamber of Deputies. He announced that there would be a small tax on the consumption of gas and the electric light by private persons.

Advantages of the Electric Light.—A pamphlet bearing the title of "The Electric Light Supplied from Municipal Works" has been prepared by Mr. R. Hammond, M.I.E.E. It deals with the advantages of the use of this illuminant and the conditions and cost of supply.

"L'Electricien."—Our French contemporary announces that on January 1 its editorial and publishing offices will be removed from 3, Rue Racine, to 18, Rue des Fossés-Saint-Jacques, Paris. All business communications are in future to be sent to M. Louis de Soye, at the latter address.

Ceylon-India Telegraph Cable.—A new cable is to be laid directly between Ceylon and India. The Ceylon Government, it is believed, is bearing half of the cost. The old cable is worn out and subject to breakdowns, and the service can only be preserved under a host of difficulties.

Telegraphy in Africa.—A Reuter's cablegram from Cape Town says that, according to advices received there from the Chinde River, the Portuguese persistently obstruct the permanent extension of the trans-continental telegraph across Portuguese territory in the direction of Tete. The work is consequently at a standstill.

Telephony in Russia.—Sebastopol and Simferopol have just been connected by telephone, which has been attached to the telegraph poles on the railway. It is expected that the Kieff military district will be connected with the naval dockyard at Sebastopol by the beginning of next spring, as the work is now being rapidly carried on.

Lectures.—Prof. Fleming has delivered a Gilchrist lecture at the Corn Exchange, Bedford, on "Magnets and Electric Currents." The lecture has followed very appropriately close upon the opening of the central electric light station there.—A lecture was delivered on Saturday evening at Toynbee Hall by Sir F. Pollock on "Tyndall as a Worker and Teacher."

Royal Society.—It is announced that a paper by Lord Rayleigh and Prof. Ramsay on a newly-discovered gas will be taken as the subject for discussion at a meeting on January 31, which will be the first meeting under a resolution of the council passed last session, whereby certain meetings—not more than four in each session—are devoted each to the hearing and consideration of some one important communication.

Prize Competition.—The Société Industrielle d'Amiens offers for the year 1894-95 gold medals for the following: a mechanical or chemical generation of electric current fulfilling the most efficient and economical conditions; a feed-water heater, to be cheap, simple, compact, and requiring little attention; and the best electric light installation which has been in operation for at least a year in an industrial works, which must be more economical than gas.

Personal.—The Government of India has recommended that Mr. Brooke, Director-General of Telegraphs, be granted an extension of his term of office, but the matter is one which has to be decided by the Secretary of State.—It is reported that Prof. G. Forbes, F.R.S., who has been engaged for the last three years on the carrying out of the scheme for the utilisation of Niagara Falls, left New York on Saturday for England by the "Campania," the construction stage of the work being now finished.

Presentation.—The employés of the Brighton and Hove Electric Light Company had a smoking concert on Monday night, this being the last concert held under the auspices of the old company, which has now closed its works, having transferred the whole business to the Corporation. Mr. George Spencer Hawes, the secretary and general manager of the company, presided, and was presented with an illuminated address, together with a handsome marble clock and side ornaments, by the employés of the company and friends.

Electric Traction in France.—Mr. Albert Sénéchal is forming a limited company for the construction and working of an electric tramway from Nice to Cimiez, for which he has received a concession. The work will be carried out by Messrs. Georges Averley and Jules Weitz, of Lyons. The line will be over three miles in length, and will be similar to that which was built in connection with the Lyons Exhibition.—The local authorities of Gérardmer, Vosges, have under consideration a scheme for an electric tramway between Gérardmer and Retournemer.

Electric Lighting in Spain.—German electricians are busy in Spain. At Baracolda, near Bilbao, Messrs. Schuckert and Co., of Nuremberg, have erected an alternating-current station using 600 h.p., which supplies current to Portugalete, Sestao, Luchana, El Desierto, Lorroza, etc.—The Allgemeine Elektricitäts-Gesellschaft, of Berlin, have come to an arrangement with capitalists in Seville to introduce the electric light into the town. The station will be in three sections, and capable of supplying current to 10,000 16-c.p. lamps, with 5,000 lamps in reserve.—Smaller stations are also being erected in Spain by Messrs. Siemens and Halske and the Oerlikon Works.

Lighting of the Stock Exchange.—The *Pall Mall Gazette* on Saturday sympathised with the Stock Exchange

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on the unsatisfactory nature of the electric lighting arrangements. The arc lights at present in use are, it is said, both insufficient in number and deficient in reliability. A strong white light alternating with intense black shadows is not conducive to raising the spirits of the bulls, however much it may suit the more melancholic temperament of the bears. But, after all, there seems to be something appropriate in this weird kind of illumination. It illustrates, the *Financial Times* remarks, the startling "lights and shadows," to quote the first-mentioned paper again, of speculative life.

Electric Lighting in Calcutta.—The contract for lighting the Columbia Skating Rink was secured by the India Rubber, Gutta Percha, and Telegraph Works Company. The plant consists of a Silvertown compound-wound dynamo having an output of 104 volts and 120 amperes at 700 revolutions per minute, and is driven by one of Messrs. Marshall, Sons, and Co.'s 10-h.p. double-cylinder portable engines. Round the skating surface there are eight lamps of 300 c.p., and two in the centre of the building of 600 c.p. The offices, skate-rooms, refreshment bars, and retiring-rooms are lighted by 16-c.p. lamps, of which 42 were required. At the main entrance there is an ornamental iron pillar supporting a 600-c.p. lamp. The whole of the work was carried out under the superindence of Mr. Walter A. Purdom, A.M.I.E.E.

Postal Telegraph Service.—A deputation of Liverpool postal telegraphists has waited upon Mr. J. H. Stock, M.P., with the object of gaining his assistance in procuring an independent parliamentary enquiry into the Post Office. Mr. T. May Smith introduced the deputation, and it was explained that an independent enquiry was now sought, because official investigations had been fruitless. The improvements demanded were in the direction of better pay after attaining efficiency as operators, abolition of classification, increase of maximum salary, and alterations in the pension system. Details were given showing that the wages paid in the telegraph branch were below those paid in private enterprises and on the Continent. It was argued against classification that it existed only in regard to salary, but that classification of work was impossible.

Engineering Laboratory for Glasgow.—A meeting of gentlemen interested in the proposal to establish an engineering laboratory for Glasgow University was held in the City Chambers, Glasgow, on Tuesday, for the purpose of taking steps for raising the £12,500 necessary to fulfil the condition of the offer of from £10,000 to £12,500 by the Bellahouston Trust. Prof. Barr explained the scheme, and in suggesting the appointment of a committee he said he had in view not only the raising of funds, but the bringing of the applied science department of the university into closer touch with the engineering practice of the district. After discussion, an influential committee was appointed, with Sir William Arrol as chairman, Mr. Robert Gourlay as treasurer, and Mr. Alan E. Clapperton as secretary. Subscriptions to the amount of £3,750 were announced.

Electric Traction in Switzerland.—It is proposed to construct an electric tramway from Interlaken railway station to Gsteig-Wilderswyl. Power will be taken from the central electricity works at Interlaken.—A scheme is also on foot for an electric tramway from Schwyz to Brunnen, Axenstein, and Schwyz to Seewen.—It is proposed to establish an electric tramway between Zofingen and Aarburg, current being obtained from the central station at Ruppoldingen.—A Reuter's message, dated 19th inst., from Berne says that the Swiss Council of State, by a large majority, have granted a concession for the construction of a mountain railway up the Jungfrau, starting from near Lauterbrunnen, and ascending by way of the Little Scheidegg, over the Eiger and the Moench. The assent of the National Council to the concession is assured, and it is stated that the capital for the new undertaking has already been found, chiefly in England and America.

Laying of New Mains.—The London County Council have received intimation from the Vestry of St. Pancras of a proposed extension of the Cobden sub-station in High-street, Camden Town, and of the proposal of the Vestry to lay mains in Kentish Town-road, Fortess-road, Highgate-road, Euston-road, Drummond-street, Melton-street, Gray's-inn-road, Pentonville-road, Endsleigh-gardens, Gordon-square, Tavistock square, street, and place, Compton-street, Regent-square, Sidmouth-street, Chalk Farm-road, Harmood-street, Clarence-road, Camden-road, Great College-street, Pratt-street, and King's-road. Notice has also been given by the Notting Hill Electric Lighting Company of intention to lay mains along a very short portion of Pembridge-villas; by the Metropolitan Electric Supply Company of intention to lay a low-tension main across Sardinia-street and along that thoroughfare, Kemble-street, and Russell-street to the Drury-lane Theatre; and by the London Electric Supply Corporation to lay distributing mains in Marshalsea-road.

Central-Station Lighting.—The fortnightly meeting of the Liverpool University College Engineering Society was held last week in the lecture theatre of the Walker Engineering Laboratories, the president, Prof. H. S. Hele-Shaw, occupying the chair. There were also present: Messrs. T. Dunkerley, M.Sc., F. G. Baily, M.A., A.I.E.E., T. Farmer, B.Sc., J. G. Armour, M.I.M.E., J. W. Anderson, M.I.M.E., and W. Donaldson. Mr. B. H. Collins, A.I.E.E., secretary of the Liverpool Electric Supply Company, read a paper entitled "Central-Station Lighting in Liverpool," with special reference to the Oldham-place station. The paper included descriptions of the boilers, engines and dynamos, switchboard and connections, accumulators, transformers, and mains, and was illustrated by diagrams and lantern views. One of the most striking features of the paper was the portion that dealt with the development of electric lighting in Liverpool, which showed that in 1883, when the company started, they only supplied 120 lamps. They now provide over 30,000.

Coherer Phenomena.—The attention of Dr. Oliver J. Lodge having been directed to some observations of Prof. Elihu Thomson and of Dr. Wm. J. Morton, published in the New York *Electrical Engineer*, he has written to that journal as follows: "Their explanation of the observed facts appears to me well founded. It is quite true that a loose carbon contact will act as a coherer, though in my experience only as a delicate and troublesome one. Carbon, like platinum and gold, makes far too good a contact usually without any electrical stimulus, so that a more oxidisable metal does better. I have not found anything stand better in the long run than iron. Brass in air, though at first extremely sensitive, deteriorates with age, becoming too much oxidised apparently, and so making too bad a contact, whereas brass in hydrogen, at first incredibly sensitive, gets too clean ultimately, and declines to make anything but a perfect contact. But iron seems to perennially keep not oversensitive, but very dependable and easy to work with."

Snowdon Railway.—The first sod in connection with this railway was turned at Llanberis on Saturday. The construction of the line has been taken in hand by a limited company, the chairman being Lord Alexander Paget. Sir Douglas Fox is the engineer, and the contractors are Messrs. Holme and King, of Liverpool and London.

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Before deciding upon the character of the line, the engineer and the directors studied the latest enterprises of Swiss engineering. The gauge will be 2ft. 7½in., the curves never being sharper than four chains (264ft.) radius, and the gradients never steeper than 1 in 5½. In Switzerland the gradients often approach 1 in 2, and curves are sometimes as sharp as 100ft. radius, curves of 150ft. radius being common. The "Abt" system will be adopted in the main. Steam will be the motive power at first, but if a steady supply of water power can be obtained, it is said that electricity will be eventually adopted. The stations will be four in number—two terminal and two intermediate. The line will be about five miles in length, and will be completed by July 1 next.

The Scott Electric Flashing Lamp.—After a trial extending over two years, the Scott electric flashing lamp, says the *Western Morning News*, has been pronounced by the Admiralty as unsuitable for the naval service. This lamp, an invention of Colonel Scott, was introduced into the navy with a view to testing its efficiency as a masthead signalling lamp. It was supplied to the battle-ships "Ramilles," "Royal Sovereign," "Rodney," "Sans Pariel," and "Trafalgar," the cruisers "Æolus" and "Spartan," and the signal schools at the home ports. It was desired that the lamp should give distinct intermittent flashes by means of metallic jalousies. It has been found, however, that the delicate mechanism necessary to work the jalousies, although giving the desired results during a short trial, becomes disabled when the light has been burning any length of time on account of the expansion due to heat. The reports sent to Whitehall from the ships mentioned differ only in detail, and after careful consideration, the Admiralty have directed that the Scott lamps now in use are to be returned to the makers, and they will be replaced by the multiple fibre electric flashing lamp.

Light Railways Committee.—Further meetings of this committee have been held at the Board of Trade under the chairmanship of Sir B. Samuelson. A circular letter has been issued by the secretary of the Royal Agricultural Society of England to the members of that society referring to this conference. It being desirable that the agricultural aspects of the question should be fully considered, the council desire to receive any suggestions which the members may have to offer on the agricultural light railway requirements of any particular district in which they are interested, and a schedule of questions is given to which answers are desired. These questions are as follows: "(1) please state county or counties to which the subjoined observations apply; (2) district to be agriculturally developed, naming terminal towns, places, or stations; (3) description of light railway considered most suitable; (4) the main line of railway, if any, with which a suggested light railway should have connections; (5) how funds for construction and equipment might possibly be provided—by local subscription, by rates, or advances on the security of rates, or by a combination of these sources or otherwise; (6) any other observations likely to prove useful for the purposes of the enquiry."

The Lighting of Mines.—Mr. Charles Latham has delivered a lecture at the University College, Nottingham, on "The Lighting of Mines." In speaking of electric lighting, he said he was quite at a loss to understand the reason why the electric lamp in a portable form had not come into more general use than it had up to the present time. The want of a good lamp could not be the cause, as there were several good ones on the market. It had, he knew, been urged as an argument against the use of such lamps that, owing to the fundamental principles on which they were founded, the light burnt independently of the surrounding atmosphere, and so gave no indication of its nature and character. This, to his mind, was a very strong argument in days gone by, but was it so to-day, when they remembered the inventions of Mr. A. H. Stokes and Dr. Clowes, whereby flames of alcohol in one case and hydrogen gas in the other had been successfully applied for the purpose of accurately testing the nature of the air in the mines? The use of hydrogen gas as a testing flame in his opinion marked the commencement of a new era in connection with colliery lighting, and he saw no reason why the miner of to-day should not obtain the advantage of the good light offered to him by electricity.

Testing Incandescent Lamps.—Continuing his series of articles in *L'Electricien*, M. A. Bainville raises the question as to how an incandescent lamp should be tested. The author seems to think that lamps should be tested on the spot—that is, in the installation where they are to be used—and that this is the only method which is likely to give absolutely certain results. Of course, much time is required for this, and if it is desired to ascertain the luminous power of the lamps special appliances are necessary. These reasons have caused those testing methods to prevail which mostly do not fulfil the conditions of practice, but which allow of a comparison between different makes. The author attaches much value to laboratory tests, which, serving to define the relative value of the lamps, should be made according to a uniform plan. M. Bainville states that the essential qualities that an incandescent lamp should possess are (1) constant lighting power, (2) maximum duration, and (3) minimum cost. Unfortunately, the first of these qualities does not exist in any artificial source of illumination. The second quality may be defined as the initial luminous power maintained for a maximum time, whilst the third corresponds to the production during the defined duration of the maximum candle hours for a determined expenditure of electrical energy.

Technical Education in London.—The Lord Chancellor, on Monday, distributed the certificates to the winners of scholarships and exhibitions awarded by the Technical Education Board of the London County Council. Sir John Hutton, chairman of the London County Council, presided, and among those present were the chairman of the Technical Education Board, the chairman of the Scholarships Sub-Committee (the Hon. E. Lyulph Stanley), Sir Henry Longley, Sir F. Abel, Sir Owen Roberts, and Sir P. Magnus. Sir John Hutton, in opening the proceedings, referred to the great services rendered to the cause of technical educational in London by Mr. Sidney Webb, and to the admirable work done by the zealous secretary of the Board, Dr. Garnett. Out of 61 candidates for senior scholarships five were successful, and out of 348 candidates for intermediate scholarships 50 were successful. The advance made recently in the direction of technical education was proved by the numbers of those who competed. The Lord Chancellor, after delivering the certificates, addressed the students and urged them not to rest content with the successes they had already attained. The scheme which the London County Council had framed was, in his opinion, calculated to be of immense service to the community, and to produce for the commercial life of this country results out of all comparison with the value of the money spent upon it.

Manchester Electric Light Works.—A meeting has been held of the Manchester Association of Students of the Institute of Civil Engineers, when Mr. C. H. Wordingham, A.M.I.C.E., read a paper describing the Manchester electric lighting works. Mr. A. Ross, M.I.C.E., president of the association, occupied the chair. The author first referred to the interest excited among

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engineers by the Manchester electric supply on account of its magnitude and importance, and more especially because the five-wire system decided upon by the engineer, Dr. John Hopkinson, F.R.S., M.I.C.E., was entirely new in this country, and had not been largely used either in Europe or America. He stated that after rather more than a year's working, Dr. Hopkinson's boldness has been fully justified, and it was interesting to note that the St. Pancras Vestry are on the point of converting their three-wire into a five-wire system. He described in detail the arrangement of the five-wire system and the method of working the same, comparing the method and arrangement of the two and three wire systems. He next explained the system of mains and the method of running the conductors, and the switching arrangements, passing on to a description of the dynamos, engines, boilers, and coaling arrangements. The author stated that up to date 55,700 incandescent lamps reckoned in the equivalent of 8 c.p. each, 311 arc lamps, and 11 motors have been connected to the mains, and that the number of applications at present is very large. Considerable extensions are contemplated for next winter, and there is every indication that this will be the largest municipal station in the kingdom.

Electric Motors on Men-of-War.—Some months ago the *Times* gave a description of two high angle fire gun mountings and turrets of her Majesty's ship "Centurion," and in March the trial on board the "Barfleur" of similar mountings, with the addition of electromotors as an auxiliary power to the hand gear, was reported. It was then stated that the pattern was new as regards our navy, the "Centurion" being the first ship fitted with high angle fire. The battle-ship was commissioned in February for the China station as the flagship of Admiral Sir E. R. Fremantle. During her commission the system has been further tested in the course of the ordinary quarterly practices with the regular crew, and a report received by the Admiralty states that the results both as to working and shooting have proved very satisfactory, and also in comparison with hydraulically - worked mountings. Sir Joseph Whitworth and Co., the constructors of the mountings, have similar sets in hand for the "Renown," building at Pembroke, which will thus be the third ship fitted with this particular type of mounting for 10in. breechloaders. The system, the *Times* concludes, has found great favour because of its independence of steam and hydraulic power and ready manipulation by simple hand gear. The four 12in. breechloaders on the "Magnificent," which was launched on Wednesday at Chatham, can be worked by electric or hydraulic power. The guns weigh between 46 and 50 tons. It may be mentioned that some such system has been adopted in the United States navy, according to the designs of Mr. Ward Leonard, a well-known electrical engineer who visited this country a few weeks ago.

South Staffordshire Tramways.—"Great regret and surprise is being expressed to-day," says a local paper of Saturday's date, "at the course of events in connection with the South Staffordshire Electric Tramways. Quite suddenly the cars have stopped running to-day, greatly to the inconvenience of the thousands of passengers who have been accustomed to use the lines, and at present it is a matter of speculation whether the service will be renewed. The hope on all hands is that some arrangement will be come to speedily by which the cars will be permitted to run. The lines extend over eight miles—from Bloxwich to Wednesbury, through Walsall, and from Darlaston to Walsall. The conditions which led to the change from steam to the electric power will be remembered by the public, as well as the hearty reception which was given to the electric cars when they took the place of the cars propelled by steam. The new departure was a most important one, and formed quite an historic event. It met with the approval of the public, and since the adoption of this system of overhead electric traction the traffic has increased enormously. The regularity, punctuality with which the cars have run, together with the increased comfort to the passengers, testified to the great superiority of this form of motive power over that of steam. No such result as that which occurred to-day was expected by the public. The cause of it is set forth in a notice which has been caused to be published, and which reads: 'The public is informed with regret that in consequence of the failure of the tramway company to pay the contractors the agreed price of running the electric cars, although it collects the fares, the contractors have given notice to put an end to their contract on Friday, the 14th current.' The contractors referred to are the Electric Construction Company, who gave notice of their intention on Tuesday last to the directors of the South Staffordshire Tramways Company. As the payment had not been made, the contractors have taken possession of their plant." The position of affairs is further referred to in our legal columns.

Electric Traction in Germany.—A general meeting has been held of the Grosse Berliner Pferdeeisenbahn-Aktien-Gesellschaft, at which it was stated that the question of introducing electric traction on the lines of the company in Berlin had not yet been determined.—It is proposed to make an electric tramway line in the Saar district to connect Brebach, Burbach, Völkingen, St. Johann, and Saarbrück.—Work is to be commenced next spring by the Union Elektricitäts-Gesellschaft in connection with the Elbing electric tramway.—The electric tramway between Bochum and Herne has now been put into operation. This is a line the want of which has been felt for 10 years past. The work was carried out by Messrs. Siemens and Halske, who have employed the overhead trolley system. The line is a trifle over four miles in length, and was completed in 4½ months. The generating station is in Bochum, the engine being of 75 h.p. An extension of the line through Bochum to the Bergisch-Märkisch railway station is already projected.—The local authorities have approved of the adoption of electric traction on the whole of the system of the Nuremburg-Fürth tramways.—At Dresden both the horse tramway companies have received authority to use electric traction on their lines. Current will be taken from the central electricity station. On the lines in the centre of the town an underground system has to be adopted, but outside this special area overhead conductors can be used.—On account of the increased demand for current from the Aix-la-Chapelle central electricity station, owing to the establishment of the electric tramway, the works will be extended at a cost of £16,600.—The local authorities at Regensburg have received two schemes for the construction of a line of tramway.—A proposal has been brought forward for the conversion of the Plagwitz-Leipsic horse tramways into an electric line.—Experiments are being made by Messrs. Siemens and Halske with accumulator cars on the lines of the Gross-Lichterfeldt tramway, Berlin.—Messrs. Schuckert and Co. propose to construct an electric tramway from Wiesbaden to Sonnenburg.—A project is on foot for the construction of an electric tramway between Frankfort-on-the-Maine and Homburg.

Brilliant Electrical Illumination.—Those who took the opportunity a year ago of visiting Electric avenue, close to the Brixton station of the London, Chatham, and Dover Railway, will well remember the beautiful effects produced by the special illuminations during Christmas

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week. At any time the lighting of the avenue is far superior to that found in any other streets, and on the occasion to which we refer the effects were magnificent. We are glad to learn that this year a similar attraction will be provided. Commencing on Tuesday evening this week, the display will be continued to and including the 24th inst. The lighting of the street will be produced entirely by Fyfe-Main arc and Edison-Swan incandescent lamps, which combined will exceed 100,000 c.p. The colonnade of the avenue will be decorated with trees, and the pillars supporting the new covered way will be entwined with foliage; festoons of incandescent lamps, representing water lilies, will be artistically looped across the roadway. In addition, there will be a number of trees fronting Brixton-road, illuminated with lamps enclosed in flowers of the same kind, only different in colour. Some colours quite different to those hitherto seen in public illuminations will be used, and the combination of these with the colours ordinarily employed for lighting effects will produce the most striking and artistic electrical illumination yet seen in any thoroughfare, either public or private. The avenue will form one vast stage, where at stated times in the evening the most beautiful prismatic effects will be created by the constant changing of the coloured lights, thereby producing results both startling and beautiful, and giving the public additional proof of the unique possibilities of electricity. The result will, it is expected, be the most charming outdoor illumination ever seen, and will form at some future time a good example of how to decorate and illuminate London on the commemoration of any national event. The decorations and electrical effects were originated and planned by Mr. A. L. Fyfe, of Brixton, and were carried out under his personal supervision. It is expected that the average number of visitors to the avenue will greatly exceed that of last year, which was more than 100,000 in one day.

Electric Lighting in Germany.—Next year at the Royal Theatre, Hanover, the electric light will be installed in place of gas.—The Plauen authorities have approved of an agreement with Mr. L. Uhmann for the erection of a central electric light station for the town.—Work has been commenced on the Olten-Aarburg central station.—A central electricity station has been built at the Munich central railway station. Current is supplied for lighting stations and railway workshops. The electrical plant has been supplied by Messrs. Siemens and Halske, and the mechanical plant by Mr. J. A. Maffei, of Munich. In connection with the Munich municipal station, the tender of Messrs. Felten and Guilleaume, of Mülheim, has been accepted for the electric light cables at the price of £15,000. The conductors for the electric tramway will be supplied by Messrs. Obermeier, of Nuremberg, for the sum of £2,000.—A central electric light station has been erected at Horb, Würtemberg, and is giving much satisfaction. The work has been carried out by Messrs. Wilhelm Reisser and Co., of Stuttgart.—Steps are being taken to provide a central station for Bingerbrück. All the leading manufacturing firms have signed a guarantee, and negotiations are in progress with a Frankfort firm for the supply of the plant.—The electric light has been installed in the Stadt Theatre, Regensburg. The electrical plant has been supplied by Messrs. Schuckert and Co., and the Lutzky gas-engine by Messrs. Klett and Co., of Nuremberg.—The local authorities at Grünhainichen propose to erect a municipal electric light station, and to borrow £3,500 for the purpose. Some interest is being shown at Oppenheim with respect to the establishing of a central electricity station for lighting and power purposes, and Mr. Kunz, of Messrs. Schuckert and Co., has visited the town and given a lecture on the subject.—It is intended to extend the central electric light station at Breslau, the whole of the output of which is now utilised.—The Munich Municipality have voted £100,000 for an extension of the electric lighting of the streets. The existing installation comprises 210 10-ampere arc lamps and 66 five-ampere arc lamps. The water power of the Isar is to be utilised. It is intended to add 456 10-ampere lamps and 48 five-ampere lamps. The work will be carried out by Messrs. Schuckert and Co., of Nuremberg.—The Esslingen Machinery Works will erect a central electric light station for the Municipality of Freudenstadt, at a cost of about £9,700.—The Gorlitz Brewery Company will light their premises electrically.—Owing to the increased demand for current, the plant at the Berlin Electricitätswerke is to be extended, and two new steam dynamos, each of 1,200 h.p., are to be erected.

Electric Power from Peat.—In the current issue of the *Nineteenth Century* is published, from the pen of Mr. J. Munro, C.E., an article on "Electricity from Peat." After asking whether something cannot be done to help the Highlands and Ireland, the author makes the following suggestions: "We cannot spare the Highlanders, and something should be done to keep them in the country. Can we not employ electricity, which has changed the prospects of so many places, to the advantage of the Highlands? The fishermen of Loch Fyne are trying to get a light railway from Strachur to Kilmun, in order to place their fish on the Glasgow market in the morning and the London market in the evening of the day on which they are caught. Here is a case in which electricity might play a part, for there is water power in the neighbourhood to drive the trains. Some time ago I was talking of this very matter with Prof. G. Forbes, F.R.S., and he asserted that he would undertake to run all the railways of Scotland by means of the water power which is now running to waste. Apart from the railways, some of the electric power might be applied to industrial purposes if there were raw material on the spot. There is, however, another source of prosperity in the Highlands and Ireland which has been too much neglected—namely, peat. In peat we have at once a fuel and a raw material, and what I desire to point out is that by burning it in engines we can obtain not only the power required to manufacture the raw peat, but also a supply of electricity for distribution. A fuel as well as a raw material, peat can supply the power required to coke, distil, and manufacture itself. For convenience and economy the associated industries ought to be carried on at the peat beds, which should be connected by rail or water with the best markets. We are now witnessing the rise of a new industrial city at Niagara, in which the machinery will be driven by electric power derived from the falls, and we may yet see the Bog of Allen or the Moor of Rannoch supporting settlements and factories for the utilisation of peat. The soil reclaimed by the removal of the peat could be brought under cultivation with fertilisers made from the peat or the sewage of towns—for example, the muck now dredged from the Clyde and flung into the sea. It is also a question for horticulturists whether fruit and vegetables could not be forced under glass on a large scale with the help of peat fuel, peat mould, and the electric light in thick weather, after the manner of the late Sir William Siemens. Moreover, just as in the case of Niagara, where electric power is to be sent by wire to the city of Buffalo, so in the Highlands and Ireland it could be distributed to work railways, and to the nearest towns or villages; and Oban, Inverness, or even Glasgow, might derive both light and energy from what is now the dark, inert, and dismal Moor of Rannoch."

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THE PROSPECTS OF ELECTRIC TRACTION.

The last meeting of the Institution of Electrical Engineers was conspicuous for two especial features: the first of these reflects disadvantageously to some inconsiderable extent upon the Council, in so far as the limited arrangements made for discussing no less than three distinct papers concerned with the all-important subject of electric traction, could hardly fail to crowd out an enormous amount of useful knowledge and opinion. This was felt by many of those who were present, and it is much to be hoped that an early opportunity will be given for another discussion upon the subject of electric tramways and traction generally, so that some practical action may be taken by the members to support and foster progress in this direction in every possible way.

Electric traction is at present, so far as the country is concerned, in a somewhat critical condition, and the sooner this is realised the better it will be. No one, of course, will have the least doubt as to the ultimate issue; but unless the electrical industry bestirs itself not only to maintain present developments, but greatly to increase them against all obstacles of whatever type, there seems a by no means remote possibility that the building and equipment of electric lines will only begin to afford profitable occupation for our children's children after the generation of to-day has vanished into dust or senility.

This fact bears upon the second of the two noteworthy features above mentioned—viz., the almost unanimous feeling amongst the members of the Institution in favour of the overhead trolley system as being by far the best and cheapest in every way. This opinion was admirably voiced by Prof. S. P. Thompson and by Mr. Ferranti, and it would be well for electric traction prospects if their speeches found an echo in the minds of outsiders as well as of those more particularly interested in electrical matters. It is, however, just this particular method or system which has the hardest battle to fight—the battle against foolish and ignorant prejudice, which objects to anything new largely because it is new, in the usual unreasoning and absurd manner.

Consider first the general position of tramway companies to-day. The majority of them have not a very long life to look forward to; thanks to the Act of 1870 a limit—far too short—is put upon their powers, which in very few cases will be exceeded. This renders it almost impossible for the companies to entertain the idea of spending large sums upon converting their method of operation from the use of horses to any form whatever of electric traction, even for the advantages of greatly-increased receipts and diminished expenditure: there is no security that their powers will be sufficiently extended to enable this outlay to be recouped. The enormous advance in late years of municipal enterprise emphasises this condition, and makes it less likely than ever that the tramway companies will obtain reasonable renewals of their present powers or leases. Efforts will, of course, be made to remedy this state of affairs and secure a more favourable position for tramway companies who may still obtain leases of systems, and for all new lines yet to be built, in the enquiry now being held respecting the better development of light railways and tramways, and much depends upon the result or practical outcome of the movement as to whether or no tramways shall exist under conditions more agreeable to modern ideas, and equally fair to all concerned. On the mere matter of length of lease alone there seems no reason why tramways should be on a different footing to that of electric lighting enterprises, which in many cases obtain powers for the maximum term of 42 years when leased to private interests.

It may be taken as absolutely certain that for the future the men to convince of the advantages and profits of electric traction are more particularly the municipal engineer and the town councillor, and, failing them, the elector, who is their master. As the leases of a tramway system fall in, the local authority will, in nine cases out of ten, purchase the lines on the general terms now finally settled. In probably five cases out of the ten, given parliamentary sanction and precedent, there will be a clamour from the constituency that the local authority shall also work the lines. What, then, will be the result? It has been shown that there is no particular inducement for tramway companies (even supposing them financially capable of doing it) to adapt their lines for electric traction: hence they will fall into the hands of the local authority equipped as now, probably with horses. In all the five cases above assumed, it is almost certain no change whatever would be made. The local authority also has no particular incentive to work the tramways in a better or more effective way, especially when it means a large capital outlay; and unless public opinion grows so strong and the public demand so vigorous that quicker and more modern systems must be considered, the whole question of improvement is certain to be postponed *sine die*. This is just what has happened in Glasgow; it is just what threatens to be the case in London unless the County Council should happily follow better advice. So long as a small—even minute—profit is made, the ratepayers are not likely to object at the outset to the employment of horse traction, as at Glasgow and Plymouth, or steam-engines as at Huddersfield. To propose anything better means that the ratepayers must all dip their hands into their pockets and pay for the advantages of better traction methods. Of course, this has had to be done in the case of municipal electric lighting stations; but these have all been put down absolutely *de novo*: they do not merely involve modifications in gasworks. It is notoriously more easy in many cases to introduce a wholly new system than modify those now employed.

With existing tramways but little change for the better can be made until the local authority obtains possession of the system (which may not be for some years), and even then only by convincing the members and constituency of the enormous advantages of electric traction.

The foregoing remarks apply to the use of electric traction methods in general for tramway working, but the difficulties become still greater when the question of installing an overhead trolley system is proposed. Even at the present time, before actually entering into possession of the lines, some local authorities have shown strong objections to the tramway companies themselves spending their own money on a change of this kind, so short-sighted is Bumble! It does not seem to be realised that the lines thus equipped will at the expiry of the lease fall into the municipality's hands in far better condition, with much increased profit-earning capacity, than if merely left to their previous state of melancholy horse service! There can be no fear of extra compensation to pay for the change, inasmuch as the terms of transfer are exact, and lean, if anything, to the side of the local authority.

The chief points which the advocates of electric trolley wires must be prepared to meet and overcome are these, and although electrical engineers may doubtless feel the entire force of their utter absurdity, it must be remembered that to some minds they present a very vivid reality.

First, there is the "ugliness" of the overhead wire. Mr. Carruthers-Wain has answered this objection by stating as a fact that the South Staffordshire people do not consider the beauties of the Black Country to have been seriously affected by the use of a trolley wire! The same remark applies in slightly lesser degree to London, Manchester, and all other large centres of industry and population.

One curious thing to take notice of is this—we are told that trolley wires are unendurable in towns from their hideousness, but would prove eminently suitable for country roads. Without denying the latter assertion, the want of logic in thus bringing the trolley face to face with Nature, whilst forbidding contact with the artificial, is too prominent to pass by. But this argument is answered best of all by pointing to the continental towns and cities, admittedly far more picturesque and beautiful than our prosaic manufacturing centres of England. How do Manchester, Liverpool, Bradford, Leeds, Bristol, Newcastle, Birmingham, and a host of other such places compare in point of municipal adornment or architectural grace with Dresden, Genoa, Milan, Hanover, Brussels, and another equally large host of continental towns? Yet all these enjoy the benefits of trolley-wire lines, not merely along country or suburban roads,

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but right through the heart of each place and along the principal streets; many of these are too narrow in places to allow of trolley poles, so that cross wires are strung across the roadway from building to building. It is time this bogey of æstheticism was laid to rest effectually and finally. We pride ourselves on being practical, yet refuse the benefits of rapid transit because of so-called appearances!

If these appearances may be so far trodden upon as to allow the laying down of such inartistic things as tramway rails upon a street, it will wound their feelings but very little more to have a light wire hanging gracefully high up from ornamental poles, that also serve to carry the electric lamps for street-lighting.

Another point sometimes brought forward as involving a serious objection to the trolley wire is that of possible danger to passers-by should the wire, or any part of the overhead equipment, suddenly give way and fall down upon the road, and fears have also been expressed that injury may result from shock through possibly defective insulation. Both these suggestions are to all intents and purposes absolutely groundless; with regard to bodily shock, the pressure generally adopted—from 300 to 500 volts—is not enough to do any real injury whatever, whilst it suffices to keep the mischievous from meddlesome interference with the line or equipment. Of course, the most careful precautions are taken with the overhead gear and with the car equipment to prevent any possibility of passengers ever coming into contact with the main circuit, although there are doubtless some who suppose the entire car to be filled with loose electricity, roaming about in a most unscientific and unnatural manner. As for the question of trolley wire breakage, whatever may have happened under the haphazard method of working formerly employed, especially in the United States, there need be no fear now of such incidents occurring in a manner to do any harm at all. In fact, the majority of those companies empowered to use overhead wires would be quite ready, if it was a necessary condition for the use of the trolley system, to hold such powers on the terms that they should expire at short notice if, say, half-a-dozen accidents be caused by wire breakages. Can a steam tramway say relatively as much?

A third objection brought forward is this: the trolley wire, being not more than 20ft. or 22ft. above the street surface, might conceivably prove an obstacle to the progress along or across the street of a fire-escape when required for the sudden emergency of a fire. It is doubtful whether the clumsy ladders on wheels which are thus dignified by the name of fire-escapes, prove of material service in the average fire; too often they seem to be locked up, or attendantless, or are brought even under present conditions at such a comparatively low speed along the streets by a couple of men that their use for instantaneous service may be considered almost valueless in comparison with a good rope ladder, or iron staircase, such as is built outside all well-designed large buildings. The proper remedy, however, for such a state of things is very obvious, assuming the existence of the obstacle thus referred to in the trolley wire. Actual experience on this point has proved no hindrance at all, but we may assume it for argument's sake. If the fire-escape in its present form cannot pass through the streets where trolley wires are employed, then its form had better be altered at once, and this can be done with manifest advantage, moreover, to its usefulness as a means of saving life and property. Light portable ladders, mounted flat upon trucks or wagons, and drawn by men or horses at a rapid rate through the streets can reach a fire wherever it may be in half the time required for a clumsy and top-heavy wooden staircase to be pushed along; they are easily put together in a few seconds, and placed exactly where wanted with much less trouble than occurs now with the ordinary apparatus. It may, however, be mentioned that in some continental cities the ordinary fire-escapes are fitted with arrangements for running them horizontally, and thus they overcome this objection.

It will tax the ingenuity of man to discover any further objections than those above detailed to the use on city streets and roads of a trolley wire for purposes of rapid transit, but the ignorance upon this subject is so profound, and the corresponding prejudice against the system so great in consequence, that the entire electrical industry may well take in hand the preservation of the interests of this one branch, because it is a most important one, and involves the prosperity of all the others, directly or indirectly. We have said but little or nothing as to the advantages of overhead trolley wires, beyond the prime fact that their use enables a line to be operated at half the cost of horses; but the municipalities will be well advised if in this instance also—just as with the question of electric lighting—they send deputations to those towns already in possession of trolley systems, in order to ascertain the results and merits of this method from unbiassed and disinterested sources.

Meantime it behoves the electrical industry to take active steps for promoting the development of trolley wires for electric traction in towns and cities, and this could be effected advantageously by means of a special committee or association, which should collect the necessary material and information for enlightening the ignorant or inexperienced, and see to this being put in an authoritative manner before the men especially empowered to help or hinder the equipment of electric tramways.

PRACTICAL NOTES ON DYNAMO CALCULATION.*

BY ALFRED E. WIENER.

(Continued from page 690.)

(*b*) *Bore of Pole-pieces.*—The diameter of the pole-pieces, or the bore of the field, d_p, is given by the diameter of the armature core, the height of the armature winding, and the clearance between the armature winding and the pole-pieces:

$$d_p = d_a + 2 \times (h_a + k_{12}) \quad . \quad . \quad . \quad (104)$$

d_a = diameter of armature core, in inches;
h_a = height of winding space, including insulations and binding wires, in inches;
k_{12} = clearance between external surface of finished armature and pole-pieces, in inches (see Table XLVIII.).

The latter dimension, which is to be taken as small as possible, in order to keep the air-gap reluctance at a minimum, ranges between $\frac{1}{32}$in. and $\frac{7}{16}$in., according to the kind of the armature and its size. Table XLVIII. may serve as a guide in fixing its limits for any particular case:

TABLE XLVIII.—Radial Clearance for Various Kinds and Sizes of Armatures.

Diameter of armature, in inches.	Radial clearance, k_{12}, in inches.					
	Smooth armature.					Toothed and perforated armature.
	Disc or ribbon core.			Wire core.		
	Wire wound.		Copper bars.	Wire wound.	Copper bars.	
	Drum.	Ring.				
Up to 2	1-32	—	—	3-64	—	1-32
,, 4	3-64	1-32	—	1-16	—	1-32
,, 8	1-16	3-64	—	3-32	—	3-64
,, 12	3 32	1-16	1-16	1-8	1-16	3-64
,, 18	1-8	3 32	5-64	5-32	3-32	1-16
,, 24	5-32	1-8	3-32	3-16	1-8	5-64
,, 30	3-16	5-32	1-8	7-32	5-32	3-32
,, 40	—	3-16	5-32	1-4	3-16	1-8
,, 50	—	7-32	3-16	9-32	7-32	5-32
,, 75	—	1-4	7-32	5-16	1-4	3-16
,, 100	—	9-32	1-4	5-8	5-16	7-32
,, 125	—	5-16	9-32	—	—	1-4
,, 150	—	3 8	5-16	—	—	9-30
,, 200	—	7-16	3-8	—	—	5-16

The above table shows that with toothed and perforated armatures the smallest clearance can be used, a fact which is explained by the consideration that the exteriors of these armatures offer a solid body, and may be turned off true to the field bore. From a similar reason wire-core armatures need a larger clearance than disc-core armatures, since the former cannot be tooled in the lathe, and

* From the *Electrical World* (New York).

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TABLE L.—Variation of Field Efficiency with Output of Dynamo.

Capacity in kilowatts.	Total average useful flux, at velocity of 50ft. per second.	Specific flux, webers per kilowatt, at 50ft. per second.
·1	100,000	1,000,000
·25	200,000	800,000
·5	350,000	700,000
1	600,000	600,000
2·5	1,300,000	520,000
5	2,300,000	460,000
10	4,000,000	400,000
25	8,500,000	340,000
50	15,500,000	310,000
75	22,000,000	294 000
100	28,000,000	280,000
200	50,000,000	250,000
300	70,000,000	233,000
400	88,000,000	220,000
500	104,000,000	208,000
600	118,000,000	197,000
700	130,000,000	186 000
800	141,000,000	176,000
900	151,000,000	168,000
1,000	160,000,000	160,000
1,200	175,000,000	146,000
1,500	195,000,000	130,000
2,000	220,000,000	110,000

TABLE LI.—Useful Flux for Various Sizes of Dynamos at Different Conductor Velocities.

Capacity in kilowatts.	Average useful flux, in webers, at conductor velocity, per second of						
	25ft.	30ft.	40ft.	50ft.	60ft.	75ft.	100ft.
·1	200,000	167,000	125,000	100,000	83,000	—	—
·25	400,000	333,000	250,000	200,000	167,000	—	—
·5	700,000	583,000	438,000	350,000	292,000	—	—
1	1,200,000	1,000,000	750,000	600,000	500,000	400,000	—
2·5	2,600,000	2,200,000	1,600,000	1,300,000	1,100,000	870,000	—
5	4,600,000	3,800,000	2,900,000	2,300 000	1,900,000	1,500,000	—
10	8,000,000	6,700,000	5,000,000	4,000,000	3,300,000	2,700,000	—
25	17,000,000	14,200,000	10,600,000	8,500,000	7 100,000	5,700,000	—
50	31,000,000	25,800,000	19,400,000	15 500,000	12,900,000	10,300,000	—
75	44,000,000	36,700,000	27,500,000	22,000,000	18,300,000	14,700,000	11,000,000
100	56,000,000	46,700,000	35,000,000	28,000,000	23,300,000	18,700,000	14,000,000
200	100,000,000	83,300,000	62,500,000	50,000,000	41,700,000	33,300,000	25,000,000
300	140,000,000	117,000,000	87,500,000	70 000,000	58,300,000	46,700,000	35,000,000
400	—	147,000,000	110,000,000	88,000,000	73 300,000	58,700,000	44,000,000
500	—	173,000,000	130,000,000	104,000,000	86 700,000	68,300,000	52,000,000
600	—	197,000,000	148,000,000	118 000,000	98 300,000	78,700,000	59,000,000
700	—	216 000,000	163,000 000	130,000 000	108,000,000	86,700,000	65,000,000
800	—	235,000,000	176 000,000	141,000 000	117,000,000	94,000,000	70,500,000
900	—	—	189 000,000	151,000,000	126 000,000	101,000,000	75,500,000
1,000	—	—	200,000,000	160,000,000	133,000,000	107,000,000	80,000,000
1,200	—	—	219,000,000	175,000,000	146,000,000	117,000,000	87,500,000
1,500	—	—	244,000,000	195,000,000	163,000,000	130,000,000	97,500,000
2,000	—	—	275,000,000	220,000,000	183,000 000	147,000,000	110,000,000

have to be used in the more or less oval form in which they come from the press. Since copper bars can be put upon the body with greater precision than wires, a somewhat larger clearance is to be allowed in the latter case. Finally, a drum armature, in general, has a higher winding space than a ring armature of same size; the unevenness in winding will, consequently, be more prominent in the former case, and therefore a drum armature should be provided with a somewhat larger clearance than a ring of equal diameter.

The figures given in Table XLVIII. may be considered as average values, and in specially favourable cases may be reduced, while under certain unfavourable conditions an increase of the clearance may be advisable.

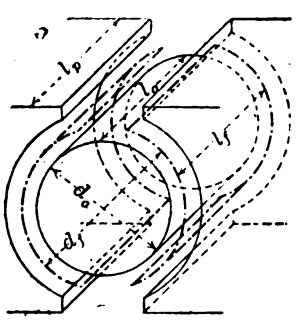

FIG. 46.

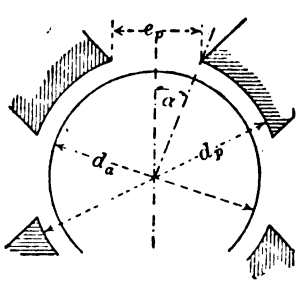

FIG. 47.

(c) *Polar Embrace.*—The dimensions of the magnetic field having thus been determined, half the pole-space angle, α (Fig. 47), can be found from the trigonometrical equation:

$$\sin \alpha = \frac{e_p}{d_p} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (105)$$

e_p = pole distance, in inches, from formula (103);
d_p = diameter of pole-pieces, in inches, from formula (104).

The ratio of polar embrace, or the percentage of polar arc, then is

$$\beta = \frac{90\text{deg.} - \alpha \times P}{90\text{deg.}} \quad . \quad . \quad . \quad . \quad (106)$$

in which α = half pole-space angle from (105);
P = number of pairs of magnet poles.

From (106) follows, by transposition:

$$\alpha = \frac{90 \times (1 - \beta)}{P} \quad . \quad . \quad . \quad . \quad (107)$$

from which the pole-space angle, α, can be calculated in the case that the ratio of embrace, β, of the pole-pieces is given.

35. *Relative Efficiency of Magnetic Field.*—The useful flux of the dynamo being found from formula (91), the number of lines of force per watt of output, at unit conductor velocity, will be a measure for the magnetic qualities of the machine, and may be regarded as the relative efficiency of the magnetic field.

The field efficiency for any dynamo can accordingly be obtained from the equation—

$$\zeta = \frac{\Phi}{E \times C} \times S = \frac{\Phi}{W} \times S \quad . \quad . \quad (108)$$

where ζ = relative efficiency of magnetic field, in webers per watt of output at a conductor velocity of 1ft. per second;
Φ = useful flux of dynamo, from formula (91) or (92);
E = total E M.F. to be generated in machine, in volts;
C = total current to be generated in machine, in amperes;
W = E × C = total output of machine in watts;
S = conductor velocity, in feet per second.

The numerical value of this constant, ζ, varies between 4,000 and 40,000 lines of force per watt at 1ft. per second, according to the size of the machine, the lower figure corresponding to the highest field efficiency; and for outputs from ¼ kilowatt to 2,000 kilowatts, for bipolar and for multipolar fields respectively, ranges as per Table XLIX., which is averaged from a great number of modern dynamos of all types of field magnets.

TABLE XLIX.—FIELD EFFICIENCY FOR VARIOUS SIZES OF DYNAMOS.

Capacity in kilowatts.	Value of ζ, in webers per watt, at unit conductor velocity.	
	Bipolar fields.	Multipolar fields.
Up to ·25	15,000 to 40,000	—
·25 to 1	10,000 to 20,000	—
1 to 10	8,000 to 15,000	10,000 to 20,000
10 to 50	7,000 to 12,000	8,000 to 15,000
50 to 100	6,000 to 10,000	7,000 to 12,000
100 to 500	5,000 to 7,500	6,000 to 10,000
500 to 1,000	—	5,000 to 7,500
1,000 to 2,000	—	4,000 to 6,000

For a newly-designed machine, the value ζ obtained by means of formula (108) will be within the limits given in this table, provided the armature has been calculated in accordance with the rules and tables furnished in the respective chapters of Part I.

As from Table XLIX. follows the self-evident fact that the magnetic fields of large dynamos are more efficient than those of small ones, a curve was plotted in order to

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examine the rate of this increase. For this purpose the useful fluxes of all the dynamos considered were reduced to the basis of a conductor velocity of 50ft. per second, when the heavy curve, Fig. 48, was obtained by averaging the values of the flux thus found.

From this curve a law can be deduced for the increase of the field efficiency with increasing size. In Table L., from the average useful flux for 50ft. conductor velocity, as plotted in Fig. 48, the specific flux per kilowatt has been calculated, showing the rate of increase of the field efficiency.

By the law of inverse proportionality between useful flux and conductor velocity, the remaining curves for 25, 30, 40, 60, 75, and 100 feet per second respectively were then drawn in Fig. 48.

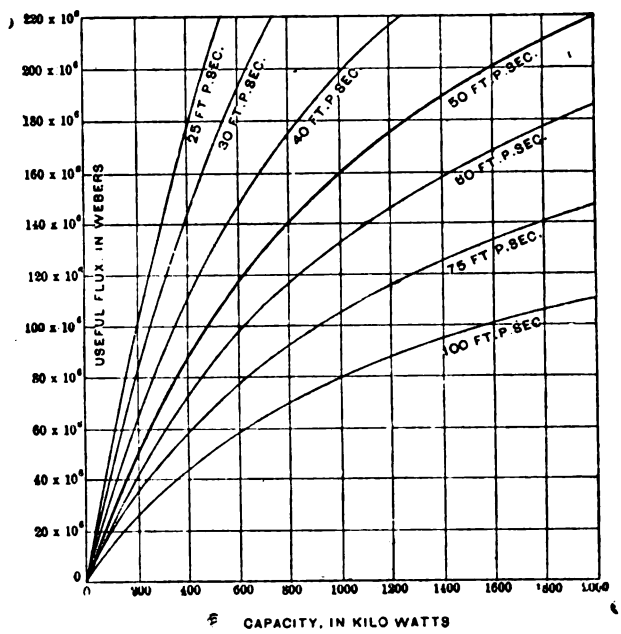

FIG. 48.

Tabulating all the values thus received, we obtain Table LI., which gives average values of the useful flux for various conductor velocities.

(To be continued.)

LIGHTING AND POWER TRANSMISSION BY MEANS OF DIPHASE GENERATORS.

A paper referring to the transmission of power and lighting by means of polyphase currents at the works of Messrs. Weyher and Richemond was presented by M. P. Boucherot to a meeting of the Société Internationale des Electriciens on December 5. After having made investigations, this firm decided to lay down in its works at Pantin a two-phase plant. Among the reasons adduced by the author for the adoption of this system may be mentioned that diphase generators have a higher efficiency than simple alternators, that these motors are more easily started, and that this type of machine is better adapted for the simultaneous distribution of power and light. The Pantin works cover a surface of some 25,000 square metres, and comprise groups of buildings. The old steam-engines of 50, 80, and 120 h.p. have been replaced by a single 400-h.p. horizontal engine running at 60 revolutions, the economical speed of which corresponds to 200 h.p. This engine drives by belting and countershaft a direct-current dynamo which serves as exciter, one three-phase alternator for testing purposes, and three diphase alternators. The countershaft can, in case of necessity, be driven by a 150-h.p. vertical engine in an adjoining room. Each diphase alternator gives 88 kilowatts at 400 revolutions; they are of the eight-pole type, and have a frequency of 40 periods per second. The field coils are fixed and the armature is formed by a drum winding. The author mentions, by the way, that at present flywheel alternators would perferably be chosen. The distributing board carries on the right the alternator switches, and on the left the feeder or line switches. The circuit of one phase is arranged on the upper. part of the board, and that for the other phase on the lower part. On the central portion of the board is placed the measuring and synchronising apparatus.

A comparison of the alternators with direct-current generators gives the following results: cost price 15 per cent. less, efficiency similar, and weak armature reaction. As regards efficiency, the author stated that at full load it was 91 per cent., at half load 87·2 per cent., and at one-tenth load 60 per cent. The distribution of the current is effected by means of eight cables, having a section of 75 square millimetres, carried in the different buildings. Diphase motors are superior to those of the direct-current type. The motors used in the works are of two kinds; in one type the armature is formed of parallel bars of copper connected at their extremity; in the other, the extremities of the armature are connected to rings on the shaft. External rubbing contacts allow of shunting variable resistances. In the first motors, and to avoid too great intensity on starting, the properties are utilised of a self-induction coil and its mutual induction properties. The installation comprises 17 motors of a total of 190 kilowatts; those of 22 kilowatts have a commercial efficiency of 94 per cent., and those of 1·1 kilowatts of 74 per cent. The efficiency of all the motors is 89·8 per cent.; with the loss on the line (4 per cent. and various losses, a total efficiency of 78·5 is obtained on full load. The lighting of the works is accomplished by means of 60 arc and 600 incandescent lamps. M. Boucherot says that if the luminous efficiency of alternating-current arc lamps has been estimated to be inferior to that of direct-current arc lamps, the fact is due to inexact comparisons. The self-induction coils used instead of rheostats allow of a large economy being obtained.

TRANSMISSION OF ELECTRICAL ENERGY FROM THE COALFIELDS.

The scheme advanced by Mr. B. H. Thwaite and Mr. Swinburne for the production at and transmission from central stations in the coalfields of electrical energy for use in the Metropolis and elsewhere is discussed by the former gentleman in the December number of the *Nineteenth Century*. The principle, as may be remembered, is stated briefly by the author as follows:

The project is to supply electric power generated in central stations built in the centre of our coalfields to our great industrial centres, and to the Metropolis itself. The power station for serving the Metropolis would be erected on the Derbyshire coalfield; an auxiliary station to serve the Midland counties would be erected in the Staffordshire coalfield. The electrical trunk lines would serve the larger towns *en route*, including Derby, Nottingham, Birmingham, Leicester, Northampton, and Bedford. Distributing, transforming, and storage stations could be erected near the Metropolis. The different metropolitan and suburban electric light stations could be supplied with energy for general distribution. Electric railways and other power stations could also be supplied. Large power consumers could be supplied with power direct. Each vestry not already supplied with an electric generating plant could be invited to put down a distributing system and a receiving station. The electric energy could be sold to the different distributing companies at such a price as to enable the power to be supplied to the light and power consumer at an economic and attractive figure, or at a little over 1d. per kilowatt-hour. The industrial centres of Lancashire, Yorkshire, and Cheshire would be supplied with electric energy generated in two coalfield stations, respectively near Wigan and Barnsley. The cost of power to the small factory owner need not exceed £5 per 3,000 working hours of one actual horse-power of energy. In the Metropolis, this energy by the present system will cost between £9 and £12.

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The centralisation of the plant in the coalfields permits the recovery of all the valuable chemical constituents from the coal, which are not recoverable by the small steam-power systems in use. One of these constituents—sulphate of ammonia—is of proved value as a manurial agent, and if this value were recovered from the coal raised from English pits, there would be no necessity to ransack the fields of Chili and Peru for nitrates. The method of transforming the fuel into power could be effected in such a perfect manner as to convert, as far as practicable, all the available heat into work, and produce such an efficiency as will be understood by the ratio of 0·75lb. of combustible to one actual or available horse-power of energy for the period of one hour. The average consumption by existing steam plants cannot be taken as less than 5lb. of fuel for the same actual power during the same time. In the transmission of this electric energy to the Midlands and the Metropolis there will be a loss of, say, 33 per cent.; so that the 0·75lb. will be increased to 1lb. of combustible per actual horse-power per hour.

The cost of the electric transmission cable and wayleaves, divided, as it would be, with the Midland consumers, would not fall heavily in the metropolitan area. For the transmission of 10,000 h.p. three bare conductors for positive and three for negative currents would be used, equipped with oil insulators. Lightning arresters would be arranged where the cables are overhead. The pressure of the current (30,000 volts) would be transformed down to 2,000 volts at the Midland and metropolitan receiving stations, for the convenience of the local metropolitan companies, who can transform the pressure at their own stations down to their normal working and distributing one. The distribution of the electric energy to the various Greater London electric supply companies, at a price of 2½d. per kilowatt or electrical horse-power, would permit them to sell the current to their consumers for 3d. to 4d. per kilowatt, instead of 7d. to 8d. charged by the Metropolitan Company for this equivalent energy.

THE COMMERCIAL POSSIBILITIES OF ACCUMULATORS.

We give below a report of the discussion on the paper read last week on the above subject by Mr. Alfred H. Gibbings before the Northern Society of Electrical Engineers. The paper itself was printed in our last issue.

Mr. Manville congratulated the author on his excellent paper. It had given him pleasure to hear it read, since it referred to a ubject of great interest; and he had had the honour of escorting Mr. Gibbings and his committee over the only tramway system worked on the principle advocated by Mr. Gibbings in the United Kingdom. He had for a long time endeavoured to persuade various local authorities to put up destructor plants in connection with central lighting stations. As long ago as 1892 he placed a complete scheme of that nature before the Vestry of Shoreditch, who adopted the report, but so far had not carried it out. Since that time another important local authority whom he was advising had resolved to erect such plant, and he was at present preparing the plans and specifications for the carrying out of the work. The scheme was almost directly similar to that referred to in the paper, since it provided not only for the erection of a large electric generating station in combination with a dust destructor for electric lighting purposes, but the generating station was to be so arranged that the current produced by it might be utilised for supplying the tramways. He could not agree with Mr. Gibbings as to the evils he stated would result from the use of boilers in a destructor separate from the remainder of the boilers required to make up the full maximum load required by the station; for in his opinion there was no necessity for any boilers to be used, however large the load of the station, within wide limits, excepting those through which the hot gases from the destructor were passing, and in the scheme referred to he was arranging for the erection of four boilers, each capable of evaporating water for 250 h.p., or a total of 1,000 h.p. Each boiler was arranged with two large destructor cells, one on each side of it, and the flues from the destructor cells were so arranged that the gases would pass underneath the tubes of the boilers immediately over the fire-bars. Then, as at heavy load times the gases from the destructor would be quite inadequate to raise the total amount of steam required, an extra amount of steam would be generated in the boilers by the addition of coal burnt in the fire-grate of the boiler. Thus, under these conditions it would be seen that whilst all the gases from the destructor were used for the steam production to their fullest extent, the boilers could always be worked up to their full power by the burning of so much coal as would make up the difference. The fronts of the boilers and the fronts of the two furnaces accompanying them were so arranged on the same level that they could all be attended to by the same body of stokers. He would not, however, dwell on the destructor portion of the question raised in the paper, for in the main he was in hearty accord with the author on the subject. He only regretted, however, that he had taken for example a slow-combustion destructor, such as that used by Mr. Jones at Ealing, as a typical furnace from which to generate steam. In such a furnace but a tithe of the power that might be realised was obtained, and he had little hesitation in expressing the opinion that with the quantity of refuse to be disposed of in Hull, in place of 45 h.p. Mr. Gibbings might rely upon attaining 120 effective horse-power on the average. He joined issue with the author as to the economical use of what he might term locomotive accumulators for running tramway cars. He was actually running the only system of locomotive accumulator traction in use in this country. Experience in such a matter was worth a deal of theory, and he could only tell them that with all the care that was taken in running that system, with all the economy that was practised, and with all the facilities at his disposal for inducing economical working, they had never yet been able to even make ends meet, although receiving very high receipts per car mile. If there was anything unsatisfactory in tramcar running, it was the use of accumulators carried in tramcars themselves. The cost of running a tramway system in that manner under most circumstances was simply prohibitive. It was not the cost of the depreciation of the accumulator plates themselves. They had found that accumulator plates did not cost them more than 1¾d. per car mile, whereas their total cost of running exceeded 9d. per car mile; and if the expenditure directly due to the use of accumulators were eliminated from the system—that is to say, if the tramcars were run directly off conductors, overhead or underground—the cost would barely exceed 4½d. per car mile. Thus, if they added the cost of the renewal of the accumulator plates, 1¾d., to this 4½d., they got a total cost of 6¼d., and there still remained the large balance between this 6¼d. and, say, 9¼d., the actual cost of running; and this 3d. was absorbed in the extra cost of labour in handling the accumulators, cleaning them out, and so forth, and the extra depreciation of the car bodies due to the fumes from the accumulators, which therefore cost a great deal more to keep in repair than in a direct system. It must therefore be obvious to them that if they had their accumulator plates costing actually nothing in themselves, the cost of handling them and making good the damage they did would prohibitively raise the cost above that of other systems, and from these figures they would get a good idea of the insignificance of the fuel question as compared with the other question. They found, as a matter of fact, that they used as nearly as might be a Board of Trade unit produced in the generating station for every car mile run; and this Board of Trade unit did not cost more than 1·2d. to produce, and therefore the energy used cost less than half the extra expenses in handling the accumulators and repairing the cars. This statement would clearly show them that they could hardly hope for satisfactory results from accumulators carried in the tramcars themselves, but he did not wish them to think that he was opposed to the use of accumulators in connection with a tramway system. On the contrary, he thought they would become an integral part of every electric tramway system, but not carried in the tramcars themselves, but used in the station, in which position they would last very well, and the heavy extra expense of charging and handling, and the repairing of the car bodies, would disappear. There would also be the advantage of reducing the size of engines and dynamos so that they would be working at their most economical load all day long, the accumulators making up those big peaks in the loads that in big tramway systems occurred for a few minutes only at a time; and the whole generating system would be worked on a more satisfactory basis than heretofore. Such a system as this had been erected by Messrs. Mather and Platt in the Isle of Man. As regarded the combination of a tramway station with an electric light station, so as to place upon the latter that day load which would produce the decreased cost of current pointed out by Mr. Gibbings, surely those stationary accumulators would be at least as applicable for that purpose as the locomotive accumulators. In connection with the local authority he had before mentioned, he had received instructions to lay out the electric lighting station in such a manner that the current it produced might be sold to the tramway company during 21 out of the 24 hours. It would be necessary for the tramway company to have a set of accumulators at their generating station large enough to run the whole of the tramway system during the time of heavy load in the electric light station, but during the whole of the day and greater portion of the night the output of the electric light station would be available for directly running the tramways and charging accumulators. The generating plant of the tramway company would then consist of two or three motor generators transforming the current supplied from the electric lighting station to one suitable for running the tramway. One or more of those motor generators would be used during the daytime for directly supplying current to the tramway conductors, and the other for charging the battery of accumulators, and when the time of day arrived when the lighting station must cut off its supply of current to the tramway station, then the accumulators would be used for running the whole system. In this way he thought the heavy day load might be given to the central lighting station, which would achieve the author's results, and at the same time the tramway system might be run as efficiently as would be possible under any circumstances. Mr. Gibbings laid stress on the fact that a low-tension system could be more advantageously employed in the central lighting station if power was to be provided for the

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running of the tramways. In this point also the speaker could not agree with him, and he thought all of them knew that an alternating-current motor, with continuous-current generator attached, would make an almost ideal motor generator when running in conjunction with accumulators, from which the fields of the alternating-current motor might so easily be magnetised, and he therefore maintained that an alternating system of supply would be equally applicable with a continuous system for use in this system.

Mr. Ferranti remarked that he had listened with great interest to the paper, and more especially to that part of it which referred to the combined use of central supply stations for doing the ordinary lighting and charging of batteries for power purposes. The picture which Mr. Gibbings had drawn of the great advantages which might result from such an arrangement, made one feel quite pleased with the great economic possibilities in that direction; but, on the other hand, they had just heard that Mr. Manville had found it practically impossible to make ends meet upon a complete system of electric traction by storage, and no matter how cheaply the current might be produced by the method which the author had described, that it was impossible to do anything very satisfactory upon that plan. Apparently the cost of handling and maintaining the batteries came to nearly as much per car mile as the total cost of working an overhead system, and, therefore, even if Mr. Gibbings got his electricity for nothing for charging the batteries, according to the information which they had had laid before them, it did not look as though it would be of any value. Of course improvements would no doubt be made, but they would have to be very vital ones before that trouble could be got over. Assuming, however, that traction by batteries could be worked commercially if the batteries were charged by current cheaply obtained from the lighting station, they would then have to remember that the plant at the lighting station could only be relied upon for a short number of hours out of the 24, as they would have to leave sufficient margin for the continuous heavy load which was experienced on a few days in the winter of every year. If it were not for that difficulty, no doubt the use of batteries for assisting ordinary supply stations would have been very largely introduced, but practice appeared to have shown that the cheapest thing which they were able to do up till now was to generate the electricity by dynamos as it was required.

Mr. Holroyd Smith observed that some things had been said, and better said, perhaps, than he could say them, by Mr. Ferranti and Mr. Manville, but there was just one point in the early part of the paper—namely, with regard to interested experts. He was afraid that he could not claim to be anything else than an interested expert, and he did not think that Mr. Manville could, and he was afraid that Mr. Ferranti was also one. He might say that that was the first time in the whole of his experience that he had heard a straightforward expression with regard to the cost of working tramcars by means of accumulators. He had seen statements put out to the world which, after falling into the hands of the public, had created an impression not altogether reliable, but Mr. Manville had been very frank in giving figures as to cost per car, etc., confirming—nay, even going beyond the statements he had from time to time made, based on calculations and careful observation of what others had done, for he fully admitted that in battery traction he had been content to profit by the experience of others. He had not wasted time and money on experiments that he felt sure could not have yielded economical results. If accumulators had shown any possibility of their being really better than the other systems, he should have adopted them long ago. But there was one thing which he would like to protest against—namely (the hope had so far been father to the thought), that statements had gone out from interested experts in the electrical world that had been readily taken up by the outside world, and had led tramway directors, town councillors, and others to suppose that batteries about the size of a hat were going to be placed under the seats of a car and drive it all day long. This had got such a firm hold in the public mind that it had been a serious hindrance in the progress of electric traction. The paper must be a very interesting one to the society, because it opened for discussion the debatable question of alternating *versus* direct current for electric lighting stations. It must be interesting to town councillors, giving them difficult questions to digest respecting corporate economy. The speaker then passed on to the 10 points which Mr. Gibbings raised in his paper about the disadvantages of the direct-driving system, taking them *seriatim*. He pointed out that the irregular demands upon the generating plant were not so severe and not so detrimental as the reader of the paper would have them believe, and he ventured to contradict a few of the other so-called disadvantages; especially that the wear and tear with batteries would be less than with direct driving, for when it was known that the weight of the batteries equalled the weight of the car (for example, a three-ton car required three tons of batteries to drive it), then it was obvious that the wear and tear with batteries must be greater, and not less, as stated in the paper. He suggested that Mr. Gibbings ought to have given them a definite tramway, stating the number of cars, hours of working, length of line, etc., and fully worked out his figures showing cost of equipment and working. There would then have been something definite to work with.

Mr. John Hesketh congratulated the author on uttering what they believed to be the cry from all central stations of "give us a day load; we want it, and if we can get it by accumulators let us get it, but by all means let us have a day load." Some people say "at whatever cost." He thought, taken on that view, that the scheme proposed by Mr. Gibbings was excellent, but taking other circumstances into account he was afraid he could not agree with him. He had had the pleasure of seeing one of the principal lines on the Continent worked on the accumulator system, and he at the time wondered how it was that with accumulators of the excellent type which they had, and with the skilled staff and every possible modern convenience, they should still make a loss. But he did not wonder long, for when he got to the station he found one large group of men attending to batteries, another group attending to repairs, and still another attending to cars; altogether, he should say there were about 100 men in the station at that time charging and attending to batteries, etc., for 20 cars. One had not to look far for additional expense, and he therefore did not agree that the running expenses in connection with the accumulator traction were in any way on the same lines as the direct system. Mr. Smith, he believed, asked for some figures in reference to comparative capital costs, and he was pleased to be able to give these. He had got out schemes for running a line on the overhead, conduit, and accumulator systems, based on the same footing, and had found that the accumulator plant cost £5,000 more in capital outlay than the other two, and he therefore thought that the point raised by the author was scarcely borne out.

Mr. A. Lester-Taylor stated, with regard to the Board of Trade regulations and fire office requirements referred to in the paper as being very stringent, that in New York they were practically prohibited from using current for traction purposes in connection with other systems, or rather that no systems might be supplied from these trolley wires.

Mr. Gibbings, in reply, stated that the system which he had set forth and advocated in his paper was simply that which had appeared to him to be the most advantageous to the town of Hull—that was to say, that he had found the conditions in Hull peculiarly suited to that particular kind of traction on account of the level roads and the situation of the central electric lighting station. He did not mean to say that very much profit would be likely to accrue to the tramway enterprise at the present time, but matters were certainly progressing in the direction of the improvement of accumulators. The great advantage which would arise would, however, be from the electric lighting enterprise, because the price could be so reduced that there would be many more people who would be induced to adopt the electric light. Of course they had to decide every case on its own merits. He might mention that Mr. Manville misunderstood his remarks with regard to separate boilers. He did not mean different sets of boilers would have to be employed at the destructor station for the destruction of refuse and generating electrical energy respectively, but the boilers at the destructor station were distinct from those at the electric light station. With reference to the Birmingham electric tramway, this was the only instance in this country of accumulator traction on a large scale, and they had therefore no other place with which a comparison could be made. In reply to Mr. Ferranti, Mr. Gibbings said he had already stated in the paper that his remarks were rather in the abstract than in the concrete, and therefore the possibilities set forth in the paper would of course only hold good where conditions and circumstances were favourable. With regard to the remarks of Mr. Holroyd Smith, he had not meant the observations which he had made concerning electrical experts to be taken in any disparaging sense. Of course, there was no reason why experts should not be given full credit for their own recommendations when lectric tramcars were dealt with as a single and independent concern. With regard to giving figures of an ideal example of such a combination, it had not been his intention in this paper to go into complete details as to total capital expenditure, interest, or depreciation, but simply to give a few suggestions on the subject. To Mr. Hesketh's remarks as to the line which he saw on the Continent, while they did not have much bearing upon the combination suggested in the paper, he would point out that Mr. Hesketh's observations were antithetical to the Rev. Laurence Sterne's, inasmuch as this was one of those things which they did not manage better in France than at Birmingham. He had no further remarks to make upon observations that had been made that evening, but if this paper would lead to further enterprise and experiment, either in the direction in which Mr. Manville or himself had pointed out, he would be amply rewarded. He did not want them to take that paper as a definite scheme which he advocated in its entirety, or as coming from an expert on the subject, but, as before stated, merely one with suggestions and possibilities thrown out, and which if acted upon under fair conditions he would look forward to with no misgiving as to the result.

Mr. Fawcus, the chairman, proposed, and the motion was carried, a vote of thanks to Mr. Gibbings for his paper. He thought that the matter which the author had brought before them was one on which there was a great difference of opinion, but one which was certainly worthy of consideration, especially with a view to increasing the day loads of central stations.

Telephony in Germany.—Telephonic communication has been established between Berlin and Frankfort-on-the-Maine, and also between Strasburg, Kölmar, and Mulhouse.—Telephonic communication has been established between Berlin, Elbing, Tilsit, and Memel.—A telephonic exchange has been opened at Nienburg, on the Weser, with connections with Hanover, Bremen, and Bremerhaven.—The subscribers to the telephone exchanges at Lübeck and Travemünde have been admitted to communication with Berlin and its suburbs.

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TRANSFORMER-CHAMBERS IN THE METROPOLIS.

ENQUIRY BEFORE THE BOARD OF TRADE.

In our issue of the 7th inst. reference was made to a forthcoming enquiry at the Board of Trade as to the position of transformer-chambers in public streets. That investigation, which is really an appeal to the Board of Trade, was commenced on Thursday of last week, Sir Courtenay Boyle being supported by Major Cardew, electrical adviser to the Department, and by Mr. F. G. S. Hopwood, of the Railway Department.

The appeal was of the London and Brush Provincial Electric Lighting Company in regard to objections advanced by the London County Council and the Wandsworth District Board of Works to the construction of transformer-chambers under the streets. The appeal is made under the County of London (North) Electric Lighting Order, 1892, and the Wandsworth Electric Lighting Order, 1892. It may be as well to first take the contentions of the London County Council, which were as follow :

Case of the London County Council.

(1) That the transformer-chambers proposed to be used by the company should not be allowed to be constructed under the streets or footways unless it can be shown that in any particular case it is indispensable to place one there.

(2) That such transformer-chambers are not necessary to the carrying on of the company's business.

(3) That such transformer-chambers would be detrimental to the use of pipes, wires, and sewers in the streets, and will be serious obstructions to such pipes, wires, and sewers, and will in practice, notwithstanding any conditions which may be imposed upon the company, necessarily involve expensive modifications.

(4) That such transformer-chambers would be a source of danger to persons passing along the streets, would greatly increase the number of explosions and accidents, and would be dangerous to workmen and others using them.

(5) That the construction of such transformer-chambers would also interfere with the construction of future street widenings and street improvements.

(6) That the use of such transformer-chambers to the large extent to which their admission as a principle would necessarily lead would be very embarrassing to the public authorities in the exercise of their duties, and could not but involve them in much expense for the purpose of supervision, etc.

(7) That from the experience obtained by accidents which have occurred, and from the difficulty of ventilating such transformer-chambers, and their constant liability to flooding and to percolation from gas, water, etc., and the very explosive character of high-tension currents when not properly ventilated, the construction of such transformer-chambers would be most detrimental.

(8) The Council maintain that the proposed use of the streets is purely one of saving the company expense, and that the company should not be allowed to increase their dividends by utilising the streets instead of acquiring houses, cellars, gardens, or courtyards for the purpose of such transformer-chambers.

Reply of the County of London and Brush Provincial Company.

The reply of the company to the before-mentioned objections is as follows :

(1) In reply to paragraph 2, that the transformer-chambers proposed to be used by them are not only necessary but essential to the carrying on of the company's business.

(2) In reply to paragraph 1, that the construction of such transformer-chambers under the streets and footways is in accordance with the practice heretofore adopted with the approval of the Board of Trade and many local authorities, and is the most convenient place, having regard to the safety of the public, the convenience of the customers, and the convenience of access for workmen and others.

(3) In reply to paragraph 3, that such transformer-chambers would in no way be detrimental to the use of pipes, wires, and sewers in streets, or serious obstructions to such pipes, wires, and sewers, or involve expensive modifications. A large number of transformer-chambers—in many cases of far greater dimensions than those proposed to be constructed by the company—have been constructed under footways and streets without detriment to the use of pipes, wires, and sewers, or any serious obstruction to the latter, and any modifications of existing pipes, wires, and sewers required have been carried out by the undertakers under the provisional order in accordance with the terms thereof. The Council are not owners of pipes or wires, or of any sewers but the main sewers, and there is no ground for the suggestion that the transformer-chambers will either interfere with the use or be a serious obstruction to such main sewers.

(4) In reply to paragraph 4, the company say that the transformer-chambers, wherever placed, are no source of danger to the public, provided reasonable precautions are taken in constructing the chambers and connecting the machinery and mains, and that if supplied with a grating at the top as proposed by the company the proposed transformer-chambers will in no way be a source of danger to persons passing along the streets, or to workmen and others using them.

(5) In paragraph 5 the Council say that such transformer-chambers would interfere with the construction of future street widenings and street improvements. The company state that their mains and transformer-chambers will not interfere with any such improvements, and, moreover, that the exercise of the powers given to the company by provisional order should not be interfered with simply on the suggestion that at some future date it may become desirable to widen or improve any particular street for reasons which do not at present exist.

(6) The Council, in paragraph 6, say that the use of such chambers to the large extent to which their admission as a principle would necessarily lead would be very embarrassing to the public authorities, and involve them in much expense for the purpose of supervision. The company would point out that the principle of transformer-chambers is no new one, but has already been accepted, and that in reference to the exercise of their duties by the Council, the company will become a large ratepayer.

(7) In reply to paragraph 7, the company claim that there is no difficulty in ventilating transformer-chambers ; that their construction as proposed by this company shows complete ventilation and no liability to flooding or to percolation from gas and water, and that they will be in no wise detrimental.

(8) In reply to paragraph 8, the company maintain that the construction of the chambers under the footway and streets is not merely a question of economy. (*a*) They point out that if they are driven to the acquisition of private property they will probably purchase the right to use cellars that extend under the pavement and into the streets to which the Council object ; (*b*) that the transformer-chambers are proposed to be placed under the footways of the streets because of the danger that would occur in the efficient lighting of the district in the possible event of the premises under which the transformer-chambers might be placed being burned down, with possible destruction of the ventilating arrangements of the transformer-chambers, of the means of access to the transformer-chambers, and of the connection between the mains and the machinery within the transformer-chamber, whereby a large district might be placed in darkness by causes entirely outside the company's operations, and over which they would have no control whatever.

(9) The company would also call attention to the restrictive clauses in their provisional orders as to the maximum price chargeable, and as to the revision of such price, and also to the purchase clauses in favour of the local authority, and say that no good reason is or can be shown by the Council for putting upon the company the additional expense of the purchase of a large number of bits of property in different parts of their districts merely to prevent the proposed small users by them of the subsoil of the pavements and streets. The company suggest that their transformer-chambers are in no way dangerous to public safety, and point out that if the Council are successful in their contention, it could in some localities prohibit the company from carrying on its operations, because it is not possible to find any space other than space under the public footways for the construction of transformer chambers.

(10) The company are prepared to take the necessary precautions to make the transformer-chambers absolutely safe, and from time to time to take such further precautions as experience may show to be necessary, and would point out that notwithstanding the very large extent to which electric mains and transformer-chambers have been laid under the streets and footways within the Metropolis and in many large and populous centres during the last four years, there has been no fatal accident or serious injury done to any human being or any appreciable damage to property, and claim that no industry can show a record so free from accident as is shown by that of the supply of electricity from central stations in populous places.

Opening of the Enquiry.

The enquiry, as already mentioned, was opened on Thursday of last week. Mr. Bassett Hopkins represented the London County Council and Mr. Earls the Wandsworth District Board of Works. For the County of London and Brush Provincial Company Mr. C. A. Cripps appeared, and for the House-to-House Company Mr. Scott, representing Mr. Germaine.

Mr. Bassett Hopkins, in opening the case for the County Council, stated their objections. He thought the convenience and profit of the company should not be allowed to prevail over the safety of the public. Electric lighting was still in its early youth, and they had not enough experience of the various systems of supply to justify them in coming to any final conclusion. He was advised that it was scarcely possible to keep gas and water out of the chambers, and under the circumstances it was a very serious matter as affecting the public safety.

Mr. Binnie, chief engineer of the County Council, said he considered transformer-chambers objectionable on the ground of the amount of area occupied, the possibility of explosions occurring through accumulations of gas in the chambers, the obstruction caused when inspection took place, and the probability of water finding its way into the chambers.

Cross-examined by **Mr. Cripps**, he stated that he objected to the proposed system of ventilation as shown on the plan put in. He did not think the air would circulate. They could not properly ventilate a vertical pit except by using mechanical machinery or running up a ventilating shaft at the side of the house. The company had not the power to do either of these.

Dr. John Hopkinson gave evidence as to the possibility of explosion. The larger the space the more serious would be the explosion. He supported Mr. Binnie's view with regard to ventilation. At Manchester the Corporation had no transformer-chambers under the streets, but hired cellars. He did not think

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transformer-chambers were necessary. They could use a different system to the high tension, and it would be as economical.

In answer to **Mr. Cripps**, **Dr. Hopkinson** said he did not think the provisions proposed by the company would ensure a proper diffusion of accumulated gas. He had no experience of a chamber so large as the one proposed.

Mr. James Enright, examined by **Mr. Bassett Hopkins**, considered that transformer-chambers under the pavements were dangerous, owing to the possible accumulation of gas. He believed in the possibility of electrolysis, and regarded the transformer-chambers as unnecessary in the streets.

Mr. Gunyon, assistant engineer to the London County Council, and **Sir Benjamin Baker** having given evidence, **Mr. Earls** spoke on behalf of the Wandsworth District Board of Works, being supported by **Prof. Henry Robinson**. The Court then adjourned until yesterday.

THURSDAY.

Mr. Radford, who was called by **Mr. Earls** at the resumption of the enquiry yesterday morning, stated that he was engineer to the Putney District Board of Works. He was of opinion that the transformer-chambers would interfere with the Board, and also with private owners in regard to gas and water mains. There would be no difficulty in the company obtaining private land for the purpose in question.

Cross-examined by **Mr. Cripps**, the **Witness** admitted that so far every public company had been allowed to take up what room they desired under the streets.

The **Witness**, replying to **Sir Courtenay Boyle**, said that the Board of Works only objected to the transformer-chambers being built in the road and streets because of the space occupied.

Mr. H. J. Martin, surveyor to the parishes of Tooting and Streatham, who was examined by **Mr. Earls**, objected to the use of the roads and footpaths for the accommodation of transformer-chambers on account of the interference with the sewers and gas and water mains. It was possible in nearly every case for land to be acquired for the chambers.

The evidence of Mr. Martin having closed the case of the London County Council and of the Wandsworth District Board of Works, that of the County of London and Brush Provincial Electric Lighting Company was commenced.

Mr. C. A. Cripps, Q.C., in opening the case, referred to the clause, which had since been adopted as a model clause, settled by Sir George Trevelyan's committee, that a distinction must be made between old works and new, and that had met the difficulty in a satisfactory way. The County Council had tried to upset that model clause which had been maintained by parliamentary committees. Dealing with the taking up of the streets, counsel stated that Parliament had left it to the Board of Trade and local authorities to determine whether the particular work was right or proper. The County Council had brought forward the plea that they had a sort of public property in the streets, and that they were not to be used without payment, and in order to enforce that argument they said that there was too much room in the streets, and that the company wishing to use them ought to pay for it. That was answered by the position of the gas and water companies and the railways, which had paid no compensation. It was, moreover, ridiculous in face of the plans and sections put in to say there was no room. The question of system whether it was safe or not was for the Board of Trade to determine. The speaker then went on to discuss Sections 12 and 13 in the Act. The question of safety rested upon the system, and was not a matter which the local authorities were intended or authorised to raise. The company's method of construction was such that the risk of any gas getting in the chambers was reduced to a minimum. He would show them that the system adopted had been introduced by local authorities.

Sir Frederick Bramwell, called by **Mr. Cripps**, said as regarded the safety of the chambers, that the question that had arisen was of exploding gases which might get into the chamber. He believed that a chamber of the small size shown and built as proposed could not under ordinary circumstances admit gas due to leakage. There was only the most remote possibility of the gas entering the chamber. But the chamber was a gastight box, and if that be conceded, all fear of explosion was at an end. Upon, however, the suggestion that it was not a gastight box, he opined that any gas getting in, even in considerable quantities, was incapable of forming an explosive mixture, with the use of the grid cover, because the gas would pass out at the top by reason of its liberty. The witness then referred to some important experiments made by himself and others in 1867 in the Southwark subway, and which showed that with openings the formation of an explosive mixture was out of the question. Whether there was a current of air or not, the gas would pass away through suitable openings. Details of the experiments were contained in the evidence in the Metropolitan Subway Bill, July 30, 1867. He had never heard of an accident in connection with a transformer-chamber.

Cross-examined by **Mr. Bassett Hopkins**, the **Witness** said that, assuming an explosion, other things being equal, it would be more violent in a large than in a small chamber. He did not consider the question of ventilation to be important, but gas drainage was. Coal gas, which might be taken as half the weight of air, would ascend. As a matter of fact, diffusion was slow compared with the power of the gas to rise through the air by liberty. He relied upon the grating at the top of the box to allow the gas out. It was only in 1892 that the County Council tried to drive the electric light mains into subways containing gas and water pipes.

Cross-examined by **Mr. Earls**, the **Witness** was not prepared to say that large quantities of water in the box would cause danger. As an instance of this, he mentioned that the bare copper mains of the Kensington and Knightsbridge Company had been submerged, and the supply of light had still continued.

The **Witness**, replying to **Sir Courtenay Boyle**, observed that there would be greater danger with a transformer in an ordinary cellar than in the chamber.

Re-examined by **Mr. Cripps**, the **Witness** said there would be no difficulty or danger from gas getting into the chambers, which were absolutely safe against this. He could not conceive any difference of temperature in the box which would prevent coal gas from passing into the air.

Prof. Silvanus Thompson did not think the chambers as proposed under the road or footway would result in any danger, and there would be no possibility of gas leaking into them. If, however, gas did enter, the arrangements provided were adequate for public safety. The gas would get away far too soon to cause an explosive mixture, and there would be no explosion. Any difference of temperature between that of the chamber and that of the surrounding air would be in favour of promoting the circulation of air and gas, or a mixture of the two. For the air to be as light as coal gas it would have to be heated more than twice as hot as boiling water. There was not any likelihood of a difference of potential being set up.

Cross-examined by **Mr. Bassett Hopkins**, the **Witness** said that he had seen transformer stations in London and on the Continent. The chambers in the former were large.

Dr. Fleming, who observed that with the types of transformer-chambers proposed there would be no danger to the public safety, thought it would be practically impossible for gas to get in them. He agreed with Sir Frederick Bramwell that even if it did it would immediately pass upwards.

Examined by **Mr. Bassett Hopkins**, the **Witness** said that there would be a circulation of air if the chamber were heated on one side.

Mr. Lawson, engineer and manager to the London and County Brush Company, put in certain plans, and stated that there would be no difficulty in adjusting the position of the transformer-chambers. He had suggested to the surveyors to point out the most suitable places to construct them. Similar chambers had been erected at Dover and Bournemouth.

Mr. Bassett Hopkins then addressed the Court on behalf of the London County Council, and **Mr. Earls** for the Wandsworth District Board of Works, but **Mr. Cripps** had previously stated his intention of not replying.

THE BOARD OF TRADE POLICY.

Sir Courtenay Boyle, who thought it convenient to state what his advice to the Board of Trade would be, had no power to say what was the construction to be placed upon the provisional order. On the occasion of various provisional orders in 1889 the Board of Trade did not contemplate that street boxes would be extended to transformer-chambers. A great deal might be in the words "boxes controlling energy," etc. If in the provisional order street boxes did not include and mean transformer-chambers, then the company had no right there, and neither he nor the Board of Trade were the proper persons to settle the matter. If there was no power given by the order to go under the streets, nothing that the Board of Trade could do could give that power. The Board had no power to give undertakers any rights as regards the streets which were not given in the provisional order. Unless the word "boxes" included transformer-chambers, it seemed to him that procedure must be taken before some tribunal other than the Board of Trade. That being so, he must act as if the word "box" meant a transformer-chamber. He proposed to place his views to the Board of Trade on the assumption that the word "box" included transformer-chambers. The next question was, were the circumstances such as to make it the duty of the Board to say that in the safety of the public no system of supply which included the use of transformer-chambers under the streets should be used. Upon that point his advice to the Board would be based upon the assumption that the case against the transformer-chambers, *per se*, had not been made out. The promoters had undertaken to listen to any representation made by the advisers of the County Council and the Wandsworth District Board of Works in the way of any improvements in the construction of these chambers that were possible or could be suggested; but having regard to the scientific evidence he would advise the Board of Trade, with the chambers made reasonably free from risk, that it was not their duty to veto their use. Then the question arose as to the limits of their use, and in this connection he was much impressed with the argument of Mr. Bassett Hopkins, that there seemed to be no limit to the introduction of transformer-chambers. It appeared to him that that was a question which local authorities were justified in resisting, and which Parliament had not provided for. The action of the Board of Trade would be based upon the assumption that the use of transformer-chambers should be as much as possible curtailed, and that the chambers should be placed where they did not unreasonably interfere with existing wires, pipes and sewers. As to where it was or not interfering, it was impossible for him to give an opinion. The object of the company, he understood, was to place the chambers where they did not cause any such interference. If there was any particular difficulty or any particular transformer-chamber held to be erected where it should not be, then the appeal clause came in, and each case must be considered by the Board of Trade. But they would not propose to veto them *in toto* under the streets. The Board would insist upon the adoption of all safeguards in the construction of the chambers, and they would see that the chambers were placed where they would interfere as little as possible with the property of the user of the subsoil in the streets.

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ACCUMULATOR TRACTION.

There is no material fault to be found with the title of the paper lately brought by Mr. Gibbings before the Northern Society of Electrical Engineers, and published in last week's issue of the *Electrical Engineer*. If we understand the author's views aright, however, the substance of his paper contains much that is, in regard to commercial results, somewhat more questionable than the vague generalities implied by its title. There can be no doubt whatever—there has been no doubt of it for some time past, and proof positive is afforded by the Douglas and Laxey Tramway results—that the use of accumulators ought to help enormously in the economical working of electric tramways upon whatever systems they are based, so long as they are maintained at the supply station and not upon the cars.

Mr. Gibbings, however, confines his financial treatment of the subject entirely to the generating plant, and shows a remarkable economy which may be obtained by judicious combination of municipal enterprises. He then assumes the employment of accumulators *upon the cars* as being essential to the success of such a method. It is not easy to follow or agree with the logic of his contention that the power from refuse destructors when applied to the service of a trolley system will only complicate an otherwise simple scheme; though, of course, if the accumulators be stationary, instead of being mounted upon cars, there must be some additional expense for the overhead working gear. But he forgets that the depreciation and cost of labour upon the latter will be far less than upon car accumulators, so that even though, in his own words, the accumulator system can be arranged and worked so as to pay off the entire depreciation of the car accumulators per annum out of lower working costs, there is just as much, if not more, final economy in a slight increase of interest charges owing to a greater capital outlay, coupled with a very marked reduction of accumulator repairs and labour when they are maintained in the central station.

This was pointed out very clearly by Mr. Manville and others in the discussion which followed upon the paper referred to, and which we print on another page. We doubt very greatly whether in any single case the extremely small generating cost per unit which Mr. Gibbings quite fairly claims to be attainable, would allow the setting aside of a sum sufficient for the enormous depreciation and general excessive cost of car accumulators, and yet bring the total working cost below the average rate of an ordinary overhead wire system. The speakers who dilated upon this point when discussing the paper emphasised the cost of attendance and skilled labour for car accumulators, contenting themselves with bringing down the cost of depreciation to something under twopence per car mile. We think that even this figure is a better one than will be maintained in regular work over an extended period; but even assuming that it is sufficiently low for permanent work, this alone is enough to condemn car accumulator traction in its present form. Overhead trolley lines may be, and have

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been, worked at no greater cost, inclusive of all charges save only management or directorial expenses.

With regard to the entire subject from a general point of view, considerable credit is due to Mr. Gibbings for showing what excellent results in fuel economy and establishment charges may be obtained from a judicious combination of electric lighting and tramway enterprises. It need not, however, be thought that these results are at present theoretical only: they have been reached in several instances where joint working of tramway lines and incandescent or arc lamps is a matter of considerable experience. In this very issue we give particulars of a combined plant of this type employed at Zwickau, in Germany; similar use is made of the electric light station at Gera and Havre also, in each case with entire and complete success.

Usually, the combination is effected with a low-tension system, the difference between pressures of a lighting circuit (one hundred or two hundred volts) and that of a tramway system (five hundred volts) being made up by means of continuous-current transformers. With a five-wire lighting system, the two services might almost be worked direct without any transformation. There is, of course, no difficulty in operating a continuous-current tramway supply from alternating lighting circuits, as Mr. Manville has pointed out: so that whatever type of current supply be chosen for a lighting system—municipal or otherwise—there are no serious obstacles whatever to the successful operation of an electric tramway system conjointly therewith.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

STEALING IDEAS.

SIR,—I find that you turn out to be a true prophet when you stated that the Metropolitan Traction Company, of New York, fraud would result in some Yankees robbing some inventor of his invention and using it for their profit under another name. That electromagnetic system of Washington which you copy this week from your New York namesake is the identical idea that I sent in for the competition. Now it is a surety where the information has been derived. I provisionally protected in England this invention last March after I sent it to them, so they have not lost much time when my seven months allowed by the United States Patent Office expired, and they fancied it safe to do so. I hope to submit to you the original when the patent is accepted at our Patent Office, and then you can judge for yourself. The funny thing of it is, the advantages that I mentioned to them are in my exact words reproduced, and are true in fact. The cost of construction is only half what the overhead system would cost; for example, the magnetic switchboxes can be made at a profit for 10s. 6d. each, the most expensive item being putting the conductors underground and connecting up. The only difference I can see is, I used three or four wheels attached to one bar, and they use two sliding bars; but I do not consider that any improvement.

I should very much like to know what conduit system the Electric Construction Company have in their yard. Is it anything on this principle?—Yours, etc.,

5, Brightside-bank, Sheffield, W. ALDRED.
December 17, 1894.

P.S.—The main point in my invention is the use of electric cells for the purpose of actuating the electromagnet for switching the main current off and on independently of the mains, two storage cells being sufficient for this work.

ELECTRIC POWER IN THE IRON AND STEEL INDUSTRIES.

Some time ago Mr. D. Selby-Bigge contributed a paper on the above subject to the Iron and Steel Institute, showing the advantages accruing through the adoption of electric motors in the iron and steel industries. The paper, which was published in this journal at the time, is discussed in the December number of the *Engineering Magazine*, which says:

While it is probable that there is no one establishment in the United States comparable in size with the Royal and National Arm Factories now employing electricity exclusively as a motive power, it is also probable that electricity has been more generally applied here in the iron and steel industry than abroad. In regard to the application of the electric motor to rolling mills, we are likely to see Mr. Selby-Bigge's prediction verified very shortly, if it has not been already. As this application is unique, it may be well to mention it here. The installation referred to consists of a 30-kilowatt motor connected direct to the rolls, the specifications requiring that it shall be capable of reversing under full load every 10 seconds. No simple shunt-wound motor could meet this requirement, but the contractors feel confident that the Leonard system, upon which they are relying, will enable them to meet every demand. Reference to electrical metal working is conspicuous by its absence in Mr. Selby-Bigge's paper. It is true that this does not properly come under the head of "electricity as a motive power," but it plays such an important part in the iron and steel industry in America, that it must needs be mentioned in this connection. In this country there are being made at this time 2,700,000 welds per annum on steel and iron wire in the utilisation of shorts. On iron pipe for refrigerators, ice machinery, etc., the work done is at the rate of 360,000 welds per annum; on axles, tyres, and hub-bands, 144,000 welds; carriage hardware, 275,000 welds; agricultural machinery (mostly wheels), 720,000 welds; railway construction work (frogs, switches, etc.), 150,000; and on copper and brass wires (from No. ½ to No. 16 A. G.) about 3,780,000 welds. The aggregate power employed, as above, is 4,000 h.p. In addition to this, 200 h.p. is employed in the U.S. navy yards for welding purposes, and 250 h.p. for the production of electrically-welded projectiles used by both army and navy.

Electric travelling cranes have come into such general use as no longer to excite remark, and they have been constructed in sizes far larger than any employed abroad. For instance, the English electrical journals recently described the completion of a 60-ton electric crane at the Seraing works of the John Cockerill Company, Belgium, as probably the largest in the world. There are quite a number larger than this in use in this country, two of which—75 and 150 tons—are at the Watervliet Arsenal. We also have put into successful practice the direct application of the motor to the tool as recommended by Mr. Selby-Bigge. Noteworthy examples of this are found in the universal drilling machines in the Cramps shipyard and in the Southwark Foundry.

In our rolling mills electricity is all but universally used for illuminating purposes, and has also found many applications as a motive power. For instance, in the Homestead mills, the cranes used for handling and transferring ingots as they come from the furnace are operated by electric motors, and at the Edgar Thomson Steelworks the ingots are charged into the soaking pits by the same agency. In the navy yards the following installations have been made: Washington, D.C., Navy Yard, 100 kilowatts for arc lighting and electric crane; Mare Island Navy Yard, 140 kilowatts for arc and incandescent lighting; Norfolk, Va., Navy Yard, 280 kilowatts for arc and incandescent lighting, motor service, and electric welding; and there is at

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present under contract for the Boston Navy Yard, 120 kilowatts for arc and incandescent lighting, and for League Island Navy Yard, 60 kilowatts for arc and incandescent lighting, making a total for the United States navy yards of 900 kilowatts. In the United States navy the total electricity capacity actually installed in all of the vessels to date is 1,470 kilowatts, chiefly employed in incandescent lighting apparatus, for hoisting ammunition, and for search-lights. One ship, the "New York," has been supplied with an electric launch, and several ships have been equipped with the Fiske electric range finder for ascertaining ranges.

Experiments are, however, being conducted with a view to a much more extensive application of electric power on board ship as a substitute for steam for elevating guns, operating ventilating fans, and last, but not least, for revolving turrets. This latter application is considered the most difficult, and, so far as the Bureau of Ordnance is aware, has not been attempted elsewhere than in the experiments recently tried by them at Philadelphia. Thus while we probably find the application of electricity in the iron and steel industry in the United States nowhere quite so complete as in the instances cited by Mr. Selby-Bigge, we find it making enormous strides in every direction, having made some important conquests here that it has not made abroad.

COMBINED ELECTRIC LIGHT AND POWER STATION.

A central electric light station is now in operation in Zwickau, Saxony, with which is combined the plant for the working of an electric tramway. The local authorities granted a concession for this purpose to the Schuckert Company and to Messrs. Leo Arnoldi, of Mayence, but for the present only one tram line from the Zwickau railway station to Schedewitz, a distance of 2½ miles, is worked by electric cars.

It was considered that to maintain a six-minutes' service on this line nine cars would be required, and that for the extension from Schedewitz to Wilkau, nearly two miles further, a service every 12 minutes with two cars in operation would be sufficient. It was also estimated that 4,000 16-c.p. lamps simultaneously alight would be ample for meeting the requirements of the town, which has a population of 50,000. These points having been borne in mind, it was thought advantageous to combine the generating plant for the two services. This was carried into effect, and the distribution of current for lighting purposes is effected on the three-wire system, and for the operation of the tramway on the two-wire system with overhead trolley and return by the rails. For the former purposes the generators are arranged in parallel, and for the latter two in series.

The boiler-house contains three Cornish boilers, constructed for a working pressure of 125lb., and fitted with Galloway tubes. The engines, three in number, are of the compound horizontal condensing type, and each gives 100 h.p. at a speed of 150 revolutions. Each engine drives two generators by belting. The first pair of dynamos, which are only intended for providing light, is arranged for parallel running, both for the charging of accumulators and for feeding direct into the mains. This disposition has been adopted in the case of the second pair. It is, however, possible to connect these two machines in series so that they form a reserve either for lighting or for traction purposes. The third pair of machines is mainly used for the operation of the tramway, but they can also be connected to the feeder mains for the supply of light. In order to increase the efficiency of the installation, a continuous-current transformer has been laid down. The object of this transformer, of course, is, according as may be required, to bring the excess of lighting current up to the pressure necessary for the working of the tramway, or to reduce the pressure of the surplus tramway current to that of the lighting circuits. The normal output of the generators is 48 kilowatts, the E.M.F. being 250 volts. The battery comprises 136 Tudor cells. The cables are of the Felten and Guilleaume type, lead-covered and iron-armoured, and mostly laid direct in the ground. The tramway, which is 2½ miles long, is worked by nine cars.

LIGHTING A RESIDENTIAL DISTRICT.

The electric lighting of the so-called Thiergarten or Zoological Garden district, which is a residential quarter of Berlin, forms the subject of an article by Mr. Emil Rathenau in the *Elektrotechnische Zeitschrift* of December 6. The Berliner Elektricitätswerke already had a generating station in the Mauerstrasse, which is some 2,000 metres distant from the extreme point of consumption in the Thiergarten quarter. Having powers to supply light in the latter district, it was decided to erect a battery station in the Königin Augustastrasse, from which consumers could be supplied. The distributing system of the Thiergarten district and that of the Mauerstrasse station are connected together. The charging main is an iron-armoured lead-covered cable laid underground. The current for the Thiergarten station is obtained from the omnibus bars in the Mauerstrasse station, where by means of auxiliary dynamos it is brought to the pressure requisite for the charging of the accumulators or for feeding into the Thiergarten network. By means of suitable switching arrangements, the current delivered into the battery station from the Mauerstrasse generating station is either utilised for charging the accumulators during the so-called charging period of working—in which a part of the current is used for supplying during the charging time, late at night and in the day, the small number of lamps alight—or the charging main is directly connected in parallel with the battery discharging mains, and is sent into the distributing network. The latter, of course, occurs at the time of maximum demand. The time of charging can be extended or restricted to a smaller or larger number of hours.

The current from the batteries is led to omnibus bars, and then distributed on the three-wire system. The latter are arranged for a capacity of 11,600 lamps simultaneously alight, when the loss in pressure in the mains reaches about 20 volts per outer conductor. It was estimated that the probable number of lamps installed in the district would be 50,000, and that one-fourth would be simultaneously alight. Experience has confirmed this view of the matter, as at present one year after the commencement of the supply 15,000 lamps are installed, and the installation has only to give current for a maximum of 3,500 lamps. The auxiliary dynamos in the Mauerstrasse station, which are driven by electric motors, give 400 amperes, and when replaced by larger machines furnishing 800 amperes the battery station will be able to supply 9,600 16-c.p. lamps. The accumulators are of the Tudor type, comprising 138 cells. The loss in pressure in the charging main at full load is between 13 and 14 volts. To compensate for this, and to provide the proper pressure at the battery station, the auxiliary dynamos work at 50 volts. The installation has been carried out by the Allgemeine Elektricitäts-Gesellschaft, and is working successfully.

THE SPERRY ELECTRIC TRAMWAY EQUIPMENT.

A forcible reminder of the paper read recently before one of the United States institutions, on "The Use of the Electric Brake in Railway Practice," is afforded by the new catalogue issued by the Sperry Electric Railway Company, of Mason and Belden streets, Cleveland, Ohio. The equipment furnished by the company consists of one motor, the armature shaft of which runs parallel with the rails and midway between the wheels. This motor is elastically supported on suitable springs from the side bars of the truck frame, and rides as easily as the car body itself. Motion is given the axles through bevel pinions and gears, a universal coupling transmitting the armature torque to the pinion shafts.

In the electric brake which has been devised by Mr. Sperry, the braking current is not derived from the central station, but is produced by the power of the moving

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car. The brake is automatic and does its work without any special act or even the knowledge of the motorman, who simply works a handle. The operations thus automatically performed are: the conversion of the motor into a special dynamo for generating currents at very low speed; the simple cutting off of all connection with the trolley current and applying the brakes. The act of releasing the brake re-establishes the connection with the trolley and reconverts the dynamo into a motor, the same rheostat and contacts being employed to control the motor while running the car and also to control the slight amount of current generated by the transformed dynamo, which is sufficient to brake the train. The simplicity of the arrangement is shown by the fact that only one small wire extra need be run to the controller in addition to the ordinary wiring of the equipment without the electric brake. The braking action is twofold. The rotating armature of the motor, instead of tugging ahead by its momentum, is itself pulling back and more or less powerfully braking the car through the gears by the retarding effort of the magnetism of its field, while generating the braking current. The power required, therefore, to perform this work is taken from energy of the moving car which it is desired to destroy; not only is the car thus retarded, but the electric brakes arrest the motion of the wheels direct with a force that is powerful and under perfect control of the motorman. Two forms of braking magnets are used, one for winding up a brake chain usually employed in connection with the trailer, and another for directly arresting the motion of the axles, one magnet only being used in connection with each axle. These magnets are truck-mounted, and are so supported that their gravity acts to automatically retract them away from the brake face. The brake face is automatically lubricated to a slight degree, receives a high polish, and does not cut or rapidly wear. This type of brake has been in operation on many lines for over a year with complete success.

NIGHT-LIGHT WATCH-STANDS.

Some ingenious watch-stands for bedroom use have been introduced by Messrs. Siemens Bros. and Co., Limited, of 12, Queen Anne's-gate, Westminster, S.W. It will, of course, be understood that the lamps fitted to these stands, types of which are illustrated, are intended to be alight for a minute or two at a time, and only for a few times nightly. In Fig. 1 is shown a cheap form of electric light watch-stand equipped with three D-size Obach dry cells and a 1-c.p. lamp. These dry cells are very suitable for the intermittent lighting of low candle-power incandescent lamps, and, as illustrated, they are fitted in ornamental cases for the purpose in question. Fig. 2 represents a similar type of electric light watchstand, fitted with three batteries, a lamp of 1 c.p., and a flexible cord with a pear-shaped push. A stand of a more ornamental character is shown in Fig. 3, the case being of highly-polished wood with gilt fittings, and equipped similarly to the two preceding watch-stands. By the judicious use of the lamps in the

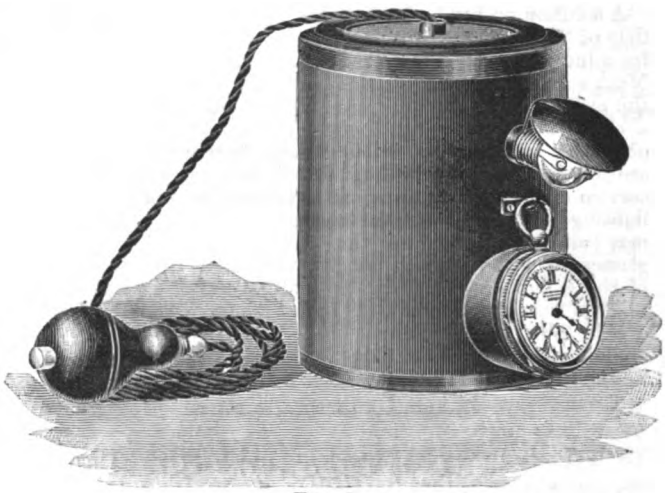

Fig. 1.

manner mentioned, the three cells with which each watch-stand is provided will suffice to light the lamps to the extent of 400

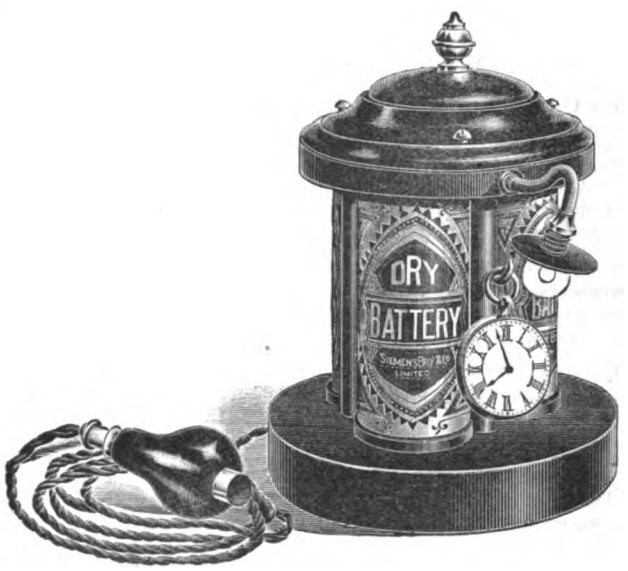

Fig. 2.

times when the lamp is only used two or three times a day. Lamps of higher than 1 c.p. can be obtained by using the A size of Obach cells. Six such cells, connected in series, and placed in a teak box with lid, terminal screws, and handles, weigh about 40lb., and will light a 5-c.p. five-volt lamp. These night-light watch-stands should prove very useful for domestic use, but they must not be made to serve the purpose of reading lamps.

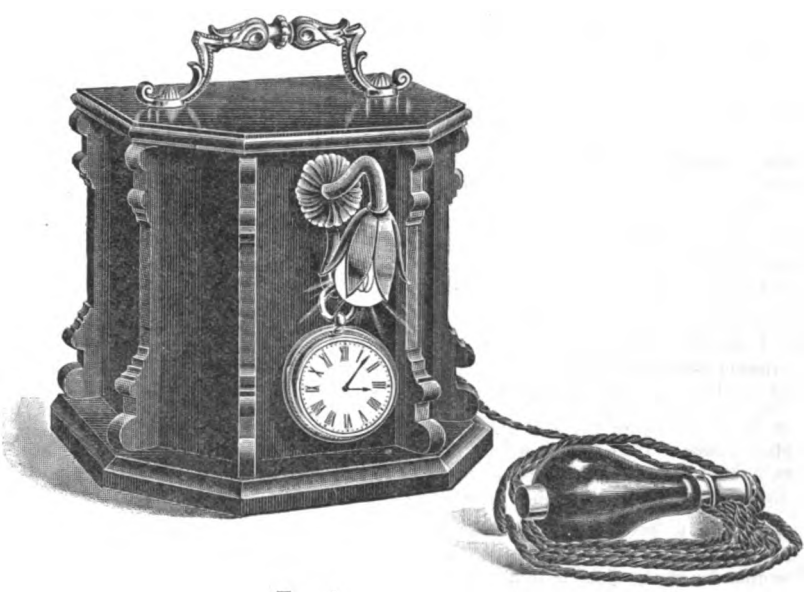

Fig. 3.

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SHADING INCANDESCENT LAMPS.

A solution or kind of paint has been introduced under the title of "Shaydolite," for the purpose of toning down the light from incandescent lamps. Messrs. Griffiths Bros. and Co., of Mack's-road, Bermondsey, S.E., who are placing this liquid on the market, state that they have been conscious of the want of a cheap and easy method of toning down the light, and of obtaining variations of colour for decorative purposes. They are of opinion that "Shaydolite" will be found of great service as a ready means of obtaining effects with electric lighting that are not otherwise procurable, and that there may also be a use for this fluid in colouring the lamp glasses of the Welsbach lamp, as to many people the glare of these lights is very trying. "Shaydolite," which is supplied in stone bottles, is made in most colours, shades of which can be obtained by mixing one with another. The paint is applied either by dipping the bulb into the "Shaydolite," or by the use of a soft brush.

DEWSBURY ELECTRICITY WORKS.

As we mentioned briefly in our last issue, the Dewsbury central electric light station was opened last week. Amongst those present were the Mayor (Alderman Kilburn), Mr. W. H. Preece, C.B. (the engineer of the works), Mr. R. E. Crompton (Messrs. Crompton and Co., London, the makers of the engines, dynamos, etc.), Mr. J. B. Recano (Messrs. Siemens Bros., London, the contractors for the mains), Mr. Mark Scott (the contractor for the buildings), Mr. H. C. Marks (borough surveyor and the designer of the buildings), Mr. J. B. Mitchell (electrical engineer to the Corporation), and Mr. A. Pickersgill (assistant electrical engineer). Messrs. Horsfield, the makers of the three boilers in connection with the works. were also represented.

The **Mayor** said his duty was a very pleasing one, of calling upon Alderman Robinson, the chairman of the Gas and Lighting Committee, to set the works in motion. A speech on electricity was not expected of him—indeed, he knew very little of the subject, but he was pleased to see around gentlemen who were well versed in matters concerning electric lighting installations.

Alderman Robinson said that during latter years the people were not satisfied with the brilliant light from Bray's burners, and it was almost a matter of compulsion to adopt some system of electric lighting. Two electric lighting companies having endeavoured to gain powers to supply electricity in Dewsbury, it became necessary for the Corporation to oppose and early in 1890 there was a conference with the Board of Trade and one of these companies, who were given to understand that the Corporation intended to protect their own interests. On October 29 the Council resolved unanimously to supply electricity, and to apply to the Board of Trade for the necessary powers. On November 17 the two companies sent notice of withdrawal. On July 9. 1891, the Town Council appointed the Gas and Water Committee the Electric Lighting Committee to carry into effect the Dewsbury electric lighting order, and shortly after that body made special visits for information to the Crystal Palace electric lighting exhibition, the stations at Kensington, Knightsbridge, Liverpool, and Preston, and on June 9 Mr. W. H. Preece, one of the most talented specialists in the kingdom, was engaged to prepare plans, specifications, etc , and report and advise generally. The report was considered, and on June 30, 1893, he had a consultation with the General Purposes Committee, and his report, etc., were approved, and tenders asked for. The site of the old gasworks in Bradford-road was decided upon as the central lighting station. Tenders for boilers, engines, dynamos, cables, etc., were accepted. Alderman Robinson gave in detail a description of the works.

Mr. W. H. Preece observed that there were several matters concerning the works that demanded their attention. In the first place, it was important to notice the compactness of the installation. Though the engines took up a very small space, they were of about 500 h.p. Ten years ago it would have been impossible to have provided a station like the present one. They would have required four times the space for the horizontal engines and belting. Another feature well worth noticing and inspecting was the battery-room at one of the engine-houses. The special object of the batteries was to enable them to tide over the night, to provide electricity as well as in the daytime—in fact, to act and serve all the purposes required when it would not pay to keep the machinery going. In the battery-room would be stored sufficient current to light the places necessary, and so save the engine power. They had been up to date with everything, and Dewsbury Corporation possessed electric lighting works on the most improved system, and such as would compare with similar works in any town in the country.

Mr. Crompton said it was in 1881 when his firm came first to Dewsbury and provided the town with electric light for a temporary period. The enemies of the electric light said there were a good many electric lighting installations started and abandoned, but that was not the case. These were only of a temporary character, and it was unfair to class them with installations of a permanent character.

Alderman Robinson, in reply, expressed the hope that the new undertaking would be a triumphant success, and immediately set the first engine in motion. The second engine was set in motion by Alderman Pyrah, and Councillor Archer (vice-chairman of the Gas and Lighting Committee) set the third engine in motion.

LEGAL INTELLIGENCE.

MUIRHEAD AND ANOTHER v. THE COMMERCIAL CABLE COMPANY.

In the Court of Appeal on Tuesday, before the Master of the Rolls and Lord Justices Lopes and Rigby, the appeal of the defendants from the judgment of Mr. Justice Kennedy at the trial of the action without a jury in April last, and reported in our issue of May 4, was decided. The Court allowed the appeal, the Master of the Rolls dissenting.

It will be remembered that the plaintiffs, who are the patentees and proprietors of certain patents for the system of duplicating cables known as the Muirhead duplex system of telegraphy, sued the defendants, a foreign company, incorporated under the laws of the United States of America, and the owners of certain telegraph cables between North America and Ireland, to recover £3,566 for royalties in respect of a part of the year 1891, under a deed dated January 2, 1884, giving the defendants a license to use certain patents of the plaintiffs in consideration of certain yearly payments. The defendants admitted the deed, but alleged that the patents in question had expired at a certain date, and that they were not liable to pay the royalties claimed. It appeared that Messrs. Muirhead took out an English patent in 1876 for duplex telegraphy, and in 1880 they took out a patent in the United States for duplex telegraphy. The English patent expired in 1890, and the defendants contended that the American patent of 1880 was substantially identical with the English patent of 1876, and that the American patent expired at the same date as the English patent, inasmuch as the law of the United States provides that every patent granted for an invention which has been previously patented in a foreign country shall be so limited as to expire at the same time with the foreign patent. They, therefore, contended that the American patent had expired, and that they were not liable to pay the royalties claimed. If, on the other hand, as the plaintiffs contended, the American patent were not substantially identical with the English patent, the American patent would last for 17 years from 1880, and the defendants would, therefore, be liable not only in this action, but also for royalties up to the expiration of the American patent. By means of Muirhead's duplex system of telegraphy two submarine telegraphic messages can be sent along the same cable at the same moment in opposite directions. Formerly, when a message was sent along the cable from, say, England to America, the receiving instrument on the English side as well as that on the American side was affected by the electric current. Muirhead's patents were to render the receiving instrument at the end from which the message was sent unaffected by a message sent from that end, with the result that a message could be sent from the opposite end at the same time. The chief essential was to maintain a perfect balance of electric pressure, and this was done by means of a mechanical contrivance, used at both ends of the cable and known as Muirhead's artificial cable, in combination with certain resistances and other known electrical appliances. At the trial a number of scientific witnesses were called upon both sides as to whether the two patents were substantially identical—that is, whether the two inventions claimed were the same. The learned judge came to the conclusion that the English patent of 1876 did not contain the same combination as was found in the American patent of 1880, and that the latter was a good and novel patent. He accordingly gave judgment for the plaintiffs. The defendants appealed.

Sir Richard Webster, Q.C., and Mr. Moulton, Q.C. (Mr. A. J. Walter with them), appeared for the defendants; Mr. Finlay, Q.C., and Mr. Bousfield, Q.C. (Mr. Pollard with them), appeared for the plaintiffs.

The Court, having taken time to consider, delivered judgment on Tuesday, as already stated, allowing the appeal, the Master of the Rolls dissenting.

The **Master of the Rolls** said that the question in the action related to two patents, one in England and the other in America. If the American patent had not expired the plaintiffs were entitled to recover. The case was tried before Mr. Justice Kennedy, and he (the Master of the Rolls) was prepared to say that he had never read a judgment more accurately written, in which the learned judge went step by step through the case most carefully, and the judgment was so admirably expressed that he was unable now to add anything to it, and he was prepared to adopt it as his own. The learned judge stated the law correctly, and the question was whether the invention patented in America was the same invention as was patented in England. The patent in America was for a combination. It was so in terms, and was so claimed. That combination consisted in the relative position of certain things in it which were to do the work, and the patent was for a combination of those things in that position. Then how could the English invention be the same unless it was for the same combination? The English invention was not claimed as a combination, nor was it used as a combination. Certain of the scientific witnesses stated that the particular placing of the things as described in the American patent was a most useful invention, and that between the time of the English and the American patents the combination was not used because it was not discovered. Therefore, he came to the conclusion that the American patent was not the same as the English patent. He came to the conclusion that Mr. Justice Kennedy was right. But if the matter was left in any doubt, in order to shorten the period of the American patent the whole burden of proof rested on the defendants, and the matter being

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left in doubt, that burden had not been discharged. In his opinion the appeal should be dismissed.

Lord Justice Rigby read the judgment of Lord Justice Lopes and himself, in the course of which he said that the decision in the case depended upon one point, and one point only—namely, whether or not the United States patent of 1880 came to an end when the English patent of 1876 expired. He did not think that Mr. Justice Kennedy's findings as to the United States law could be impeached, and he agreed with the learned judge that a test of the identity of the patents was whether a structure made according to the foreign patent would infringe the United States patent. He also agreed that the burden of proving the identity of the two inventions lay upon the defendants, and that the principle of introducing into any patent by implication any claim not expressly contained therein ought to be applied with the greatest possible caution. His Lordship then proceeded to consider the construction of the two patents and the evidence relating thereto, and, having elaborately examined the two patents, and having gone through the scientific evidence upon the point, came to the conclusion that the defendants had made out their case affirmatively, and that there was no room for the application of the principle that, where there was a doubt, the doubt should be resolved in favour of the United States patentee. He did not in any way differ upon the law from the learned judge, whose judgment, he agreed, was most admirably expressed, but he did differ from him in the conclusions of fact at which he had arrived.

SHELFER v. THE CITY OF LONDON ELECTRIC LIGHTING COMPANY—MEUX'S BREWERY COMPANY, LIMITED, v. THE SAME

In the Court of Appeal on Tuesday before Lord Halsbury and Lord Justices Lindley and A. L. Smith, an important decision was given in the case of the appeals of the plaintiffs against a judgment of Mr. Justice Kekewich reported in our issue of April 27 last.

The plaintiff in the first action is the tenant, under a lease granted to him in March, 1893, by the plaintiffs in the second action, for a term of 21 years, at a rental of £70 per annum, of a public-house called the Waterman's Arms, situate at Bankside, Southwark. The plaintiffs in the second action are the owners of the public-house. The plaintiff Shelfer by his action claimed an injunction to restrain the defendants from using or working in or upon their premises at Bankside, which adjoin the public-house, any dynamo or other engine or machinery, in such a manner as, by reason of vibration or otherwise, to injure the structure, fixtures, or fittings of the public-house, or to interfere with the enjoyment by the plaintiff of the house, or his use thereof for the purposes of his business, or in any way so as to cause a nuisance to the plaintiff or injury to his house or business. The plaintiff also claimed damages for injury arising from the subsidence, vibration, and noise caused by the works and operations of the defendants, and generally for the alleged wrongful acts of the defendants. The plaintiffs in the second action made a very similar claim. The defendants contended that, in the absence of negligence on their part, they were exempted by their statutory powers from any liability to an action for nuisance, and, moreover, that no actionable nuisance had been proved to exist. It was also urged that the plaintiffs in the second action being reversioners, they had no cause of action in respect of a nuisance which was not necessarily permanent, and might have been removed before the reversion fell into possession. Section 82 of the provisional order (afterwards confirmed by Act of Parliament), under which the defendants derive their authority to carry on their works, provided: "Nothing in this order shall exonerate the undertakers from any indictment, action, or other proceeding for nuisance in the event of any nuisance being caused by them." Mr. Justice Kekewich held, upon the construction of the Acts and the provisional order under which the defendants obtained their powers, that the defendants were not exempted from liability to an action for nuisance. His Lordship further held, upon the evidence, that it had been proved that, by reason of the working of the defendants' engines, injury was caused to the premises in question by vibration and noise, and also, in some degree, structurally. Having regard to the manifest inconvenience which would result to the inhabitants of the district which the defendants supplied with electricity, if their works were stopped, his Lordship did not think fit to grant an injunction. The plaintiff lessee was, however, entitled to enquiries as to the damages caused to him as such lessee by vibration, noise, and structural injury, and to the costs of the action, and there must be judgment to that effect. As regarded the other plaintiffs, their action so far as it claimed an injunction must be dismissed with costs, it being clear upon the authorities that being reversioners they were not entitled to relief by injunction in a case such as the present. They were, however, entitled to an enquiry as to any damage done to the inheritance, but the costs of such an enquiry must be reserved. Both plaintiffs appealed, mainly on the ground that an injunction ought to have been granted. It was said that Lord Cairns's Act did not authorise the substitution of damages for an injunction in such a case as the present.

Mr. Warmington, Q.C., Mr. Badcock, and Mr. Waggett were for the plaintiffs; Mr. Moulton, Q.C., Mr. Renshaw, Q.C., and Mr. W. C. Braithwaite were for the defendants.

Lord Halsbury gave the following judgment on Tuesday morning: The two plaintiffs in this case complain of a nuisance created by the defendants by the vibration of their engines and the annoyance caused by the carrying on of their electric lighting works. Of the result and gravity of the nuisance no serious denial has been made before us. The two plaintiffs are respectively the lessee and reversioner of the house known as the Waterman's Arms. The considerations which arise are applicable to both plaintiffs, except in so far as one is lessee and the other reversioner. I will deal with this question separately. The nuisance being established, it is said, first, that the defendant company are authorised by law to carry on the business, and that they have done all that skill and care can effect to prevent any nuisance; that they are in the same position as a railway company, and they are entitled to do what they have done under the authority of the Legislature. If the analogy were a correct one, I should think the defendants had fallen very far short in the proof that they had done all that was possible to prevent a nuisance. A railway company has a definite line of operation within which it may make its works, and if it does all that can be done to prevent a nuisance in that place, the thing having to be done in that place and the traffic having to be carried on by means of locomotives over the line of railway, the Legislature is taken to have sanctioned that proceeding. No such considerations apply here. There is a difference—the object of the legislation and the results. It is not, however, necessary to deal with this part of the case, and I only mention it to disclaim the notion that I acquiesce in the allegation that it has been here proved that it is essential to the carrying on of the electric lighting business in the district in question that there should be a nuisance created. The main question turns on the Electric Lighting Act, 1882, and the provisional orders which have become Acts of Parliament. It was boldly contended by Mr. Moulton that the provisional order protected the undertaking, and that if a nuisance were necessarily created by the carrying on of the company's undertaking such nuisance was authorised and even imposed as a duty on the undertakers. I think it is only necessary to read the provisional order in connection with the tenth section of the Electric Lighting Act, 1882, to dispose of that argument. The provision in the Act, so far as relates to powers under provisional orders, is in these words: "The undertakers may, subject to and in accordance with the provisions and restrictions of this Act, and of any rules made by the Board of Trade in pursuance of this Act, and of any license, order, or special Act authorising or affecting their undertaking, and for the purpose of supplying electricity, acquire such lands by agreement, construct such works, acquire such licenses for the use of any patented or protected processes, inventions, machinery, apparatus, methods, materials, or other things, enter into such contracts, and generally do all such acts and things as may be necessary and incidental to such supply." And then, in the order relied on for the authority to create the nuisance, come the words: "Nothing in this order shall exonerate the undertakers from any indictment, action, or other proceeding for nuisance in the event of any nuisance being caused by them." The general Act only gives them power subject to the restrictions of their particular order, and the particular order makes them liable for nuisance. I have also come to the conclusion that the powers given by the seventeenth section of the Act, read together with the tenth section, are applicable to the execution of the authorised works; and when one considers how frequently the distinction between the execution of the works and the use of them when executed has been the subject of comment and discussion, I think it must be taken that the language used has been deliberately chosen by the Legislature as pointing to the distinction, now well recognised, between the construction of works and the user of them when constructed. But assuming that there is a nuisance, and that there is no authority justifying it, the question still remains, What is the relief to which the plaintiffs are entitled? But for the provision of Lord Cairns's Act, I suppose no one would have doubted that in the state of facts I have now assumed to exist the plaintiff Shelfer would have been entitled to an injunction to prevent the continuance of the nuisance. Lord Kingsdown, in the House of Lords (Imperial Gaslight and Coke Company *v.* Broadbent), has laid down the principle in words which comprehend such a case as this as follows: "The rule I take to be clearly this: if a plaintiff applies for an injunction to restrain the violation of a common law right, if either the existence of the right or the fact of its violation, he must establish that right at law (and its violation). I apprehend, unless there be something special in the case, he is entitled as of course to an injunction to prevent the recurrence of that violation." But it is said, and truly said, that the law has been altered by Lord Cairns's Act, and the question is, What construction is to be placed upon this enactment. Undoubtedly it conferred upon courts of equity the jurisdiction to award damages which did not exist before. But the question is, Did it mean to interfere with the well-settled principles upon which courts of equity were in the habit of interfering in such cases as the present? It seems to me that the defects in the powers of the equity courts which were sought to be supplied by that statute give ample grounds for the provisions of the statute, without supposing that it meant to revolutionise the principles upon which equitable jurisprudence had been administered up to that time. The language, of course, is general; the discretion given is necessarily wide enough in terms to authorise a judge to award damages where formerly he would have given an injunction. But there is nothing in this case which to my mind can justify the Court in refusing to aid the legal rights established by an injunction preventing the continuance of the nuisance. On the contrary, the effect of such a refusal in a case like the present would necessarily operate to enable a company who could afford it to drive a neighbouring proprietor to sell, whether he would or no, by continuing a nuisance, and simply paying damages for its continuance. But, while I can agree with neither Mr. Warmington

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nor Mr. Moulton upon the alternative restrictions which each respectively seeks to place upon the statute, I see no trace of any such intended alteration of the principles upon which equity should interfere with an injunction as would be involved in a refusal of an injunction here. And further, I think the question is here covered by authority of which Martin *v.* Price in this court is the last example. For these reasons I think the judgment of Mr. Justice Kekewich should be reversed as far as the refusal of an injunction is concerned, and that an injunction should be granted. The point which I have reserved for treatment in respect of Meux's action depends on their interest in the premises. They are reversioners, and the action by the reversioners can only be justified if the reversion is affected. But how is it possible to contend that the reversion is not affected if the walls of the house are so shaken by the nuisance in question that cracks are developed in the building, which experts consider will increase with the continuance, indeed, to increased sources of vibration, by the erection of larger and more powerful engines? I think there is ample evidence here of serious and permanent injury to the reversion by the continuance of the nuisance, and that, therefore, the same judgment ought to be given in respect of the reversion. As the reversioners and the leaseholder represent the entire interest, it will be proper, in respect of the assessment of damages for past injuries, to see that the defendants are not made liable for the same damages twice over. The result is that the appeal succeeds so far as the injunction is connected, and that, therefore, the judgment of Mr. Justice Kekewich should be reversed in that respect, and the defendants should pay the costs.

Lords Justices Lindley and **A. L. Smith** gave written judgments concurring.—*The Times.*

GR ST AND TURNER v. FOWLER-WARING CABLE COMPANY, LIMITED.

This case, which has been heard before the Lord Chief Justice and a special jury, was an action by a firm of electrical engineers to recover damages for breach of a contract to supply them with a cable fit for work similar to that of a telephonic exchange. The defence was that the defendants supplied the cable ordered by the plaintiffs, and were not informed of the particular use to which it was to be put. They further pleaded that the matters in dispute had already been the subject of litigation, which had been settled in the following terms: "August 24, 1893.—Received of W. Culross, Esq., the sum of £20 in full settlement either way of action and counterclaim 'Fowler-Waring Company *v.* Grist.' Defendant to consent to application to stay all proceedings if required. Wood, Bird, and Wood—£20." Mr. McCall, Q.C., and Mr. G. M. Cohen were for the plaintiffs; Mr. Channell, Q.C., and Mr. Wedderburn for the defendants.

The plaintiff's case was, says the *Times*, that in July, 1891, they ordered a 12-wire cable from the defendants, which was to be laid across the Cannon-street railway bridge, so as to enable the plaintiffs' customers to communicate across the river, as many of them had two places of business. So long as only one customer used the cable at the same time everything worked well, but when business increased and two or more customers used it at the same time there were complaints of cross-talk, which the plaintiffs contended was due to induction, arising from the 12 wires being too closely bunched in the cable. The defendants, after investigating the matter, said the mischief was caused by the manner in which the cable was laid and insulated, and they agreed to put a second cable which should be suitable. Meantime the cable company had occasion to sue the present plaintiffs in the Mayor's Court for an admitted balance of account, but there was a counterclaim for damages arising from the unsatisfactory working of the first cable. The action was, however, settled on the terms mentioned above. The second cable was laid in Jauuary, 1893, but according to the plaintiffs no complaints had been made by customers prior to the settlement of the action, nor were they aware of any defects in the cable. On September 11, however, complaints were made, and it was then found that the induction was just as bad as in the first cable, and that, in fact, the two cables were identical except as to the outer casing, which in the second cable was made of a harder substance than in the first.

Mr. Grist, one of the plaintiffs, stated that he always understood he was to be supplied with one of the defendants' anti-induction cables. The defendants were fully aware of the purposes for which he required the cable.

Mr. Gatehouse, electrical engineer, said both the cables were unsuitable for the plaintiffs' work. There was no provision in either of them against induction. Other evidence was given.

The case for the defendants was that they supplied what was ordered according to the specification. They had no knowledge of the cable being used for any special purposes, and certainly never represented either cable to be an anti-induction cable. As to the settlement of the previous action, they contended that the plaintiffs must have been aware of some complaints about No. 2, yet those complaints were suppressed so as to avoid being specifically mentioned in the terms of the settlement, which were to cover the whole of the transactions between the parties.

Mr. Mavor, the defendants' general manager, stated that when No. 1 cable was supplied he was not aware whether it was to be an aerial or an underground cable. No. 2 cable was identical with No. 1, except that it had a hard casing instead of a soft one. That, however, was only to obtain better insulation, as No. 1 had been badly insulated. It had nothing to do with any complaints about induction. In such a cable there was bound to be more or less induction, the only effective means of preventing it being the use of a return wire. Similar cables were in use all over London on the single-wire system, otherwise there was bound to be cross-talk. The use of return wires, however, would double the expense. Cross-examined: When complaint was first made he thought the cross-talk might have arisen from leakage due to bad insulation. He had written to the plaintiffs promising that the second cable should be a suitable one. It might be suitable to plaintiffs' purposes, and yet not suit their customers who used it. Anti-induction cables would be double the price of these cables. He did not intend them to think that they were to be supplied with an anti-induction cable. The use of tinfoil or leadfoil to prevent induction was out of date. The modern plan was to use double or return wires.

Other evidence having been given, and counsel having addressed the jury,

The **Lord Chief Justice**, in summing up, said the main questions were whether the plaintiffs had any claim in respect of No. 2 cable, and if yea, whether that claim was included in the settlement of the Mayor's Court action. They must remember that while, no doubt, there was generally an implied warranty that goods were fit for the purpose for which they were sold, yet if a specific known article was ordered the purchaser was supposed to know what he wanted. A letter of July 22, 1891, would rather tend to show that the plaintiffs were aware of the difference between single lead-covered wire and return-wire cable, for they were asking for a sample of each. It was also remarkable that all parties agreed not only that both cables were perfect of their kind, but also that in both of them there must be more or less induction. That being the case, it was difficult to believe that the plaintiffs really expected to get a low-priced cable absolutely free from induction. It was also curious, to say the least of it, that no tests had been made for induction, and that no customers of the plaintiffs had been called to complain about the cross-talk. The learned judge then reviewed the evidence in detail, and left the following questions to the jury: 1. Did the defendants undertake to supply a cable suitable for telephonic purposes? 2. Did they, in fact, do so? 3. If they did not, what damages? 4. In the settlement of the Mayor's Court action did both parties proceed on the basis that No. 2 cable was satisfactory, and was it intended by them that the settlement should end all questions relating to both cables?

The jury answered the questions as follows: 1. Yes. 2. Yes. 3. No damages. 4. Yes.

The **Lord Chief Justice**: On those findings I give judgment for the defendants with costs.

PRINTING TELEGRAPH AND CONSTRUCTION COMPANY.

In the Queen's Bench Division, before the Lord Chief Justice and a special jury, the case of the Printing Telegraph and Construction Company of the Agence Havas *v.* Beer came up for hearing this week.

This was an action to recover the sum of £980 alleged to be due in respect of calls on shares in the above-named company. The defendant denied that he was the holder of any shares in the company, alleging that the allotment was not properly made, and, further, that he had been induced to take the shares by fraud and misrepresentation.

Mr. Bingham, Q.C., and Mr. Crisp appeared for the plaintiff company, and Mr. Carson, Q.C., for the defendant.

The case as opened for the plaintiff was that the company was formed in 1893 with a capital of £115,000 for the purpose of acquiring and working, through the Agence Havas of Paris, certain receivers and transmitters of general news. The defendant had agreed to underwrite 1,000 shares of £5 each, and, accordingly, the public subscription being very small, the directors allotted to the defendant 980 shares. The application and allotment money on those shares was duly paid, as was also a call of £1 per share, amounting together to £1,960. A second call of £1 per share had since been made, but the defendant had not paid, and the present action resulted.

Before the case had proceeded far the parties came to an arrangement, the terms of which were not stated in court.

SOUTH STAFFORDSHIRE TRAMWAYS COMPANY.

The petition of W. Smallman and others for the winding up of this Company again came before Mr. Justice Vaughan Williams on Wednesday.

Mr. Parker (with Mr. Buckley, Q.C.) said the five petitioners had all been paid with the exception of one, who being an undischarged bankrupt had been improperly made a petitioner; but as the bankruptcy was a good many years ago, and the trustee had never interfered with the trader, he had a right to sue for goods sold and delivered. If the petition were dismissed, the petitioners should have their costs.

Mr. Eady, Q.C., for the company, said all the petitioners would be paid, including the one who had been made a bankrupt, and therefore the petition should be dismissed, with costs.

Mr. Willis Bund, on behalf of debenture-holders who could not get the interest on their debentures, supported the petition.

Mr. Levett, Q.C., for the Electric Construction Corporation, applied to be substituted as petitioners on the petition. The South Staffordshire Tramways Company were hopelessly insolvent. They had given notice to stop working the electric tramways, which was the only part of their system which paid. The Electric Construction Company had a claim of something like £30,000.

Mr. Eady: Which is disputed.

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Mr. Levett: Yes: and the only reason given is that Mr. Jabez Spencer Balfour was a promoter of my company. They think it a sufficient answer to my claim to say, "Oh! Jabez Balfour was a promoter of your company."

Mr. Justice Williams: Do you gentlemen want me to hear all about Mr. Balfour? Because all I can say is that, having had a great deal to do with his schemes, I think some of them were exceedingly good ones.

Mr. Levett said Mr. Justice Kekewich, in a debenture action, had made an order releasing £7,000 and the electric company wanted these profits to be applied to the payment of their debt

Mr. Eady was anxious that the Electric Construction Corporation should at once bring their action for finding the motive power for the trams, and he would undertake that this £7,000 should remain in court until the trial of their action. On this undertaking the petition ought to be dismissed.

Mr. Willis Bund applied that the debenture-holders should be substituted as petitioners.

Mr. Justice Williams declined to substitute the debenture-holders as petitioners. The debenture-holders could bring a separate petition if they liked. On the tramways company undertaking to give the Electric Construction Corporation a charge on the £7,000 in the debenture action, and paying costs, the petition would be dismissed.

EDMAN v. CHURTON.

This case has been tried at Leeds before Mr. Justice Charles. The plaintiffs were the Rev. Ed. Hudson Edman, rector of Thornton-le-Moor, Caistor, Lincolnshire, and his son, C. E. Harold Edman, and the defendant was Mr. Churton, electrical engineer, of Leeds Damages were sought for an alleged breach of the terms of a deed of apprenticeship, by the failure of the defendant to properly instruct the younger plaintiff in his business. A counterclaim was made by the defendant for the loss of the services of the younger plaintiff. Mr. Scott Fox appeared for the plaintiffs, and Mr. Bairstow for the defendant.

It was stated on behalf of the plaintiffs, that in 1891 the younger plaintiff, who was a minor, was apprenticed to Mr. Churton to learn the business of an electrical engineer. In 1893 he went home ill, and it was alleged that this was due to overwork and that he had not yet fully recovered his health. He stated that during his residence with Mr. Churton he had learned next to nothing. He admitted, in cross-examination by Mr. Bairstow, that no dispute or dissatisfaction arose, except in his "secret mind," at the extent of his instruction, until a dispute arose between his parents and Mr. Churton as to the amount due for his board. His father was very hard up, and was not able to pay the amount agreed upon. In the course of the dispute a letter was written to Mr. Churton by Mrs. Edman, wife of the senior plaintiff, saying that her son was very comfortable at Mr. Churton's, but that she could not afford to pay the terms for board previously arranged.

After hearing the evidence, his **Lordship** gave judgment for the defendant, remarking that the case was one which ought not to have been brought.

Mr. Bairstow, addressing the judge at the opening of the court after the adjournment, said that having regard to his Lordship's views, the defendant was disposed to relinquish his claim for costs.

His **Lordship** said that in that case the defendant had behaved very handsomely; it was an act for which he deserved the greatest credit.

JEFFREYS v. PRITCHARD AND GOULD.

On Monday, in the Westminster County Court, his Honour Judge Lumley Smith, Q.C., and a jury had before them this case, in which the plaintiff sued, under the provisions of the Employers' Liability Act, to recover damages for personal injuries sustained whilst in the employ of the defendants, a firm of electrical engineers carrying on business in Soho.

From the opening statement of Counsel it appeared that on the 16th of October last the plaintiff was employed in conjunction with other men in fitting up the electric light at a house in Hanover-square. and for the purpose of fixing up the wires he was ordered to do his work from the roof of a lift which ran down a well in the centre of the premises. While he was so engaged the lift was moved by the foreman or one of the men on the job and gave a sudden jerk upwards, with the result that the unfortunate plaintiff was thrown down and sustained a fracture of the back, from which he would never again recover. From first to last he was acting under the instructions of the foreman, and although he did not approve of working on the top of a lift he was obliged to do it. The plaintiff, it was stated, was still too ill to leave his bed, and probably never would do so again, and accordingly his evidence, which was now read, had been taken on commission.

The **House-Surgeon** of the hospital was called, and said the injuries to the back were of such a character that the man would never be able to leave his bed again, and although a careful operation had been performed he was in a worse condition than he was when admitted, and the continuance of life only depended on the most careful nursing and general attendance.

The defence was that the work which the plaintiff was given to do could have been done with absolute safety had proper care been used, and a number of expert witnesses were called in support of the defendants' case to prove that it was a very common thing when fixing up electric light wires to carry out the work from the roof of the lift and raise and lower it as necessity arose.

Plaintiff's **Counsel**, in addressing the jury, submitted that it was a highly improper thing to put any man to do work of this kind under such dangerous conditions, and the plaintiff had previously complained about it, but was told that if he did not like to do it someone else would.

His **Honour** said the question was as to whether or not the defendants' plant was defective by reason of the absence of a hand-rail on the top of the lift, and was the accident caused thereby, but there was a second question as to whether or not the plaintiff had been guilty of contributory negligence, because if so he would not be entitled to recover damages against defendants.

After a hearing which occupied practically the whole of the day the jury found a verdict for the plaintiff, and assessed the damages at £150

Judgment was so entered, with costs.

IMMISCH ELECTRIC LAUNCH COMPANY v. WHITE.

Before Judge Holl, at the Windsor County Court on Friday, an action was brought by the Immisch Electric Launch Company, Limited. against Mr. F. W. White, of Windsor, to recover £21. 9s. 6d as compensation for damages caused to the "Viscountess Bury" launch through the alleged negligent navigation of the defendant's vessel

The **Plaintiffs** stated that while the "Viscountess Bury" was being pushed away from the Windsor landing place, upon the occasion of the races, the "Amo" came astern before she had time to get away. and a collision occurred.

For the defence it was contended that the "Amo" was waiting for the "Viscountess Bury" to go out, that she was not being pulled astern, and that the collision was really caused by the "Viscountess Bury" getting too much across stream while attempting to go through the centre arch of Windsor Bridge.

The **Judge** decided in favour of the plaintiffs and allowed the amount claimed.

COMPANIES' MEETINGS.

ELMORE'S GERMAN METAL COMPANY, LIMITED.

The third annual general meeting of the above Company was held on Wednesday at Winchester House, Mr. John McFarlane presiding.

The **Chairman** stated that the loss of £12,076 8s. 2d shown in the metal balance-sheet did not represent the loss for the one year, 1893, but for the period since the formation of the Company, and it is all but covered by the profit of £11,750 made by the German and Austro-Hungarian Company in 1894, and referred to in the report submitted with the accounts. A great advance had been made as compared with 1893 There were no bad debts The preference share issue had been a success. and there was a reduction in the debenture liability. He was sanguine as to the future of the Company. He moved the adoption of the report and accounts.

Mr. John Heal seconded the motion, which was carried.

NEW TELEPHONE COMPANY, LIMITED.

An extraordinary general meeting of this Company was held on Wednesday at the Cannon-street Hotel to consider a resolution for winding up the Company voluntarily. Mr J. S. Forbes presided

The **Chairman** stated that the purpose for which the Company was created had been served, and experience showed that the interests of the telephone business and of the public would be better served by having the complicated work which had to be performed carried on by one company instead of by two. The New Company had accepted certain obligations to individual subscribers, and they had carried these out loyally but the time had now come when it was thought that it would be much better for the New Company to be wound up The places in which business had been carried on were very few, and the business itself was on a comparatively small scale. The capital of the Company subscribed and paid up was, however very large, and a good deal of it was lying aside absolutely unproductive. They felt that this capital ought to be restored to those to whom it belonged He concluded by moving the resolution.

After some discussion the motion was adopted.

British Aluminium Company.—The British Aluminium Company, Limited, is a new Company with a share capital of £300 000, divided into 20,000 7 per cent. cumulative preference shares and 10,000 ordinary shares of £10 each. Fifteen thousand 7 per cent. cumulative preference shares have this week been offered for subscription. The preference shares will also be entitled to one-half of the surplus profits after the ordinary shares have received a dividend at the same rate, and to priority in distribution of capital. The Company has been formed for the purpose of making aluminium in this country by an electrical process now carried on by the Société Anonyme pour l'Industrie de l'Aluminium de Neuhausen (Aluminium-Industrie-Actien-Gesellschaft) in Switzerland, and by the Société Electro-Métallurgique Française at Froges (Isère, France), and of carrying on the manufacture of aluminium and its alloys.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Scarborough.—The Lamps Sub-Committee of the Town Council have been instructed to obtain tenders for the lighting of certain streets in the borough by electricity.

Portsmouth.—The Town Council invite tenders for the purchase of certain electrical plant at the Town Hall, Portsmouth. We have already given particulars. Tenders must be sent in by to-morrow (22nd inst.).

Edmonton.—Tenders are invited for the supply, delivery, and fixing of a system of electric call bells and telephones, for fire brigade and Local Board purposes, for the Edmonton Local Board. Tenders must be delivered by noon to-day. We gave particulars last week.

Walsall.—Tenders are invited for alterations to buildings at the Wolverhampton-street gasworks, including the construction of boiler-house, dynamo-house, offices, and other works for an electricity generating station, for the Corporation. Tenders are to be sent in by the 24th inst.

Great Yarmouth.—Tenders are invited for installing the electric light at the Town Hall, free library, and Great Yarmouth police station, for the Town Council. Drawings and specifications can be seen and forms of tender can be obtained at the office of Mr. J. W. Cockrill, A.R.I.B.A, A.M.I.C.E., borough surveyor, Municipal Buildings, Great Yarmouth. Tenders, to be separate for each building, to be upon the form and in the envelope supplied, are to be delivered at the office of Mr. T. M. Baker, town clerk, before noon on January 2.

Birmingham.—The committee of the Birmingham Municipal Technical School invite tenders for the installation of the generating plant, fittings and appliances for both the electric lighting and transmission of power by electricity in the new school. Plans of the building may be seen, and specifications and forms of tender obtained, at the offices of Messrs. Hy. Lea and Thornbury, consulting engineers, 38, Bennett's-hill, Birmingham, on a deposit being made with them of £2. 2s., which will be returned on receipt of a *bonâ fide* tender. The committee do not bind themselves to accept the lowest or any tender, and no tender will be considered except upon the prescribed form and accompanied by an undertaking that not less than the minimum standard rate of wages current in the district is paid by the contractor and sub-contractors (if any). All tenders must be sent in to Mr. Geo. Mellor, secretary, endorsed "Tender for Lighting," on or before January 12.

Hanley.—The Corporation of Hanley are prepared to receive tenders for the supply and erection of the following plant: Contract No. 10—extension of engine-house plant, including 200-kilowatt alternator, 25-kilowatt alternator, and 20-kilowatt exciter, each separately driven by a compound steam-engine, with all necessary steam and exhaust pipes, valves, switchboard, and appurtenances; Contract No. 11—extension of condensing plant, consisting of circulating pump, air-pump, boiler pump, surface condenser, with all necessary pipes and appurtenances. The drawings can be inspected, and specifications, prepared by Mr. G. H. Cottam, Corporation electrical engineer, together with general conditions and forms of tender, can be obtained at the offices of Mr. Joseph Lobley, Town Hall, Hanley, on payment of 5s. Tenders are to be delivered to Mr. Arthur Challinor, town clerk, on or before January 5, 1895. The Corporation do not bind themselves to accept the lowest or any tender.

RESULTS OF TENDERS.

Worcester.—The tender of Messrs. Verity and Sons has been accepted for the substitution of three electroliers for three sunlights in the assembly-room at the Guildhall, with wiring, at the price of £49. 12s. 9d.

Enniscorthy (Ireland).—The tender of Messrs. W. Curtis and Sons, Middle Abbey-street, Dublin, has been accepted for providing the Enniscorthy District Lunatic Asylum with internal telephonic communication.

Aberdeen.—The Gas and Electric Lighting Committee of Aberdeen Town Council have held a meeting to consider the tenders lodged for the supply of a new engine, dynamo, and other necessary plant for the extension of the electric lighting system. A report by Prof. Kennedy, London, to whom the tenders had been submitted, contained an analysis of the specifications. In Prof. Kennedy's opinion the offer of Messrs. J. H. Holmes and Co., Newcastle, which amounted to £3,300, was the best and cheapest, and the committee decided to accept that offer. The tenders sent in were as follows:

Johnson and Phillips	£3,860
Mather and Platt, Limited	3,820
Electric Construction Company, Limited ...	3,742
Easton, Anderson, and Goolden, Limited ...	3,600
Siemens Bros. and Co., Limited	3,578
Crompton and Co., Limited	3,493
J. H. Holmes and Co.	3,300

City and South London Railway.—The receipts of the Company for the week ended December 16 were £962, against £909 for the corresponding week of 1893, or an increase of £53. The total receipts for the current period of the present half-year amount to £21,479, as against £20,097 in the corresponding period of 1893, an increase of £1,382.

BUSINESS NOTES.

Blackburn.—The use of the electric light is extending.

Cheltenham.—Enquiries are being made as to the probable cost of lighting the library by electricity.

Belfast.—The electric light has been installed in the Empire Theatre.

Milford Haven.—The electric light has been installed in St. Catherine's Church.

Rimington.—The electric light has been introduced into Newby Mill, there being 45 16-c.p. lamps employed.

Hucknall.—The chairman of the Local Board has stated that he hoped the town would soon be lighted by electricity.

Hove.—The Library Committee of the Town Commissioners have rearranged the electric light in the reference-room.

Appointment.—Mr. Ross Cotton, of London, has been appointed assistant electrical engineer to the Local Board, Halifax.

Whitechapel.—The new Pavilion Theatre, which is to be opened on Boxing Day, will have the stage lighted electrically.

Plymouth.—There has been some conversation in the Borough Council as to whether the Theatre Royal ought not to be lighted by electricity.

Eastern Telegraph Company.—For the quarter ended September 30 an interim dividend of 2s. 6d. per share is announced, payable on January 14.

Harrow.—A ratepayers' meeting has passed a motion asking the Harrow Local Board not to proceed any further with the electric lighting question.

Kilwinning.—Nine 16-c.p. lamps have been fitted in the underground passage at Messrs. William Baird and Co.'s Lady Sophia pit. There are 24 larger lamps on the surface.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 16th inst. amounted to £917, as compared with £634 in the corresponding week of last year.

Coventry.—On the recommendation of the Electric Light Committee, the City Council have resolved to charge 4d. per Board of Trade unit for current supplied for other purposes than lighting.

Wakefield.—Mr. Lee, the chairman of the Electric Lighting Committee of the City Council, has stated, in reply to Mr. Sherwood, that the committee had not yet done any actual business in regard to electric lighting.

Yacht-Lighting.—The twin-screw steam yacht "Giralda," which has been built by the Fairfield Company, of Govan, for Mr. McCalmont, is lighted electrically, and has two search-lights of the Admiralty pattern.

Burton.—The following are the members of the new Gas and Electric Light Committee of the Town Council: Alderman Lowe, Councillors Austin, Auty, Cain, P. Evershed, Graham, T. E. Lowe, Metcalfe, Morris, Blackhall, Oliver, and Turner.

Harrogate.—The following have been appointed members of the Electric Lighting Sub-Committee: the Mayor, Aldermen Hammond and Simpson, Councillors Chippendale, Hudson, Morrison, Oxley, Simpson, Thwaites, and Ward.

Woking.—The surveyor reported to the Local Board last week that he had had an interview with Mr. Mayne, and while no positive guarantee would be given, the electric light company expected to have everything finished by December 22.

Bedford.—The electric light is creating a very favourable impression in the town. Among the buildings lighted are the Town Hall, the Council-chamber, and the Modern School Hall. The heaviest load on the station has been equal to about 14,400 c.p.

Heywood.—Councillor Chadwick, at a meeting of the Town Council, stated that he should like the Gas Committee to take into their serious consideration the question of preparing for the adoption of electric lighting in the town. Other members spoke to similar effect.

Forfar.—Mr. Forbes Waddell, the new Corporation gas manager, states that as the electric light has now been adopted in most of the factories in Forfar, the sale of gas under that head has steadily decreased from 7,500,000 cubic feet in 1891-92 to 3,000,000 cubic feet in 1893-94.

Liverpool Electric Supply Company.—The Lighting Company of the Liverpool Corporation have decided to recommend the Council to offer to purchase the undertaking of the Liverpool Electric Supply Company instead of waiting until the time arrives when the Corporation can compel the Company to sell.

Fire Brigade Communication.—The Fire Brigade Committee of the London County Council reported on Tuesday that they had sanctioned the establishment by Messrs. Strode and Co., at a cost of £27, of electrical communication between the Tooting fire-engine station and lodgings occupied by men attached to that station.

Aberdeen.—A sub-committee of the Town Council have been instructed to take the requisite steps for having the fire stations electrically connected with the house of each fireman, with the offices of the gas and water departments, telephone exchange, and with special telephone between the police office and fire station.

Electric Battery Company, Limited.—This Company has been registered with a capital of £30,000 to adopt an agreement, made December 7, 1894, between H. T. Barnett of the one part and T. J. Moffett, for the Company, of the other part, and to manufacture and deal in batteries, motors, etc., in accordance with certain patents to be acquired by the Company.

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Metropolitan Electric Supply Company, Limited.—This Company announces the payment by warrants on January 1 next of interest from July 19 last (or from the respective dates of payment of instalments) to December 31 on the 4½ per cent. first mortgage debenture stock. The transfer books are closed from December 18 to December 31, both days inclusive.

Victoria Electric Railway Company.—The numbers are published of the 5 per cent. first mortgage debenture bonds of the Victoria Electric Railway and Lighting Company, Limited, amounting to £1,000, which have been drawn for repayment on and after January 2, 1895, at the rate of £105 per cent., in accordance with the provisions of the trust deed.

Islington.—At a meeting of the Vestry a report was received from the Special Electric Lighting Committee recommending that the offer of the lessee of 5, Burnard-place, to assign her interest and to give possession of this house to the Vestry upon payment of the sum of £350, and her surveyor's fees under Rhyde's scale, be accepted subject to a good title being shown. The report was agreed to.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,937. The following telegrams have been received by the Western and Brazilian Telegraph Company, Limited, from their representative in Rio de Janeiro: "12th—Bill passed second reading Upper House yesterday;" and "14th—Purchase passed third reading in Senate yesterday, and sent to President for sanction."

New Swindon.—The clerk to the Local Board has produced a draft of the provisional order for lighting the district electrically, and suggested that the streets to be included in the first draft should be what he might term the "inner circle"—Bridge-street, Regent-street, Regent-circus, Commercial-road, Milton-road, Farringdon-street, and Fleet-street. On the proposition of Mr. Longland, seconded by Mr. Batt, it was resolved to include these streets.

Worcester Extension.—The contract for lighting the works and offices of Messrs. Hill, Evans, and Co. with electricity has been entrusted to Messrs. B. Verity and Sons, through their agents, Messrs. Alfred Mann and Sons, of High-street. The same firm have also secured the order for the fittings required in the Shire Hall and Law Courts. The electric pumps recently fixed at the waterworks are now pumping water to the high-level reservoirs at Elbury Hill, and are performing the work in a satisfactory manner.

Bristol.—The Electrical Committee met at the Council House on Friday, when there were present Mr. George Pearson (in the chair), Alderman Pethick, Councillors Bastow, Hill, Hughes, Lloyd, Pembury, Tryon, and Wills The committee determined not to extend the main along Boyce's-avenue and the west side of Victoria-square at present The engineer informed the committee that Mr. Duncan, one of the improvers, had secured an appointment as assistant engineer at the Cheltenham Corporation electric light works.

Ayr.—The engineer reports that the new site in Mill-street for the electric installation at Ayr was proving from the borings a most excellent one. Without any extra expense beyond the ordinary excavation, the Council would be able to arrange for the foundations to rest upon the solid rock. The cost of the site is £1,550. The Ayr Harbour Trustees have been offered by Ayr Town Council a supply of electric light for the harbour, on condition that the trustees provide the lamps and other plant required, and pay at the rate of 4d. per unit.

Luton.—Mr. Wilkinson, at a meeting of the Town Council, proposed that a memorial be forwarded to the Board of Trade, praying for the grant of a provisional order for the supply of electricity in the borough, in the terms of the draft proposed order, or as the Board of Trade deemed fit. Mr. Smith seconded, and the motion was carried with one dissentient. The clerk read the borough surveyor's estimate for carrying out the scheme—viz., £10,000. It would also be necessary to send a cheque for £50. It was resolved that the documents and the cheque be sent to the Local Government Board.

Carlisle.—The minutes of the Gas Committee of the Town Council showed that the engineer had reported to the committee that the town clerk had forwarded communications respecting the Carlisle electric lighting order, and that he had been instructed to confer with the town clerk on the draft provisional order submitted. The minutes also showed that the committee had passed resolutions that the sum of £40,000 be the amount asked for in the Carlisle electric lighting provisional order, and that the sum of £100 be remitted to Messrs. Mellor, Smith, and May on account of expenses in connection with the electric lighting order. The minutes were confirmed.

Brayton Petroleum Motor Company, Limited.—This Company has been registered with a capital of £80,000 to acquire letters patent granted, or to be granted, to Hugh Thompson Reid by the Governments of Germany, France, Belgium, Italy, Spain, Austria, Russia, and India for improvements in hydro-carbon engines, and the inventions therefor, and also any improvements already made, or hereafter to be made, in the said invention; to acquire any other patents and inventions which may seem capable of being turned to account by the Company; as iron, brass, and other metal founders, fitters, engineers, toolmakers, millwrights, colliery owners, chemists, etc.

Llandudno.—Mr. William Williams, in supporting a vote of thanks to Mr. John Jones, the chairman of the Improvement Commissioners, alluded particularly to the chairman's action with regard to the electric light. He stated that it was due to the chairman's energy that the local authority had the power to carry out an electric light undertaking. At a special meeting of the Llandudno Improvement Commissioners, held on Tuesday, the seal of the Board was ordered to be attached to a memorial to the Board of Trade upon the grant of a provisional order to supply electricity within the Commissioners' district, and a cheque was drawn to cover preliminary expenses.

City of London Electric Light Company.—The warrants for the interest payable on January 1, 1895, at the rate of 5 per cent. per annum for the six months ending 31st inst., on the City of London Electric Lighting Company's first issue of £100,000 debenture stock will be posted on the 31st inst. The directors of the Company announce the further issue at £128 of £200,000 5 per cent. debentures redeemable at the option of the Company at £125 on six months' notice after 1910, and secured as a first charge by way of floating security upon the whole undertaking. The Company has a capital of £800,000; the gross annual revenue is estimated at over £100,000, and the amount expended to the end of October on land, buildings, plants, etc., was £963,571.

Halifax.—Mr. Wilmhurst and his staff have been busy extending the Corporation electric light supply to business and other establishments in the town, and between 20 and 30 customers are now having their premises illuminated from the works in Foundry-street. Among those in enjoyment of the privilege are the Masonic Hall, Messrs. T. Simpson and Sons, Messrs. Hodgson, Messrs. Whitley and Booth, Mr. G. Davis, Mr. C. E. Rose, Mr. F. Buckley, Messrs. Seed Bros., and Messrs. Murgatroyd and Horsfall, in addition to Trinity-road Baptist Chapel, which was lighted up with the electric light for Sunday evening's service. From first to last not a single hitch has been experienced with the machinery. Messrs. Ullerthorne and Hartley, electricians, have a brilliant electrical display at the shop of Mr. Ward, plumber, Broad-street, the latter of whom is among the present customers of the Corporation.

The "Cruto" Incandescent Lamp.—Under the title of the Cruto Incandescent Lamp Agency, Limited, of Dock House, Billiter-street, E.C., a company has been formed to acquire the sole agency for the supply in the United Kingdom of the incandescent lamps manufactured by the Societa Italiana di Elettricita Sistema Cruto, of Turin. The feature of the latter's factory is that the whole of the air-pumps and other machinery required in the manufacture of the lamps are driven by water power, and the company consequently claim that they are able to manufacture lamps of the highest possible quality at a moderate price. The Cruto lamp consumes 3·2 watts per candle per hour. This fact, the company state, combined with a life of 900 to 1,000 hours, makes it the cheapest lamp obtainable. The Cruto lamp has been awarded medals at various exhibitions, and, after exhaustive tests, it has been adopted for the Italian navy.

Leith.—A preliminary test has taken place of the plant which has now been all but completed for the electric lighting of the Victoria Dock and the Old Docks, Leith, the Commissioners having decided to have the plant subjected to trial at these docks before extending it to the Albert and Edinburgh Docks. The machinery has been placed in a building adjoining the Commercial Graving Dock. The generating plant consists of two engines and two large dynamos. The lighting is to be done by means of arc and incandescent lamps, large arc lights being suspended from poles on the quays and from the side of the sheds, and smaller ones being hung inside of the large sheds, with incandescent lights of a smaller size on the south side of the Victoria Dock. The plant is expected to be completed and ready for operation in about a week. The installation of the electric light, which has cost about £4,000, has been carried out by the Brush Electric Lighting Company, under the supervision of Mr. E. G. Craven, superintendent for Scotland.

Swansea.—The General Purposes Committee of the Swansea Corporation have decided to light the compulsory area by electricity on the high-tension alternating-current system, and to use a refuse destructor in combination therewith. The streets comprised in the compulsory area are: Quay-parade, Mount-street, Wind-street, Castle-square, Castle Bailey-street, Temple-street, Castle-street, High-street, Alexandra-road, Grove-place, De la Beche-street, Cradock-street, Union-street, Oxford-street, Dillwyn-street, Northampton-place, Goat-street, and Caer-street. The sub-committee have reported that they have consulted Mr. Manville, of London, who had estimated the cost of lighting the town by electricity at about £47,000. The question of the site of the works was not gone into for the present. The report was adopted, and it was decided to place the work in the hands of Mr. Manville at a remuneration of 5 per cent. on the estimated outlay. The question of the acquirement of the tramways by the Corporation was gone into, and a sub-committee appointed to report upon the scheme to the whole of the committee.

City.—The City Commission of Sewers held a meeting on Tuesday, when Mr Johnson enquired whether any progress had been made towards securing an advantage to the public by means of a bargain with the City Electric Lighting Company for the use of the telephone tubes, or whether there was any fear that by undue delay the Commission might be placed in a false position. Mr. Burmester, in replying, explained that in July Mr. Gordon placed on the paper of business a motion to accept an offer of the company for the use of the tubes in question, but that offer was not officially before the Commission, so it could not be described as a bargain. But the sense of the Commission was against any such offer, notwithstanding that it was one which, in his opinion, should have been accepted, it being somewhat in excess of what the company was prepared to offer originally. The question was, how-

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ever, still before the Streets Committee. The clerk read a letter from the solicitor to the London County Council, asking the Commission to assist the Council in an enquiry as to the number of transformer stations in the City. Mr. Baylis said he thought there could be no objection to the giving of the information. The Court concurred.

Kingston-on-Thames.—Major-General C Phipps-Carey has held a Local Government Board enquiry into the application of the Corporation of Kingston for an extension of the municipal boundaries so as to include the whole of the civil parish of Kingston and the adjoining parish of Ham. In the course of the enquiry Mr. W. H. Preece was called, and in reply to Mr. Bidder, Q.C., he said he had examined the electric installation of the Corporation of Kingston. They had consulted him in reference to it, but not professionally. He believed it was quite an "up-to-date" installation. Assuming that Surbiton and the other districts surrounding the borough required lighting by electricity, it would be more advantageous and cheaper to supply them from one central station than from a number of independent stations. If they had three or more separate installations in the district it would involve a much greater expense in plant. The Kingston works readily lent themselves to extension. A much less number of men would be required on the working staff at one central station than at a number of separate stations, and only one set of machinery would be necessary. The Kingston works escaped the floods; the machinery never stopped.

Edinburgh.—The Lord Provost's Committee of the Town Council are considering whether it is advisable to lay down high-tension cables from the central electric light station to Nicholson-street. At Tuesday's meeting of the Town Council Mr. Auldjo Jamieson, in accordance with notice, asked the convener of the Electric Lighting Committee (1) what was the reason of the delay in the completion of the electric lighting system of the city, (2) when was it confidently anticipated that the system would be introduced and the supply afforded to intending consumers? Mr. Mackenzie replied that the reason of the delay was mainly in consequence of the Corporation having wisely decided to make the power station sufficiently large to accommodate all the machinery which might be required to light the whole of Edinburgh. As to the second branch of the question, he might state that Prof. Kennedy had been in Edinburgh on the previous day, and in answer to a question stated that from the progress of the work he saw no reason for changing the opinion he had expressed two or three months previously, that they would have the current turned on in the month of March. Prof. Kennedy was certain that they should have the current turned on then. He (Mr. Mackenzie) did not commit himself to the beginning, the middle, or the end of March, however. They would not have the whole of the public lighting started by March, but they would have Princes-street in full blaze. The new dental hospital which has been opened in Chambers-street is lighted electrically.

Cardiff.—A meeting of the Cardiff Lighting Committee has been held under the presidency of Alderman Fulton. Tenders for a six months' supply of steam coal for the electric lighting station at Canton were received. Fifteen estimates were sent in, but the selection was deferred. A letter was read from Mr. Yeaman, the newly-elected engineer, regretting that his employers, the Croydon County Council, would not release him from work at so short notice, thus preventing him from entering on his duties at Cardiff till the beginning of next year. It was decided to communicate with Mr. Yeaman, asking him to acquaint the committee with the earliest date on which he could come to Cardiff. At a meeting of the Lighting and Electrical Committee of the Cardiff Corporation on Tuesday morning, under the presidency of the Mayor (Alderman P. W. Carey), attention was called to the necessity of lighting up a number of back lanes in various parts of the town, but the Mayor suggested that the responsibility of taking this step should rest with the Council. If they once began to light up back lanes it would mean a considerable expense, as there were some scores of such lanes in the town. There were also many of the principal thoroughfares which were at present badly lighted, and these needed attention first. The recommendation of the borough engineer to erect new lamps in certain streets was adopted. Mr. W. H. Massey said his attention had been called to a letter in which complaints were made about the irregular nature of the incandescent light. If there had been any irregularity the committee ought to know it, but, if not, such damaging statements ought not to be made. Mr. Harpur knew whether the light had been working regularly or irregularly. Mr. Harpur said there had not been any irregularity, and he had not had a single complaint from any customer.

Portsmouth.—The third direct-driven alternating dynamo, a duplicate of those already in use at the Portsmouth electric lighting works, is rapidly being put in position. Messrs. Yates and Thom, the builders of the driving engine, say that no engine of the kind has ever been put out in the time. The dynamo, which has been built by Messrs. S. Z. de Ferranti and Co., now remains to be erected, and under the terms of the contract, unless the engine is in running order by Christmas Eve the contractors are liable to a fine of £100 apiece. There is no doubt, however, that barring accidents, the dynamo will be in complete running order by the day named. The work has been much facilitated by the fact that the Electric Light Committee had a third foundation built at the time that the first two engines were erected, thus avoiding the danger involved in doing the brickwork close to the moving machinery. The new engine is of 330 h.p., and the dynamo has a capacity of 5,000 16-c.p. lights, but the applications as yet made are considerably below that limit. There will be a great advantage, however, in the fact that there will be a spare engine should any breakdown occur. For the past few weeks the engines have been working up to their full capacity, and the fact that a slight breakdown would mean the shutting off of some of the lights, has been a source of no little anxiety to the engineers. Alderman Ellis, the chairman of the committee, states that after Christmas it is hoped to considerably extend the electric lighting area, and that estimates are already being prepared with a view to the proposed extension. A large number of applications has been received from residents and tradespeople outside the prescribed area—principally in Marmion-road and Castle-road, Southsea, Arundel-street, Landport, and at North End. The engine-room affords space for no less than eight dynamos similar to those now in use.

Radcliffe.—The Local Board have had a meeting at which it was reported that a committee had resolved that the seal of the Board be affixed to a memorial to the Board of Trade, asking for a provisional order giving the Board power to apply for borrowing powers to borrow money to carry out the proposed system of electric lighting. In the course of a discussion which ensued, the Chairman stated that it was very likely the committee would decide to ask for borrowing powers for £20,000. He did not think it was likely that such a sum would be borrowed. In answer to Mr. Brooks, the Chairman said that the amount of money likely to be asked for would be inserted by the Electric Lighting Committee. They would probably ask for £20,000, but they might not spend £5,000. Mr. Brooks objected to this proceeding, and contended that before the seal of the Board was attached to the memorial the committee should meet and agree as to what amount should be asked for, and their recommendation should come before Board and considered as part and parcel of the memorial. The Chairman intimated that the memorial had to be in by a certain date. Mr. Brooks: It is the first time such a thing has been attempted to my knowledge, and I shall object to the committee deciding what amount shall be asked for without the Board considering that matter. The Chairman: It is the first time we have had to deal with such a thing as sending a memorial within a certain time to an authority in London. It was explained that it was absolutely necessary that the memorial should be in London by a certain date, but although the committee would ask for powers to borrow £20,000, it did not follow that they would borrow anything like that amount, and the Board would have to sanction any application to the Local Government Board for an order before it was made. The resolution as mentioned was agreed to, and the matter dropped.

Ealing.—Mr. C. Jones, the surveyor to the Local Board, has stated that 63 applications had been received for private installations of the electric light, these applications being for 4,000 8-c.p. lamps. In regard to these applications, 44 connections (2,649 lamps) had been made. Some 39 of the public arc lamps were now in working order, and between 60 and 70 gas lamps in the streets into which the electric light had been introduced had been extinguished. The surveyor was questioned as to delays that had occurred in repairing the paths that had been disturbed by the laying of the electric light mains, in erecting the arc lamps along the Uxbridge-road, and in making the private installations applied for. In response to these questions, he stated that he was endeavouring to come to an arrangement by which the paths would be temporarily repaired until the spring, when they could be permanently retarpaved; the delay in the making of the private connections was due to a want of transformers; and the non-erection of some of the lamps along the Uxbridge-road was owing to the non-delivery of the iron standards. The surveyor added that, compared with the time that had been occupied in effecting electric light installations in other towns, the work in Ealing had been rather quickly pushed forward. As regarded the private installations, the installations were made according to the date of the applications for them, priority being given to the applications that were first received. The Chairman said he had also heard complaints of delay in making the private connections. He thought, however, that the Board had done fairly well in bringing the scheme to the point of completion it had reached within the period the work had occupied. The clerk was directed to write urging that the standards required for the public arc lamps should be furnished as quickly as possible.

Glasgow.—For some considerable time past the Glasgow Post Office authorities have been much hampered by the lack of accommodation afforded by the present premises in George-square, and during the past four years a large building has been erected on ground in Ingram-street, to the south of the building, to meet the increasing requirements of the department. This building has now been completed, and will be used for the first time in connection with the extra work which falls to be dealt with at the Christmas season. One of the first buildings in the city to adopt electric lighting, the current in the post office has been obtained from the city supply station. Owing to the additional supply of current required in the extended building, the question of laying down the generating plant necessary for the lighting of the whole building was at an early stage considered by the Post Office authorities, and the estimates were prepared by Mr. W. H. Preece, C.B., F.R.S., the engineer-in-chief to the Department, which showed that a large saving would be effected by following that course. The work of carrying out Mr. Preece's specifications has now been completed. The new plant has been erected in the basement of the new block, and has this week been brought into use. Every modern improvement has been utilised by the authorities, and when the telegraph department move into the new building in the course of a few months it is proposed to use the current generated by the new dynamos for working all the telegraph instruments at the head office, 5,000 primary cells being replaced by 250 secondary cells.

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By this means a very large saving in the cost of maintenance will be effected, as the primary batteries at a busy office like Glasgow require constant attention, and their elements require frequent renewal. All the work has been carried out under the supervision of Mr. E. Ashton, superintending engineer of telegraphs for the western district of Scotland.

Elmore's American and Canadian Patent Copper Depositing Company.—"A Shareholder" writes to the *Financial News* as follows on the subject of this Company: "Having regard to the impossibility of obtaining satisfactory or definite information with regard to the progress of this Company, I venture to trespass upon your space with a view to bring to the recollection of other shareholders a company which, were it not for the losses it seems likely to entail upon numerous persons, might very easily be forgotten. In the prospectus dated January 26, 1892, was intimated the intention of the Company to erect in New York 'plant of a sufficient size to demonstrate, on a working scale, the merits and simplicity of the invention, the extraordinary low cost of manufacture, and the enormous advantage to users of the articles when so made.' In a later paragraph the directors expressed their great satisfaction in announcing that Messrs. Jere. Abbott, and Co. had accepted the commercial agency for the United States In a circular letter dated October 31, 1892, issued 'by order of the Board,' it was stated that after careful consideration and conference with Messrs. Jere, Abbott, and Co., the Board decided that the interests of the proprietors would be best served by postponing the erection of a trial plant in America, the reason being that the Board was convinced that the mere erection of such plant and the demonstration of the process on a comparatively small scale would be insufficient to effect a re-sale of our property. No doubt many, like myself, desire to ascertain what chance, however remote, there may be of obtaining some return for our money; and as the directors do not seem to be exhibiting any undue haste in giving effect to their anxiety to meet us in general meeting, you may bring the matter before somebody competent and willing to afford some reliable information. It would be a source of gratification to know who, if anyone, besides the vendors and promoters, is likely to obtain any pecuniary benefit from a company the avowed objects of which have been so ingeniously conceived and so brilliantly carried out."

Warwick.—An electric light installation has been completed at Warwick Castle. Every portion of the castle is lighted, and about 500 lights are altogether used. In lighting such a historic place as Warwick Castle great care was required to be exercised as to the manner in which the wires were introduced into the various apartments and also in the disposition of the lights themselves, so that they should be in harmony with the style of the place. In all the state apartments and in the large hall the electric lamps have been adapted to the existing chandeliers and wall brackets, in most cases being fitted on imitation candles and prettily shaded with white silk shades, so that the general effect of the old style of lighting is retained. In the private apartments the same plan is adopted, the lights being fitted in shaded lamps of various descriptions, giving a soft and pleasant light. The whole of the bedrooms are lighted and also the servants' quarters, gas being entirely dispensed with. A special feature has been made of the lighting of the approach from the lodge to the castle, electric lamps being placed as to thoroughly light the carriage drive. These lights are controlled both from the castle and the lodge, so that they can be turned on or off in a moment from either end of the drive when required. The electric current for supplying this large number of lights is generated by machinery placed in the old mill close to the castle, the motive power being obtained partly from a turbine worked by the River Avon, and partly by means of a gas engine. There are two dynamos, each capable of supplying 250 16-c p. lamps, one being attached to the turbine and the other to the gas-engine, the latter being specially held in reserve for times when the water power may be deficient in times of drought or flood. An accumulator is provided for storing a sufficient amount of current for use when the dynamos are not working, so that the light is available for use at all hours, both by day and night. The whole of this installation has been carried out, under the consulting engineer, Mr. Vaughan Fowler, M I.E.E., by Messrs. Edmundsons, Limited, of Great George-street, Westminster. The turbine has been supplied and fitted up by Messrs. Gilkes, of Kendal.

Brighton.—A report of the engineer, Mr. Arthur Wright, which was considered yesterday by the Town Council, is dated December 10, and says: "As the arc lighting of the principal streets at our present prices will be so little in excess of the price at present paid for gas, and the improvement in the illumination will be nearly as great as that which was effected by the electric lighting of the King's-road, I recommend the committee to at once make arrangements for lighting the following principal roads and streets by means of arc lamps—viz., Queen's-road, West-street, Western-road, North-street, East-street, Preston-street, Old-steine, St. James's-street, Marine-parade, North-street Quadrant, part of Ship-street, and the central valley northwards to New England-road. On the supposition that the committee decide to adopt my recommendation, the scheme would involve the use of 115 six-ampere arc lamps, 40 of which I propose should be extinguished between 11 and 12 o'clock at night, the remaining 75 being burned all night. The capital outlay required for the above 115 arc lamps will depend to a certain extent upon the designs chosen for the pillars and arch supports, but I do not think the inclusive cost of the lamp wires, lamps, pillars, and arch supports will exceed £5,200." The Electric Committee, of which Councillor Stafford is chairman, announce that they have carefully considered the proposals contained in the above report, and recommend the same to the Council for adoption. To enable the scheme to be carried out, it is necessary that the contract with the gas company of June 9, 1893, for lighting the Marine-parade, should be determined as from June 24, 1895, and that the contract with the gas company of October 31, 1890 for the lighting of the remaining street lamps in the borough should be determined as from the same date, so far as regards the lamps in the streets named in the above report, and the committee recommend that notices be given to the gas company determining such contracts. The committee further recommend that application be made to the Local Government Board for sanction to borrow, under the powers of the Public Health Act, 1875, the sum of £5,200 for a period of 25 years, to defray the cost of the new lamp columns, lamps, supports, and appliances.

Dewsbury.—The report of the Gas and Lighting Committee stated that an order for six arc lamps and pillars was given to Messrs. Crompton and Co., London, at £23 per lamp, to be ready for lighting on December 21. The following appointments were made for the electric lighting station: J. H. Windham, Cheltenham, dynamo attendant, £1; S. Mitchell, Bradford, jointer, £1. 15s.; D. H. Chadwick, Dewsbury, engineer, £1. 18s.; Thos. Newsome, Dewsbury, stoker, £1. 4s.; Jabez Auty, Dewsbury, joiner, £1. 10s.; Jackson Best, Dewsbury, clerk, £1. 6s.; C. M. Shaw, Dewsbury, office boy. 8s. It was agreed to extend the electric lighting mains to Union and Grove streets. A fresh dynamo for the sulphate plant works was obtained. The electric arc lamps were ordered to be erected in the Market-place, Lower Westgate, and at the end of Church-street. A further extension of the electric mains was ordered for Bradford-road. Alderman Robinson moved, and Councillor Archer seconded, the confirmation of the minutes. Alderman Fox referred to the recommendation of appointments in connection with the electric lighting station, and said that in his opinion they might have done with a less staff He asked if the different installations put into the shops by private consumers had been properly tested and certified by the engineer before the works were opened, and said the arc lamps should be so arranged in the streets that they would not be called upon almost immediately to erect a half-dozen more lamps Alderman Robinson said they asked Mr. Mitchell to report only as to the men he would actually require, and a sub-committee was appointed to go through some 60 applications. He could assure the Council that the committee would not keep an unnecessarily large staff. With regard to a question put by Councillor Vero as to the £318 for an extension of the main in Bradford-road, it was to supply people who had applied for electric light. The committee did not sanction the expenditure of £228 in Bond-street, as they considered the outlay much too great for the revenue at present. He entered into a long explanation regarding the instructions given to the engineer to see that everything was perfectly secure and in order and under proper supervision before the electric current was switched into the distributing mains. Alderman Fox moved an amendment that the minutes be confirmed, with the exception of the resolution referring to the appointment of workmen at the central electric station, and that this matter be referred back for further consideration. In addition to the salaries of Mr. Mitchell and Mr. Pickersgill, the total amount recommended for wages was £468 per annum. Councillor Vero seconded the amendment. Councillor Archer said it would be better for Alderman Fox to make some suggestion, to tell them where the committee had done wrong, or where they could improve upon their action. Seven voted for the amendment and seven for the motion, and the Mayor gave his casting vote in favour of the former.

Devonport.—The Streets and Highways Committee of the Borough Council reported that, having carefully considered the application of the County of London and Brush Provincial Electric Light Company, Limited, for the consent of the local authority to the application of the company to the Board of Trade for the grant of a provisional order for the supply of electric lighting in the borough, they were of opinion that it was not advisable at present that the local authority should give such consent, and that the company be so informed. Mr. Graves moved the adoption of the report. Mr. Oram, in seconding, said the feeling of the committee was that the power should be kept in the hands of the Council. The company had received no encouragement from the committee to take proceedings, but it had been clearly intimated to them that whatever action they took was on their own responsibility. Mr. Rendle expressed surprise that Mr. Graves had not explained why the committee opposed such an important question as the introduction of the electric light in Devonport. He took it, from what Mr. Oram had said, that the committee intended to oppose! The Town Clerk said no independent company or outsider could apply for this provisional order without the consent of the local authority, and therefore unless such consent was given there was no chance whatever of the application succeeding. Mr. Rendle, continuing, asked what chance there was of the Council applying for a provisional order to supply the town with electricity themselves, or to lease it to a company while the Streets Committee was constituted as at present. There was not enough go in the Council. He knew to what extent they suffered at present from impure gas, and was almost tempted to ask why they had not appointed a gas inspector, because the quality of the gas of late had been something fearful. He did not think the committee had been just to the company which had intimated its intention to apply for electric lighting powers, and seeing that they were not all gas company shareholders or directors, they should consider, in their representative capacity, the requirements of the town. He moved that the recommendation be referred back. Mr. Hornbrook seconded, and said it should not go forth

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that they were against the principle of electric lighting. They could not afford to stand before the public in that sense, and it would be unjust and impolitic if they did anything that would lead the public to suppose they were opposed to the electric light. There were, perhaps, too many gas company shareholders in the Council, and some of them not members of the committee whose recommendation was under consideration. The question ought to be considered by a committee none of whom had the slightest interest in the gas company. Mr. Tozer said as members of the Corporation they should set aside all personal interest. Mr. J. May thought electricity had not sufficiently advanced to justify them in permitting its adoption for street-lighting. The Mayor suggested that Mr. Rendle should withdraw his amendment, and this having been done, the committee's recommendation was agreed to.

Yarmouth.—The borough surveyor to the Town Council produced a plan he had prepared showing the positions of the arc lights necessary for lighting St. Peter's-road, and stated the cost would be £100. The annual cost would be £48. The cost of the 10 gas lamps now on the district which would be turned out was £33. 15s. The annual additional cost of lighting road by electricity over gas, including capital and interest charges, would be £14. 5s. The committee resolved to recommend the Council not to carry out the work at present until a more general scheme of extension became necessary. Mr. J. H. Palmer said he thought as the cost was so small as compared with that of the gas lamps, it ought to be carried out on the Jetty-road. The residents in the district were very anxious to have the light there. There was a strong feeling in favour of it, and he did not see why it could not be done at once. He moved that it be carried out before next summer. Mr. A. Peaton seconded. He found, on enquiring, that the residents on St. Peter's-road were very much in favour of the electric light being laid on instead of the gas lamps, and he hoped to see it carried out. Mr. W. Worlledde said it was very evident from the remarks made that if they were to put the light on St. Peter's-road, all the other roads in the town would want it too. In course of time every road in the town would be lighted; but he considered they ought to feel their way, and not embark upon a scheme which would be sure to cause unpleasantness in other parts of the town. He thought, therefore, it would be best to abide by the decision of the committee. Mr. Press objected to spending any more money just yet upon the extension of the light. It would not do to go ahead too fast. It was strange that they were so impatient, seeing that they had been content with the gas so long; they must move on by degrees, and in time all would have the light. Mr. Martins said it would be very unwise to do more at present; as the work increased and the light was extended a larger sum of money would have to be borrowed to carry it out. Mr. Palmer's amendment was then put, and lost by 4 to 18. Replying to the remonstrances of the town clerk, Messrs. Crompton and Co. wrote stating that they were sparing no efforts to complete the electric light contract, and that various portions of the plant would shortly be delivered. Mr. W. H. Preece, the Council's electrical adviser, wrote that the floods in the Thames Valley had delayed the testing of the dynamos. The Local Government Board wrote sanctioning a further loan of £1,500 for the purpose of electric lighting. The present screens on the parade lamps being considered insufficient to meet the requirements of the Trinity Board, the surveyor was directed to confer with Mr. Thorp. To reach three customers, it was decided to lay mains at a cost of £36, though the surveyor said that this would represent the first year's income from the trio. He also reported five applications for 205 lamps. The managing engineer recommended the use of Clifton coal at 14s. 3d. per ton, and the surveyor stated that he expected the consumption, when the plant was in full working order, would be 20 tons per week.

Bath.—Mr. Cedric Chivers asked at a meeting of the Surveying Committee of the Town Council what position they were in with regard to the application made to the Board of Trade by the electric light company to extend their powers. The company had applied for a provisional order, and he wished to know whether there was any proposal to take a vote in the Council and establish their intention to buy up the works and carry on the lighting themselves; if not, the company were in a very strong position. The Chairman said the Urban Authority had already decided to oppose the application. Alderman Sturges said the matter had not been overlooked or forgotten by the Lighting Committee, who had discussed it at several meetings. They had sent a set of questions to the electric light company for them to answer. The company had delayed answering for an undue time, but as soon as they got their written answers the committee would be in a position to recommend to the Council what they thought in their wisdom was best to be done. As soon as they got the necessary data to go upon they would be able to send up a recommendation either to oppose, to buy, or to make an application. Mr. Taylor was afraid there was considerable reason for Mr. Chivers asking the question, and that the Lighting Committee had not gone far enough. If they appeared to be lax in this matter they would suffer in consequence. They knew Mr. Pitman and Mr. Titley very well, and if their action was subject entirely to their replies to certain questions they could delay these answers just as long as suited their purpose, and they might delay them long enough to injure the Authority's position. He proposed that Alderman Sturges, the chairman, and the clerk be instructed to convene a special meeting of the Lighting Committee. Alderman Sturges thought Mr. Taylor was unnecessarily frightened. The Chairman said the memorial would not be presented until the 21st of the present month. Mr. Moore strongly agreed with Mr. Chivers that prompt action should be taken. It was of no use to oppose unless they could show that they were going to do something. Mr. Chivers: That is the point. The Chairman, after further discussion, said he believed the matter would come before the Authority next week, and he believed that Mr. Titley was to be there, so that up to then at all events there could be no time lost. Mr. Chivers could not agree that no time had been lost. When the company made their application they also should have filed their opposition to it. The Clerk said no time had been lost. Alderman Marshall thought the company should be pressed for an answer. The Chairman said they could not put in any counter application; the application of the electric light company must be treated on its merits. Mr. Chivers said he understood that in all such cases where corporations had not sent in a counter application the provisional order had been granted, and *vice versâ*. After further discussion, Alderman Sturges said he hoped they would be able to recommend to the Authority next week what course to adopt. They would urge the solicitor of the company to send the answers, and a special meeting of the committee would be called as soon as they were received. The subject then dropped. Mr. E. B. Titley has since written stating that there had been no delay. He explained that the draft provisional order had to be revised, and the replies to the Authority's questions settled at a special meeting of the board of directors to be held in London. These replies would be in the hands of the clerk to the Authority by the end of the week. The Surveying Committee agreed, on the motion of Mr. Knight, to remit the fines which would otherwise have been due from the electric light company for lamps out during the flood.

Ulverston.—The clerk to the Rural Sanitary Authority read the minutes of a meeting of the Electical Lighting Sub-Committee held on the 21st ult, at which a letter was read from Mr. Sydney Morse, stating that the terms upon which the Windermere and District Electricity Supply Company would vary the purchase clauses of the Electric Lighting Company, 1888, in favour of the local authorities. Messrs. Savory, Fewkes, and Morse had met the committee for the purpose of explaining and arranging the terms as offered in Mr. Morse's letter. After considerable discussion, the committee decided to ask the representatives of the company to make, formally in writing, offers to each of the authorities of the terms which they were prepared to agree with the authorities for the supply of electrical energy, and the committee recommended that the new district councils be advised to appoint committees at the earliest possible moment to receive and consider these terms. The committee recognised the importance of the negotiations, and regretted that the change in the constitution of the authorities would much increase the difficulties of dealing with the matter which must be settled before the meeting of Parliament, or action must be taken by the district councils to safeguard their interests before the Board of Trade. Mr. Hodgson, the chairman of the committee, said that he had come there specially that afternoon to move the adoption of the report There was no doubt this was not only one of the first, but one of the most important questions the new District Council would have to take up and deal with. The company in question aimed at getting a provisional order which would give them power to supply electrical energy and light over the whole of the present Rural Sanitary Authority's district, and it would be necessary for the different public bodies interested to watch their proceedings very carefully, for, although the negotiations seemed up to a certain point to proceed satisfactorily, he was sorry to say he was afraid, from the correspondence since received, that the terms would not be so easily arranged as they had thought they would be. Probably the company thought the local governing bodies were just now in such a state of transition that they might be able to get their provisional order without any trouble, and it behoved the new Council to take the earliest steps to closely watch, and, if necessary, protect the interests of the public. Of course, if the worst came to the worst through their being unable to get reasonable terms, then opposition would have to be taken, and they would have to go before the Board of Trade and prove their case. There was no doubt a great future for electricity and its development for lighting and other purposes, and that any single company should be allowed to get a practical monopoly in regard to electric lighting over the whole district was certainly not fair or reasonable, or conducive to the public interests, and he did not think the new Council would allow it unless they got such terms as they were trying to get the company to agree to. It was not right that these terms should be made fully public at present, but he might say the basis of what they asked for was that if the company was allowed to come into the district the Authority should have the power to take over at any time the works and mains and distributing arrangements on terms reasonable for all parties, and that those terms should be precisely fixed before the company obtained its provisional order. That was the crux of the whole question, and he hoped the new Council would elect a committee as soon as possible to try and get these terms. They did not want to oppose the company for the sake of opposing it, but they felt they should look well after their own rights and interests, and not allow any company because it was a little sharper than its neighbours, to get hold of a perpetual monopoly of a thing which might be of the greatest value and importance to the community in the future. Mr. Dove seconded the motion, and the report was unanimously agreed to.

Taunton.—The Electric Light Committee of the Town Council presented the following report: "A letter has been received from Mr. A. E. Witham resigning his appointment as clerk and collector, in connection with the electric lighting works, on January 31 next. Your committee report that Messrs. Shand and Thornhill (assistant electricians) have asked for an increase in their salaries. The committee recommend that Mr. Thornhill be

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raised to £75 and Mr. Shand at £65 a year, as they have been offered other situations at larger salaries. Your committee report that the estimated cost of the cables and making the necessary house connections in connection with the No. 2 sub-station is £681, and the committee recommend the Council to authorise them to order the same from the Fowler-Waring Cables Company directly the sanction of the Local Government Board to the borrowing of the money has been received." Councillor Potter moved the adoption of the foregoing report. As regards Mr. Witham's resignation, Mr. Potter said he was personally indebted to him for much valuable assistance, and would be sorry to lose his services. The committee hoped to get all the wires put underground by the time the Bath and West of England Society visited Taunton, and they would carry out the work as soon as the sanction of the Local Government Board was obtained to the loan and subject to the sanction of the Council. Mr. Potter also broached the subject of discounts on electric lighting accounts, and said it was suggested that when 4,000 units were used by a customer in a year, which would cost him £100, they should charge 5d. instead of 6d. per unit. Speaking of the complaints which had recently been made respecting the unsatisfactory nature of the electric light, the speaker said it was well to know that it was not due to negligence on the part of anyone, but simply the result of an unfortunate series of circumstances, and those circumstances he proceeded to explain very satisfactorily. Alderman Standfast spoke against the proposed increase of salaries, but Councillor Perkins expressed himself in favour of the proposal, stating as his reason that they could not expect young men of education and considerable technical knowledge to undertake duties of a responsible and even dangerous character for a lower salary than they could get elsewhere. Councillor Nation said there was an impression alive that they had a lot of juveniles at the work, and some people were deterred from taking in the light on that account. Councillor Sibley said they were not overmanned at the works, as Alderman Standfast seemed to suppose, but quite the reverse, and Councillor Potter supported the statement in his reply. Councillor Potter, in replying to the criticisms on the actions of the committee, said the arguments that had been advanced were out of all reason. With regard to the reduction of the staff, it was perfectly ridiculous to talk of doing so. The plant was running 19 hours on a stretch, and there was no one employed on the works who did not work eight hours a day, including Sundays, and he contended that the only fault in the management of the works was that they had been too economical, and had suffered in consequence. If they dismissed the present staff and took on older men, they would have to pay much larger salaries. The mistake they had made was that they had not sufficient on their staff. They should understand that these young men were not placed in charge of the works, and in reference to the young man that met with the accident he would remind them he was not in charge. Mr. Couzens could not always be there, and the second electrician was in charge at that time. The young man was doing work that he had done some hundreds of times, and if he had done it with safety ninety-nine times he might with the same care have done it the hundredth time. An amendment which had been moved by Councillor Westlake, to refer the question of salaries back to the committee, was lost by eight to nine.

Southampton.—The town clerk, at a meeting of the Town Council, read the following letter from Messrs. Sharp, Harrison, Turner, and Turner, on behalf of the electric light company: "Dear Sir,—We are instructed by the Southampton Electric Light and Power Company, Limited, to apply to the Southampton Town Council, as the local authority specified in the Electric Lighting Acts, 1882 and 1888, for their consent to a provisional order, now being promoted by the company under the said Act, for authorising them to supply electrical energy for public and private purposes throughout the county borough of Southampton. In making this application we would remind you that, under Section 1 of the Act of 1888, the granting of a provisional order to our clients will not in any way hinder or restrict the granting of a similar order to the local authority if they decide to apply for one. Our clients desire us to state that, should the Southampton Corporation decide within six months from this date to negotiate for the purchase of their undertaking, they would be willing to sell at a fair price, and agree not to include in it any additional value by reason of the consent now asked for being given. In acquiring the provisional order to be obtained by our clients, the Corporation would gain the advantage of securing an order a year sooner than they otherwise could. Our clients trust it will be taken into account that they have in every way fulfilled the obligation under the license they now hold, and have given general satisfaction to the public, and that their undertaking has been promoted by the local enterprise which should entitle their present application to receive the most favourable consideration." Mr. Lemon said it would be in the recollection of the Council, when this matter first came up he proposed that the Council should purchase the powers obtained by the company, but the Corporation in their wisdom, or, perhaps, unwisdom, did not see their way to do so. Since that time the company had been giving a supply of electric energy to the town, and now asked that the consent of the Corporation should be given to their obtaining a provisional order. He had had the opportunity of discussing the matter with his colleagues on the Works Committee, and was able to speak on their behalf to this extent—they advised the Council not to oppose the provisional order. It was quite open for the Corporation to claim the provisional order for themselves, but they would be in this position—they would have to compete against an existing company, and when they considered the result would be filling up the streets with two lines of wires, pulling up footways, and also the remote chance of getting back a return of the capital expended, the Corporation would be very unwise to enter into a competition of that kind. It would be noticed in the letter that the company said they were willing to sell at a fair price, and did not wish any additional value by reason of the consent being given taken into account. He thought the time had come when they should purchase these works if they could do so at a reasonable price. He had had an opportunity of looking into the matter, and he was able to say that they could purchase them at a very reasonable sum indeed. The only question they had to consider was one—they should be advised by an expert as to whether the money laid out by the company had been properly expended, and would the Corporation, if they started the works in the first instance, have laid out the money to better advantage? He would say from his knowledge that they could not have done so. He proposed that they should not oppose the granting of the provisional order. Alderman Bance seconded the proposition. The Town Clerk, in reply to questions which were raised, said the matter had been referred to committee, and they had the matter under consideration, but the question of this provisional order must be dealt with by the full Council. They could give or refuse their consent, but if they refused it would be for Parliament to say whether it was a reasonable refusal, and if they thought not they would take no notice of it. If they consented, the company would get the order as a matter of course. If they withheld their consent, they would have to give some excuse such as that they were going to apply for a provisional order for themselves, and they would have to go to some expense to be successful in their opposition. After a long discussion the motion was agreed to.

Windsor.—An item on the agenda of the Town Council was as follows: "Mr. Alderman Dyson to ask for the Electric Lighting Committee minutes of July 4 and September 13, and to make a statement thereon." In again introducing the matter, Alderman Dyson made a long speech, in which he complained of the hard words used towards him on a previous occasion. On September 13 he considered that Mr. Shoolbred had been invited to Windsor without a resolution having been passed by the committee to that effect. If he were wrong he would withdraw and apologise, but he did not withdraw one word. He asked for the production of the minutes. Mr. Lovegrove said that a motion of the Council must first be passed. Councillor Bampfylde said that if Alderman Dyson really wished to see the minutes he would move that they be produced. Councillor Soundy seconded. This was passed. Mr. Lovegrove then read the minutes of July 4, in the course of which appeared a resolution to the effect that Mr. Shoolbred be written to to ask upon what terms he would come to Windsor and report. Alderman Dyson said that was the whole of his complaint. No authority had been given to invite Mr. Shoolbred down here. This he emphasised in some lengthy remarks. Councillor Withnall asked that the minutes of September 5 be read also. Mr. Lovegrove did so, and in those minutes appeared a resolution approving of the action of the chairman in inviting Mr. Shoolbred to attend, and also authorising his engagement to come down and make a report. Alderman Dyson, reading from a newspaper report, said that on October 4 the deputy town clerk, in reading the minutes of July 4, had said that the resolution was to the effect that Mr. Shoolbred be written to asking him to come to Windsor and make a report. In conclusion, he assured them he had no intention of attacking any committee. Mr. Lovegrove said that Mr. Dyson had said many things in his speech which, if he (Mr. Lovegrove) were a member of the Town Council, he should be able to controvert and confute, but being the representative of the town clerk he was not able to enter into any argument with him. The attack which Alderman Dyson made was made upon him, but he stated emphatically that in all he had done he had acted under the direct and explicit instructions of the committee. He was not responsible for what appeared in the paper. He read the resolution from the book at the time, and he was sorry if Alderman Dyson relied upon the report in the paper. He repeated that he had received the instructions of the committee for everything he had done. Alderman Dewe confirmed this, and said that all Mr. Lovegrove had done had been by the direct instructions of the committee. In reply to advertisements they had 49 answers, and at the meeting on July 4 Mr. Shoolbred was chosen therefrom, and it was resolved to write for his terms, and if under 30 guineas he (Alderman Dewe) was authorised to write to Mr. Shoolbred to come down and meet the committee. It was arranged that he be invited on September 13, and he was admitted on that date and engaged with the full sanction of the committee. What Mr. Alderman Dyson had to stand upon he did not know. He seemed to presume that he and the deputy town clerk had invited Mr. Shoolbred down without authority. That was not so, and if Mr. Dyson had been at that meeting of the committee he would know it. Alderman Sir Joseph Devereux said he should be sorry to think that Alderman Dyson had made an attack upon the deputy town clerk, upon whom he seemed to lay all the charge. He made an ample apology on the occasion when the matter was last brought up, and he (the speaker) was sorry the matter had been brought forward again. He considered it to be a waste of their time, and he moved that the meeting proceed to the next business. Councillor Gane seconded, and fully supported all that Sir Joseph Devereux had said. Councillor Soundy said that he thought the wiser course would be to allow the matter to be thrashed out. He did not like the idea that any member's mouth should be closed. Alderman Dyson again returned to the attack. He said he had stated most solemnly that a personal attack was very far from his mind. He then proceeded to go all through the case again with respect to the resolution of July 4. Mr. Lovegrove again warmly repudiated the newspaper report of the minutes which were read at the meeting of October 10. He said that if

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the words "for terms" were left out by the reporter, he (Mr. Lovegrove) was not responsible. Councillor Bampfylde said that the very point had been argued out in committee. He thought that Alderman Dyson was going to keep to the point whether the minutes had been correctly read or not. Mr. Lovegrove had denied that the newspaper was a correct report of what he read, and Alderman Dyson should receive and accept that. He (Alderman Dyson) had appealed for the treatment of a gentleman, and he considered he should accord the same treatment. Councillor Burt said he felt bound to justify the conduct of Mr. Lovegrove. It was most distinctly understood when Mr. Shoolbred was written to that if his terms were reasonable he was to be asked to come down. Alderman Sir Joseph Devereux withdrew his motion by request, and Alderman Dewe moved "That this Council having heard Mr. Lovegrove's statement accepts the same." This was seconded and carried *nem. con.*, and the incident then closed, after occupying nearly an hour.

PROVISIONAL PATENTS, 1894.

DECEMBER 10.

23970. **Improvements in electric conductor supports.** Albert Anderson and John Marinius Anderson, 62, St. Vincent-street, Glasgow. (Complete specification.)

23980. **Improvements in sentinel electrical alarms.** Antoine Moise Morin, 76, Finsbury-pavement, London.

23988. **Improvements in electric lighting devices.** Robert Walker Inman, 55. Chancery-lane, London.

24002. **Improvements in the manufacture of armatures for electric bells.** Isaac Hardy Parsons, 4, South-street, Finsbury, London.

DECEMBER 11.

24075. **Improvements in regulating electric dynamos and motors.** Thomas Drake Hollick and Frederick William Hollick, 604, Commercial-road, London.

24076. **Improvements in and relating to telegraphic transmitting and receiving apparatus.** Bernard Hoffmann, 55, Chancery-lane, London.

DECEMBER 12.

24173. **Improvements in and relating to electric motors and to the distribution of electric energy.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Hermann Gutmann, Germany.)

24194. **Multiple electric fuse-box.** Edward Avery Parson and Haldane Millar, Philadelphia, U.S.A.

24195. **A mode of controlling magnetic energy.** Henry Monroe Paine and Albert Russell Brandly, Philadelphia, U.S.A. (Complete specification.)

24198. **Improvements in electrical resistances and in processes for rendering inert or electrically non-conductive substances electrically conductive.** Augustus John Marquand, Emmanuel Hancock, and David Lowdon, 24, Southampton-buildings, Chancery-lane, London.

DECEMBER 13.

24234. **Reflectors for electric lighting.** Paul Körber, 62, St. Vincent-street, Glasgow. (Complete specification.)

24266. **Improvements in apparatus for starting alternating-current electromotors.** Arthur Bergtheil and Robert Alfred Marples, 1, Queen Victoria-street, London.

24285. **Improvements in and connected with electric systems for lighting of trains and for other purposes.** Anthony George New and Arthur James Mayne, 55, Chancery-lane, London.

24291. **Improved means for securing the terminal wires to carbon and other electrodes.** Franz August von Alimonda and Nino von Alimonda, 11, Southampton-buildings, Chancery-lane, London.

DECEMBER 14.

24297. **An improved porous cell for an electric generator or battery.** William McChleary, 154, St. Vincent-street, Glasgow.

24340. **The electrical nail detector or finder for prevention of crippling of animals caused by deviation of shoe nails.** Frederick Jones, 76, Wakehurst-road, Clapham Junction, London.

24353. **Improvements in brackets for poles or standards for electrical conductors and similar purposes.** Siemens Bros. and Co., Limited, and George William Perry, 28, Southampton-buildings, Chancery-lane, London.

24369. **Improvements in or appertaining to electric bells or alarms.** John Thomas Brierley, 6, Lord-street, Liverpool.

24372. **Improvements in shade-holders for gas, electric, and other lamps.** Sigmund Sinauer, of the firm of S. Hoffnung and Co., 191, Fleet-street, London. (The Utility Shade Company, United States.)

24374. **Improvements in the insulation of electric wires or cables.** Franz Clouth, 18, Buckingham-street, Strand, London. (Complete specification.)

DECEMBER 15.

24385. **Improvements in electric supply meters.** John Perry, 31, Brunswick-square, London.

24431. **An improvement in tubular posts for telegraphic and other purposes.** Siemens Bros. and Co., Limited, and George William Perry, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

24440. **Improvements in devices for joining or connecting telegraph and telephone wires, and for other purposes.** William Broomhead Shaw, 6, Lord-street, Liverpool.

24441. **Method and apparatus for preventing sparks in electrical apparatus.** Wilhelm Friedrich Ostwald, 433, Strand, London.

SPECIFICATIONS PUBLISHED.

1888.

2246. **Dynamo-electric machines.** Lake. (Eickemeyer.) (Second edition.)

1890.

9361. **Electric reduction of metals.** Willson. (Second edition.

1893.

18173. **Electrolysis of chlorides, etc.** Hargreaves and Bird. (Second edition).

22674. **Electric batteries.** Haddan. (Riguelle.)

23231. **Micro-telephones.** Anders and Kottgen.

23472. **Electrical measuring instruments.** Nalder and others.

24471. **Electric supply meters** Baron Kelvin.

1894.

294. **Type printing telegraphic apparatus.** Thompson. (Kustermann.)

439. **Girder clamps and hangers for supporting pipes, electric conductors, etc.** Lake. (MacTaggart and another.)

1433. **Advertising by electric lamps.** King.

2487. **Secondary batteries.** Hall.

3859. **Electric gas-lighting apparatus.** Thompson. (Ulmer.)

12877. **Electrically controlling steam machinery, etc.** Lake. (Williamson.)

13358. **Electrolysis.** Lake. (Roberts.)

16851. **Electric railways.** Thompson. (Enholm.)

18522. **Electric arc lamps.** Pendleton.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	£5	5½-6
Bournemouth Electric Company	—	—
Brush Company, Ordinary	£3	2⅜-2½
—— Nom. Cum., 6 per cent. Pref.	£2	2⅜-2½
—— 4½ Debenture Stock	£100	111-114
Charing Cross and Strand	£5	4½-5½
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	£10	14-15
—— 6 per cent. Cumulative Pref.	£10	14½-15½
—— 5 per cent. Debenture Stock	£115	132-135
City and South London Railway, Consolidated Ordinary	£100	42-44
—— 4 per cent. Debenture Stock	£100	124-126
—— 5 per cent. Pref. Shares	£10	13½-14½
Crompton and Co., 7 per cent. Cum. Pref. Shares	£5	2⅞-3¼
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	£100	97-102
Electric Construction, Limited	£2	½-¾
—— 6 per cent. Debentures	—	95-97
—— 7 per cent. Cumulative Pref.	£2	1½-2
Electricity Supply Company for Spain	£5	—
Elmore's Copper Depositing	£2	1-1½
Elmore's French Company	£2	1/16-3/16
Elmore's Wire Company	£2	¾-1
Fowler-Waring Cables	£5	½-1½
W. T. Henley's Telegraph Works, Ordinary	£10	8½-9½
House-to-House Company, Ordinary	£5	2½-2¾
—— 7 per cent. Preference	£5	6½-6⅝
India Rubber and Gutta Percha Works	£10	26½-26½
—— 4½ per cent. Debentures	£100	102-104
International Okonite, Ordinary	—	—
Kensington and Knightsbridge	£5	4½-4¾
—— 6 per cent. Pref.	—	6½-6¾
Liverpool Electric Supply, Ordinary	£5	7⅛-7¼
—— Pref.	—	—
Liverpool Overhead Railway	£10	8⅜-8¾
—— Pref.	£10	13-13½
—— 4 per cent. Mortgage Debentures of £100	£100	112-114
London Electric	£5	¾-1⅛
Metropolitan Electric Supply	£10	9½-10¼
—— 5 per cent. Reg. Debentures, 1-10,000 in Bonds of £10, £20, and £40	—	—
National Telephone, Ordinary	£5	5½ 5⅝
—— 6 per cent. Cum. First Pref.	£10	15-17
—— 6 per cent. Cum. Second Pref.	£10	15-16
—— 5 per cent. Nom. Cum. Third Pref	£5	5½ 6
—— 4½ per cent. Deb. Stock	–	110-113
Notting Hill Company	£10	7-7½
Oriental and Electric Company, £1 shares	£1	1-1½
—— £5 Shares	—	7-7½
—— £4½ shares	—	5¾-6½
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	£5	7⅜-8½
—— 7 per cent. Pref.	£5	8½-9
Swan United	—	—
Telegraph Construction and Maintenance	£12	41-43
—— 5 per cent. Bonds	£100	106-109
Westminster Electric Supply, Ordinary	£5	7-7½
Yorkshire House-to-House	£4½	4¼-4⅝

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NOTES.

Calendar. — The Electrical Installation Company, Limited, of 66, Victoria-street, S.W., and of Edinburgh, send us a neat little pocket calendar.

Electric Light in Japan.—According to a French contemporary, there are 11 electric lighting companies in Japan, with a total capital of £487,200.

Brush Company's Diary.—The Brush Electrical Engineering Company, Limited, have sent us a handy diary for 1895 suitable for carrying in the vest pocket.

Paper-Knife Almanack.—The Eastern Telegraph Company have sent us a paper-knife which indicates the routes followed by their cables and also gives an almanack for 1895.

Central London Railway.—It was mentioned at a meeting of the Exploration Company last Friday that the company hope next year to make a successful issue of the capital of the Central London Railway.

The Theatrophone.—An illustrated description of the theatrophone is given in the *Revue Industrielle* of the 22nd December. The offices of the company working this system in Paris are at 23, Rue Louis-le-Grand.

Electric Bells and Medical Coils.—A trade list has reached us of the specialities made by Messrs. Howard B. Little and Co., of 20, Eldon-road, Kensington, W. Among these are the "ringing" bells, portable bell sets, and medical coils.

The Proposed Jungfrau Railway.—The Swiss Federal Council on Friday agreed to the Jungfrau Railway scheme on condition that the company contributes £4,000 to the construction of the observatory, as well as monthly subscriptions to certain scientific societies.

Telephony in France.—Telephonic communication has been established between Paris and Toulouse *viâ* Limoges. By March next connections will be made between Toulon and Bordeaux *viâ* Montauban and Agen, and between Toulouse and Cette *viâ* Carcasonne, Narbonne, and Béziers.

Electric Traction in Switzerland.—The Government have given authority to the Zurich Mountain Railway Company for the construction of three lines of electric tramway.—Powers have been given for the construction of an electric tramway between Bruggen, St. Gall, Neudorf, and St. Fiden, with a branch between St. Gall and Heiligkreuz.

Presentation.—A smoking concert promoted by the staff of the Electric Construction Company, Limited, took place last week at Wolverhampton, when Mr. R. Johnston, chief of the office staff, who was to be married on Christmas Day, was presented with a marble clock from his fellow employés, a purse of gold from the directors, and a gold ring from several friends.

French Colonial Telegraphs.—Considerable progress is being made with the length of telegraph line between Grand Bassam and Hou, which is situated at the mouth of the River Bandama. A distance of 140 kilometres has been completed. Only another 20 kilometres remains to be done, and the work will be finished as soon as a fresh stock of wire arrives.

Telephony in Spain.—The lines between Madrid and Barcelona and Bilbao and Vittoria, it appears, are only a portion of a projected network of telephone lines. According to *Industria é Invenciones*, Mr. Los Arcos has obtained a concession for the erection and working of telephone lines between Barcelona, Sarragossa, Bilbao, and Madrid, and various towns in the north-east of Spain.

Personal.—Prof. Kohlrausch has been appointed head of the Physical-Technical Governmental Institute at Charlottenburg.—Sir David Salomons has, as Mayor of Tunbridge Wells, issued invitations for the mayor's banquet, which will be held in the Great Hall, Tunbridge Wells, on Saturday, January 12.

Liverpool Engineering Society.—The president, Prof. H. S. Hele-Shaw, M.I.C.E., presided last week over a meeting of this society at the Royal Institution, Colquitt-street, when Prof. Oliver J. Lodge, D.Sc., F.R.S., read a paper entitled "The Second Law of Thermo-Dynamics." The paper was listened to with great attention, as well as the remarks of Prof. FitzGerald in the discussion which ensued.

The Telautograph.—A Paris correspondent states that the Société Internationale des Electriciens have held a special meeting to examine the Gray telautograph introduced by Mr. John Aylmer, the telegraph agent of the British Government in Paris, and Mr. Cushing, of Chicago, the representative of Mr. Gray, the inventor. The instrument has been submitted to the French Government, and has been experimented with in an exhaustive manner, even between London and Paris.

Electromotors on Men-of-War.—In connection with our "Note" on this subject in our last issue, it is interesting to observe that the United States Naval Ordnance Bureau has invited a number of electrical firms to submit designs of electrical apparatus for the operation of turrets and guns. Electricity has been used for the operation of the "Montauk's" turrets for some time, and the experiments have resulted very satisfactorily. It is intended to place electrical apparatus in the turrets of the "Brooklyn" and "Iowa."

Electric Traction in France.—The Lyons Tramway and Omnibus Company have sent to the Municipal Council a scheme for adopting electric traction on the whole of their system. An enquiry has also been held into a proposal to construct an electric line from Lyons-Vaise to Saint-Cyr-au-Mont-d'Or. This is brought forward by the Ecully Tramway Company. Negotiations are also in progress between this company and the communes of Dardilly, Champagne-au-Mont-d'Or, and Limonest for the construction of electrical tramways. These districts are very badly served at present in the matter of traffic facilities.—Mr. Stulzmann, a Swiss electrician, proposes to construct an electric tramway between Gex and Ferney, Ain.

Light and Heat Exhibition.—Under this title, an exhibition which promises to be of more than ordinary interest, from a general as well as a domestic point of view, is to be opened in May, 1895, at Woodhouse Park, Shepherd's Bush. The site, which is in close proximity to the Uxbridge-road railway station, is an exceptionally good one. The exhibition will be one of a complete and instructive character, in which all means of lighting and heating—civil, naval, and military—will be thoroughly illustrated, whilst photography in all its developments will be well represented, and a historical gallery will furnish examples of lighting from the earliest ages up to the present time. The profits will be devoted to the Sunday Hospital Fund.

Electric Traction in Germany.—The large project for a network of electric tramways for the Bochum district, with which a commencement has been made with the Bochum-Herne line, appears likely to be carried out at no distant date. Definite arrangements have been made for constructing the Herne-Recklinghausen line, and now the sanction of the Government has been obtained for a line

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between Gelsenkirchen, Waune, and Eickel. From this last connection will be made with Bochum. This will be the largest system of electric tramways in Germany.—It is expected that arrangements will shortly be concluded for the conversion into electric lines of the Dantzic horse tramways.—The Municipality of Barmen have decided to build an electric tramway between Barmen and Schwelm.

Telegraph Rates to Egypt.—A memorial, signed by 62 Liverpool merchants in trade with Alexandria, asking for a reduction in the charge for telegrams to Alexandria, was recently forwarded to the Eastern Telegraph Company with a request that the representation should be considered and concessions made to meet the views of the memorialists. The rate to Alexandria is 1s. 7d. per word, whilst the rate to Malta is only 6d. per word, and to Syrian ports 6½d. per word. Sir John Pender has replied that at the present time the company's dividends are not such as to warrant reductions, but that the matter will be borne in mind and discussed at the international telegraph conference to be held in 1896, as any reduction that might be made would apply to correspondence with Europe as well as Great Britain.

Crypto Electric Motors.—Small dynamos and electric motors are being made on a large scale by the Crypto Works Company, Limited, of 29, Clerkenwell-road, E.C., a copy of whose catalogue has reached us. The S type of motor is combined with a ventilating fan for use both on board ship and land. This motor is intended for working either with direct or alternating current. Another arrangement, which comprises a C motor and rotator equipped with five coloured chain lamps, is a useful lighting device for placing in shop windows, so as to attract the attention of passers-by. A variety of small motors and dynamos for lecture purposes is also detailed in the catalogue, which concludes with references to a hand-feed focussing arc lamp for the lighting of theatrical stages in place of limelight, and for experimental use.

Electric Welding Patents.—The action brought by the Thomson Electric Welding Company, of Lynn, Massachusetts, against the Two Rivers Manufacturing Company, of Wisconsin, has resulted in a decree sustaining the validity of the fundamental patents of Prof. Elihu Thomson on electric welding and apparatus therefor, and adjudging that the defendants have infringed them. A preliminary injunction was granted several weeks ago against the Two Rivers Manufacturing Company by Judge Siemens, who rendered an opinion sustaining these patents. The case was tried on behalf of the defendants, and all known defences were before the Court. The judge found, however, that the patents were valid, and that they were not affected by any of these defences, and therefore an injunction was granted.

Lecture.—Mr. H. A. Mavor has read before a meeting of the Institution of Engineers and Shipbuilders in Scotland, held in Glasgow, a paper on "A New Mining Motor." He referred to the application of electricity to mining operations, and afterwards gave a detailed description of the new motor. The distinctive features of the motor were that it was entirely enclosed in a cast-steel casing, was very light, and of specially strong mechanical construction. He described the principles of an electric motor, pointing out that these might be most easily understood by looking at magnetism and electricity as two aspects of the same phenomenon, magnetism being a whirling motion in the medium surrounding the electric current. By the study of these whirls the interaction of electric currents and magnets might be more easily understood than in any other way. He remarked that the possibility of making a light enclosed mining motor had been reached largely through the use of a new material which, although it was called steel, was merely chemically pure iron obtained by a steel process.

People's Palace Day Technical School.—The annual distribution of prizes and certificates to the pupils took place in the Queen's Hall on Friday. Prof. Alexander Kennedy, F.R.S., was the distributor, and Mr. W. Hales, master of the Drapers' Company, presided. Prof. Kennedy said that he wished to add his testimony to the good work which the school had done. He had seen many drawings done by the pupils and much of their practical work, and he had been very much pleased with them. They showed him that the line taken in that school, and the general course adopted, were the best suited to prepare lads for apprenticeship to the engineering trade. He considered it most important that the engineers of the future should not only be apprentices, but educated apprentices. Such work as that school was doing should, he thought, be encouraged by the great trade unions, whose status would be considerably raised if they insisted on the proper training of their future members.

Storage Battery Amalgamation.—Our American contemporaries announce that all the fundamental storage battery patents have been acquired by the Electric Storage Battery Company, the owner of the chloride battery patents. The Faure group of patents (including those of Swan, Sellon, Volckmar, and Griscom) were acquired from the Accumulator Company, the Brush-Julien patents from the Consolidated Electric Storage Company, and the Brush patents from the General Electric Company. This terminates the litigation in which the various companies had become involved, and the Electric Storage Battery Company will now be the sole manufacturer of storage batteries under the patents acquired. No official statement has as yet been made in regard to the future relations with the companies from whom the various patents were purchased, but it is reported that there will be a friendly co-operation. The Electro-Dynamic Company, which has always been closely connected with the Accumulator Company, will continue to manufacture dynamos and appliances for storage battery plants, and it is reported that the General Electric Company will exert its influence in favour of the interest now in possession of the patents.

Municipalisation of Tramways.—The Bill which will be promoted by the London County Council next session for powers to enable it to work tramways has been finally drafted. The preamble recites that under powers granted by Parliament the Council has purchased a portion of the undertaking of the London Street Tramways Company, and is proceeding to acquire others. It is, therefore, expedient that powers should be given for working the tramways when secured. Clause 2 enacts that it shall be lawful for the Council to place and run carriages on any tramway which has been, or shall be, purchased or acquired by them, and to provide such stables, buildings, horses, cars, engines, fixed and movable plant, etc., and to employ such persons as may be requisite or convenient for working the tramways. The several provisions relating to the working of the tramways and the taking of tolls contained in any Act relating to any such tramway shall extend and apply to the Council, instead of to the former company. Clause 3 provides that the Council, on the one hand, and any company owning any tramway connected with any tramway of the Council, on the other hand, may enter into any agreement with respect to the exercise of running powers either by such company over the tramways of the Council, or *vice versâ*, provided always that during the currency of any such agreement all by-laws and regulations shall be observed by the Council or the company, as

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the case may be, exercising such running powers. Clause 4 enacts that all the expenses of the Council incurred in the execution of the powers contained in this Act shall be defrayed as payments for general county purposes within the meaning of the Local Government Act, 1888.

Electric Lighting in Austria-Hungary.—Among the public buildings at Graz which have been lighted electrically are the Law Courts on the Stadtsquai, where 700 incandescent lamps are employed. The installation has been carried out by Messrs. Kremenezky, Mayer, and Co., of Vienna. The same firm have done the work in connection with the electric lighting of the business houses belonging to Raimund Noë, Albin Fleischmann, J. K. Klammerth, and G. Bachner, and the Zum Schwan and Florian Hotels.—Offers were lately invited by the Municipality of Werschetz, Hungary, for a scheme for the electric lighting of the town. Projects were presented by Messrs. M. Zeller and Co., the Helios Company, and Messrs. Ganz and Co. The Municipality have decided that the scheme of the last named is the most satisfactory. They intend to keep the electric lighting in their own hands. A central electric light station has been opened at Weinberge, near Prague, the work having been carried out by Messrs. Bartelmus and Co., of Brünn, the plans being prepared by their engineer, Dr. Stefan Doubrava. There are connected 3,000 16-c.p. incandescent lamps and eight 8-ampere arc lamps. An extension of the works is to be made.—The Ungarische Elektricitäts-Aktiengesellschaft, which own a large central station in Budapest, have established a small station for the lighting of Erlau and Fünfkirchen, the work being carried out by Messrs. Ganz and Co.

Crystal Palace School of Engineering.—The annual distribution of prizes and certificates to the students took place on Friday in the lecture-hall of the School of Art, Science, and Literature, Mr. J. H. Greathead distributing the certificates. Mr. R. G. Hodson presented the report of the examiners (Mr. Sidney R. Lowcock, Mr. R. Elliott-Cooper, and Mr. James N. Shoolbred), who praised the work done by the students. Forty-three attended the lectures: 37 were available for examination; 28 passed. The Chairman fully endorsed the examiners' opinion, and congratulated the students on their choice of a profession. Mr. G. T. Rait, chairman of the Crystal Palace Company, thanked the examiners. Mr. Lowcock, acknowledging the compliment, congratulated the school not only on its growth since his student days, 16 years ago, but on its improved accommodation. Mr. Shoolbred also responded. Dwelling on the rapid development of electrical undertakings, he estimated that, excluding telegraphs, about £20,000,000 were profitably invested in electric works in this country; £30,000,000 in France; £40,000,000 in Germany; £35,000,000 in Austria, Italy, Spain, and Switzerland; probably £10,000,000 in Russia, Sweden, Norway, and Denmark; perhaps £90,000,000 in the United States; £10,000,000 in Canada and other parts of America. Then there were electrical works in India, Australasia, and China. Altogether about £250,000,000 was invested in these enterprises throughout the world; the total for Europe being something like £115,000,000, for America about £100,000,000. It was nearly all the work of the last 10 years, a record surpassing every other, including those of railways, gas, and water.

Determination of Dielectric Constants.—Mr. W. Nernst discusses this question in a German contemporary. In the arms A B, A C of a Wheatstone bridge, two adjustable electrolytic resistances are placed; the two arms B C, C D contain two similar condensers consisting of two metal plates separated by a movable glass plate. The ends A D are connected with an induction coil and B C to a telephone in which silence or at least a minimum of sound occurs when $R_{ab} : R_{ac} = C_{db} : C_{dc}$. A condenser consisting of a nickel or platinum trough with a fixed metal plate in the interior can be placed in either arm D B or D C, and its capacity added to either of the measuring condensers, and this contains the liquid whose dielectric constant is to be measured. Minimum sound is then obtained by moving the glass of the measuring condenser. The arms D B, D C contain also auxiliary resistances, so that if the compound examined is not a perfect insulator its resistance can be also determined, since a minimum also results when $R_{ab} : R_{ac} = R_{db} : R_{dc}$. The condensers and other parts of the apparatus are calibrated once for all, and full details of the precautions and a discussion of the probable errors are given in the paper. The availability of the method is well seen by comparing the numbers which the authors obtained with it, and the determinations made by Landolt and Jahn. In the case of 13 hydrocarbons the mean difference is about 2 per cent., the results by this method being in almost all cases the higher. A number of measurements of the capacity of benzene, aniline, amylic alcohol, ethylic alcohol, and water at varying temperatures are also recorded; from the results the temperature coefficients are calculated, the dielectric capacity in each case decreasing with increasing temperature.

Electric Lighting in Germany.—Mr. M. Weiss, an hotel proprietor at Glewitz, has an electric light plant for lighting his establishment, and has supplied current to neighbouring premises. He has now joined Mr. F. Kochmann, a local brewer, in a scheme for supplying the electric light to the town generally.—A central electric light station has been opened at Oberehnheim. Power is obtained partly from the Ehnbach stream and partly from the overflow of the local waterworks. The work has been carried out by Messrs. O. L. Kummer and Co., of Dresden.—The Municipality of Bregenz propose to establish a central electricity station, using the water power of the neighbouring river. It is intended to supply current for lighting and power purposes, and for working the pumps at the waterworks.—Mr. Rix has brought forward a project for the electric lighting of the streets of Plön.—The electric light is being largely adopted at Strassburg.—At Nuremberg applications have been received for 26,000 incandescent lamps, and for motors of 450 h.p. The full capacity of the station will be for 56,000 incandescent lamps, 400 arc lamps, and motors of 1,400 h.p. It is expected that the agreement with Messrs. Schuckert and Co. will be signed next month.—It is intended to introduce the electric light into Kandorn.—Messrs. Schuckert and Co., of Nuremberg, are in negotiation with the local authorities of Brünn for the establishment of a central electricity station for the supply of current for lighting and power purposes, and possibly for an electric tramway.—A central station is to be established at Tuttlingen at a cost of £14,500. The work will be carried out by the Maschinenfabrik Esslingen, who will run the installation under the condition that the local authorities can buy it up after a certain lapse of time.—At Laibach the Municipality have decided to establish a central station.

Frankfort Central Station.—The central station at Frankfort-on-the-Maine, where trial runs have recently been made, is on the point of being officially opened. Originally the battle of the systems was fierce, but eventually the alternating-current method triumphed, and the contract for the machinery was given to Messrs. Brown,

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Boveri, and Co., of Baden, Switzerland. The works were commenced last April, and in November the first generators were started. The site of the station is near the harbour and the railway bridge. There are three tandem steam-engines, each capable of giving 750 effective horse-power at a speed of 85 revolutions a minute. The pistons of the two cylinders drive a 24-ton flywheel, which at the same time serves as the field magnets. The engines are fitted with centrifugal governors and with automatic lubricating arrangements, and they can be worked with or without condensation. The boilers, of which there are eight, are equipped with the Kubon smoke-consuming appliance, and the working pressure is 135lb. The flywheel of the engine serves as the frame of the 64 field coils, which are fixed radially to the periphery. Around the flywheel is arranged a fixed armature, which also has 64 coils. The exciting dynamos are six-pole series machines, having drum armatures. The alternators give current at 3,000 volts, which is led to a main switchboard and thence to a distributing board, by means of which the current is passed along the feeders to the sub-stations. The feeders are laid to six points from which the high pressure current is distributed throughout the whole of the town to 92 transformer-chambers built in the ground. The transformers are arranged in oil, and reduce the high pressure to 120 volts. The feeders, as are also the distributing mains, are concentric cables of the Felten and Guilleaume type. The capacity of the station is 35,000 lamps, of which 10,000 are already connected to the mains, together with 29 motors of a total of 150 h.p.

Electric Lighting in France. — The Société Générale d'Electricité, which obtained the concession for the electric lighting of Chambéry, is offering to establish a central station at Aix-les-Bains.—The Bordeaux Municipality have voted the requisite funds for the establishment of an electric light station to supply light to the public gardens. It will probably ultimately be extended.—The Compagnie des Mines, of Bruay, Pas de Calais, have adopted the electric light. Two Armington and Sims steam-engines, each of 100 h.p., are employed to drive two dynamos. The electrical work has been done by the Société Alsacienne de Constructions Mécanique.—A central electric light station has been opened at Saint-Léonard, Haute Vienne, the work having been carried out by the Compagnie Française Thomson-Houston. Water power is utilised. The turbine is of 45 h.p., and made by Messrs. Grèzes and Piques, of Toulouse. This drives, by means of belting, a Thomson-Houston alternator giving current at 2,000 volts. The station is about a mile and a quarter from the town, and current is transmitted by naked overhead copper conductors to a transformer station. There are 60 200-c.p. lamps employed for street-lighting.—A competition is to take place at Saint-Dié among those desirous of obtaining the monopoly for the public and private electric lighting of the town. Offers are to be submitted to the Mayor by February 1, and will afterwards be examined by the Municipal Council.—The electric light has been introduced into Aouste, Drôme. Water power is utilised.—At Troyes, the municipal theatre is to be lighted by electricity. The Compagnie de l'Est intends to adopt the electric light at its Troyes-Ville and Troyes-Preyse railway stations, taking current from the Troyes central electricity works of the Compagnie Nationale de l'Electricité.—Some new arc lamps are to be erected at the harbour, Brest.—It is proposed to establish a central station at Châtillon-sur-Chalaronne, utilising the water power of the River Chalaronne.—Mr. Stulzmann, a Swiss engineer who has lighted Ferney electrically, is applying to the Municipality of Gex, Ain, for power to introduce the electric light there.—The electric light is to be introduced into the mining town of Langeac, Haute-Loire.—The Municipality of Moirans, Isère, offer a subvention for the best scheme for the electric lighting of the town.—Projects are on foot for the establishment of electricity works at Montereau, Seine-et-Marne.—M. Bastide has commenced work in connection with the central electric light station at Riez, Basses-Alpes, for which he has obtained a concession.

Utilisation of Niagara Falls.—A letter from Prof. G. Forbes, who has now returned from the United States, was published in the *Times* on Saturday last. The letter is as follows: "Nearly three years ago you published a letter from this place in which I gave some account of how the dreams of the engineer were in the act of being realised, and without injury to the natural beauties of the spot. Three years have passed, my work is ended, and it seems natural to continue the narrative and tell what these three years have brought forth. I am perched on the top of a small Eiffel tower, lately erected, and, casting my eyes up the river, over the house-tops and beyond the town, I see a new world created. There is a wide canal leading water into that gigantic power-house where three turbines are set up to drive three dynamos of 5,000 h.p. each. There is the bridge to carry cables across to the transformer-house. Inside the power-house the water is carried down pipes 7½ft. diameter into the turbines, and thence it passes through a 7,000ft. tunnel under the town, emerging below the Falls, and capable of developing 100,000 h.p. Far as the eye can reach extend the company's lands, with here and there a huge factory either now using the water power, or waiting for the electric supply. One of them uses 3,300 h.p., another 300, a third one 1,500, and that unfinished mill requires 1,000. You can see, far away, the model village for working-men, and improved sewage works with drainage, pumps for water supply, electric light, and well-paved streets. There, again, is the dock where ships from all parts of the great lakes can unload, and there a huge expanse of reclaimed land; while the whole is swept by the company's railway, seven miles long, connecting every factory with the great trunk lines. The power is transmitted by electricity, and the first work is to produce aluminium with 1,500 h.p. New types of machines have been devised for this work as also for every other purpose. All criticism as to cost of electric works has been swept away by the results achieved, and the efficiency of each type of machine is greater than has been attained before. All the machinery for the first working has been made and tested in the shops, and the last parts are now being set up. The plans for carrying the power to Buffalo, 18 miles distant, are complete. In a month or two factories will be in full operation; in a year Buffalo will be supplied; in two years the same company will be working the Canadian side of the Falls, and in 10 years (shall we say?) the whole of the 100,000 h.p. which can be supplied by the existing hydraulic works will be giving power to smokeless manufacturing towns. The period of planning the transmission scheme, of designing the greatest dynamos in the world, and of construction of the first plant, now closes. The financial period commences with the new year. The earning of dividends and the ordering of duplicate machinery is the future work of the company. In conclusion, it is difficult for me to say who were the boldest—the capitalists who embarked on the scheme before any plans were matured, or the manufacturers who moved their factories to this field before a single result had been achieved. The action of both was typically American, but their confidence was not misplaced. Their success is now assured."

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Gravitation Water Supplies and Electrical Energy.—The rapidly extending use of water power for the generation of electricity at many places abroad, the *Engineer* remarks, has naturally directed attention to the home possibilities in this direction. These are soon found to be disappointing, the best water-power locations having been long ago utilised for various motive purposes. There are, it is true, numberless points on the smaller streams throughout the country capable of furnishing power for small lighting installations; but generally the water power in Great Britain not subject to old-established rights is meagre or capricious. In some parts of Ireland, however, there is abundance of water power capable of utilisation. But apart from natural sources, there is another and constantly increasing form of water power in the great works, completed and in progress, for supplying the inhabitants of cities, towns, and villages with potable water. Here, also, however, a very slight amount of investigation shows that though the power represented in many cases by the flow of water and its fall may be great, the energy capable of utilisation is generally small, and often practically non-existent. For instance, at Glasgow nearly 50,000,000 gallons of water flow daily into the city and suburbs from Loch Katrine, which has an elevation of about 350ft. above the lower streets of the town. The power represented by these figures would, if capable of employment for lighting by electricity, effect a great saving in the Corporation coal bill. But, of course, the water does not run direct from the highest to the lowest point. It runs first into the distributing reservoirs at Craigmaddie, situated some 50ft. below the level of Loch Katrine, and is conveyed mainly in open culverts, so that little power is derivable at its debouchment. From Craigmaddie the water is piped; but some of the natural elevations in Glasgow are over 250ft. in height, with buildings of about 50ft. elevation on their summits, so that in some cases the head of water does not suffice for the supply, and pumping is resorted to. In short, though in some of the lower districts there may be at times an excess of pressure, practically all the energy due to the head and volume of water is absorbed in its own distribution. Very similar conditions obtain in cities like Manchester and Liverpool. There are, however—especially in Scotland—many towns where the gravitation water supplies are capable of furnishing considerable quantities of electrical energy at a comparative small outlay and without detriment to the water distribution. To cite, a case a small town on the Clyde, with reservoirs at over 500ft. above the river level, gives its inhabitants a liberal supply of 600,000 gallons per day. To keep the pressure at the lower parts of the town within reasonable limits, the main pipe is broken 250ft. below the level of the reservoirs, the water discharging into a distributing-tank with an amount of energy equal to nearly 100 h.p. in the meantime unutilised. To have undertaken the construction of the works merely to get this power would have been out of the question; but the instance shows, the *Engineer* concludes, that it may be quite worth the attention of engineers, when laying out new works in hilly districts, to consider the power possibilities of their schemes, as there are no doubt many localities adapted for the combination of a power station and water-supply works.

The Marvellous (!) Primary Battery Again.—Judging from the reports now circulating in Scotch papers, the experience and results gained by many persons in the production of different kinds of primary batteries do not deter others from attempting the impossible—the discovery of a battery to replace the dynamo. In the present case it appears that two young Dumbartonians have devised a marvellous battery! As it would be a pity to destroy the humour of the statement in a Glasgow paper, we quote the following: "What these young Clydebank engineers are said to have accomplished is the discovery of a primary battery in which, while the decomposition of the zinc plates is rendered enormously slower, and the chemicals used of trivial value, the strength of the battery thus formed is very greatly increased. The matter has been taken up by a number of gentlemen in Glasgow, who have formed themselves into a syndicate, which has started with a capital of something like £4,000 to enable the young men to prove and develop their discovery. An arc lamp at Queen-street Station, Glasgow, has been as brilliantly lighted by one or two of the cells of the battery as by the power supplied from the big dynamos. The new form of battery is understood to include the use of common salt water, ash, bluestone, and other very cheap chemicals." Mr. E. T. Ruthven Murray, electrical engineer to the Aberdeen Corporation, in the course of an interview on the subject, at once threw cold water on the battery. He is reported to have said: "I do not think the matter has been properly gone into by scientific men who know what it is possible to do with primary batteries. If the statement which appeared in the newspapers is correct, there must be something very extraordinary in the invention, because, up to the present time, I do not think that with any two metals or substances known, a greater potential difference than that of about two volts can be maintained. I also notice in the report it is stated that an arc lamp has been brilliantly lighted by one or two of these cells. An arc lamp requires at least 45 volts to overcome the resistance of the arc and the lamp. Consequently with any ordinary cells—take storage batteries such as we have here—you would need to have 45 divided by 2—that is to say, 23 cells to maintain one arc; and though you could make a battery which would hold a sufficient current strength or number of amperes to light 25 arcs off the same cells—and that is the capacity of the batteries at the central station here—you would still require the 23 cells to enable you to maintain the requisite pressure to get the current through the lamps. It appears to me that the account of the supposed discovery has not been written by a technical man." Mr. A. W. Stewart, M.I.E.E., of Dalmuir, also dashes to the ground the fond hopes raised for this battery. He says: "A few nights ago I had the honour of inspecting the wonderful battery, which, from report, had burst all the incandescent electric lamps yet tested, none of them being able to withstand the enormous tides of current generated therein. The battery consisted of two sets of unassuming boxes, each about 2ft. square and 1ft. deep, inside of which were packed 15 glass jars containing the wonderful elements to be used hereafter in driving our ocean greyhounds at from 40 to 60 miles per hour. The inventor took up the positive and negative wires in his bare hands and placed them on the terminals of a small motor, which responded at once by setting off a-spinning as fast as its little wire-bound sides would allow it, considering that all the work it had to do was to overcome the friction of its own oily bearings. This was certainly very awe-inspiring to anyone accustomed with the running of motors, but on placing my finger on its pulley I found that the friction was too much, and it stopped altogether. Not having any instruments with me to measure the output of this 30-cell battery, I therefore tried a test, well known among electricians for very weak currents, and this was to place the positive and negative wire on each side of my tongue. I survived the feeble shock, and live to tell the tale."

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PHYSICAL UNITS.

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(Continued from page 655.)

MEASUREMENT OF ELECTRIC UNITS BY THEIR ELECTROMAGNETIC EFFECTS.

§ 76. *Quantity.*—Quantity can be measured practically by a ballistic galvanometer (1) when we know the steady current (§ 77) that gives unit deflection on it, or (2) when we know the dimensions of the ballistic galvanometer and the horizontal component of the earth's magnetism at the centre of its coil (§ 77). Quantity can also be measured by electro-chemical effects (§ 79).

§ 77. *Current.*—In the electromagnetic system currents can be measured (1) by their action on a magnetic needle, as described in last paragraph of § 55. This involves a knowledge of the horizontal component of the earth's magnetic force. An exact determination of this can be made by the Gaussian method of finding the deflection produced on a magnetometer needle by a magnet at a given distance, and then finding the period of the magnet vibrating under the earth's horizontal magnetic force, when suspended in the position occupied by the magnetometer in the deflection experiment.*

§ 78. Currents can be measured (2) by their mutual action on one another. Ampère has investigated the laws of mechanical action between conductors carrying currents; and he has shown that the action of a small closed circuit at a distance is the same as that of a small magnet placed at the centre of the closed circuit, provided that the axis of the magnet is at right angles to the plane of the closed circuit and that its magnetic moment is equal to the product of the area of the closed circuit into the current.

Hence we might define unit current electrodynamically as follows: Let there be two straight parallel conductors, unit distance apart, and carrying equal currents. Let one of them be of finite length, and the other very long. Then unit current flows in each of them when there is unit force between them per unit length of the finite conductor. This unit of electrodynamic current is $1/\sqrt{2}$ of the unit of electromagnetic current, or 7·07 amperes. It is not used in practice. Hence, to make this unit of current coincide with the electromagnetic unit of current, we must define it as that current which, flowing in each of our two conductors, produces two units of force per unit length of the finite conductor, when they are unit distance apart.

Electro-dynamometers and electro-dynamic balances measure currents by the mutual action of their coils on one another. The Board of Trade has accepted instruments of this type for measuring standard currents, in practice the recommendation of the Board of Trade Committee on electrical standards being "that instruments constructed on the principle of the balance, in which, by the proper disposition of the conductors, forces of attraction and repulsion are produced, which depend upon the amount of current passing, and are balanced by known weights, should be adopted as the Board of Trade standards for the measurement of current whether unvarying or alternating."

§ 79. Electric currents can be measured (3) by their electro-chemical action. Faraday has shown that when a current passes through an electrolyte the quantity of each substance decomposed is proportional to the quantity of electricity which passes. The ampere is thus defined as the unvarying current which, when passed through a solution of nitrate of silver in water (definitely specified in the report previously referred to), deposits silver at the rate of 0·001118 of a gramme per second. The balances referred to in (2) are standardised by the electrolysis of a solution of silver nitrate or of copper sulphate.

§ 80. *Resistance.*—Various methods have been used for the determination of resistances in absolute measure, and the reader is referred to the following papers and books for detailed descriptions and discussions of them: "On the Methods Employed for Determining the Ohm," by G. Wiedemann, *Phil. Mag.*, October, 1882, p. 258; "Comparison of Methods for the Determination of Resistances in Absolute Measure," by Lord Rayleigh, *Phil Mag.*, November, 1882, p. 329; "Electricity and Magnetism," by Clerk Maxwell, Vol. II., Chapter XVIII.; "Absolute Measurements in Electricity and Magnetism," by Prof. A. Gray, Vol. II., Part II., Chapter X., pp. 538 to 602.

§ 81. The tables of results in § 83 are taken from a report by R. T. Glazebrook to the British Association in 1891 on the "Absolute Resistance of Mercury." The methods referred to in the fourth column are fully described in the papers and books referred to in the previous section. Here it may be briefly stated that the method of the rotating coil, though first suggested by Weber, was first practically carried out by Clerk Maxwell, Balfour Stewart, and Fleeming Jenkin, in 1863, by an apparatus designed by Prof. Wm. Thomson (now Lord Kelvin). The method is sometimes known as the B. A. Committee method: "The coil of wire is made to revolve about a vertical diameter with constant velocity. The motion of the coil among the lines of force due to the earth's magnetism produces induced currents in the coil which are alternately in opposite directions with respect to the coil itself, the direction changing as the plane of the coil passes through the east and west direction. If we consider the direction of the current with respect to a fixed line in the east and west direction, we shall find that the changes in the current are accompanied with changes in the face of the coil presented to the east, so that the absolute direction of the current, as seen from the east, remains always the same. If a magnet be suspended in the centre of the coil, it will be deflected from the north and south line by the action of these currents, and will be turned in the same direction as the coil revolves. The force producing this deflection is continually varying in magnitude and direction; but as the periodic time is small the oscillations of the magnet may be rendered insensible by increasing the mass of the apparatus along with which it is suspended. The resistance of the coil may be found when we know the dimensions of the coil, the velocity of rotation, and the deflection of the magnet. The intensity of terrestrial magnetism enters into the measurement of the E.M.F., and also into the measurement of the current; but the measure of the resistance, which is the ratio of these two quantities, is quite independent of the value of the magnetic intensity."*

§ 82. Lorenz's method is as follows: "A circular disc of metal, maintained in rotation about an axis passing through its centre at a uniform and known rate, is placed in the magnetic field due to a battery current which circulates through a co-axial coil of many turns. The revolving disc is touched near its centre and circumference by two wires. If the circuit were simply closed through a galvanometer, the instrument would indicate the current due to the E.M.F. of induction acting against the resistance of the circuit. The E.M.F. corresponding to each revolution is the same as would be generated in a single turn of wire coincident with the circumference of the disc by the formation or cessation of the battery current. If this be called γ, and M be the coefficient of induction between the coil and the circumference, m the number of revolutions per second, the E.M.F. is $m\,M\,\gamma$. For the present purpose, however, the circuit is not simply closed, but its terminals are connected with the extremities of a resistance, R, through which the battery current flows, and the variable quantities are so adjusted that the E.M.F. $R\,\gamma$ exactly balances that of induction. When the galvanometer indicates no current the following relation, independent, it will be observed, of the magnitude of the battery current, must be satisfied,

$$R = m\,M;$$

and from this, M being known from the data of construction, the absolute resistance, R, of the conductor is determined."†

* Gray's "Absolute Measurements in Electricity and Magnetism," Vol. II., Part I., Chapter II., pp. 70 to 79.

* Report of the Committee on Electrical Standards appointed by the British Association, 1863, Appendix D, Spon's reprint, p. 97. The mathematical theory of the experiment is given by Clerk Maxwell on pp. 101 to 109 of the same reprint.

† Lord Rayleigh, *Phil. Mag.*, November, 1882, p. 341.

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§ 83. TABLES OF RESULTS.

—	Observer.	Date.	Method.	Value of the ohm in centimetres; cross-section 1 sq. mm.; temperature 0° C.	
1	Lord Rayleigh	1882	Rotating coil	106·31	
2	Lord Rayleigh	1883	Lorenz method	106·27	
3	Mascart	1884	Induced current	106·33	
4	Rowland	1887	Mean of several methods	106·32	
5	Kohlrausch	1887	Damping of magnets	106·32	mean 106·31
6	Glazebrook	1882, 1888	Induced currents	106·29	
7	Wuilleumeier	1890	—	106·31	
8	Duncan & Wilkes	1890	Lorenz	106·34	
9	Jones	1891	Lorenz	106·31	
10	Strecker	1885	—	106·32	
11	Hutchinson	1888	—	106 30	mean 106·31
12	Salvioni	1890	—	106·33	
12*	Salvioni	—	—	106·30	
13	H. F. Weber	1884	Induced current	105·37	
14	H. F. Weber	—	Rotating coil	106·16	
15	Poiti	1884	Mean effect of induced current	105·89	mean 105·94
16	Himstedt	1885	—	105·98	
17	Dorn	1889	Damping of a magnet	106·24	
18	Wild	1883	Damping of a magnet	106·03	
19	Lorenz	1885	Lorenz method	105·93	

§ 84. From the average of these experiments the ohm is defined as the resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice, 14·4521 grammes in mass, of a constant cross-sectional area, and of length 106·3cm.

Calling this the Board of Trade ohm, or the international ohm, the following table gives the value of the principal practical units of resistance which previously existed:

Unit.	International ohm.	B.A. ohm.	Legal ohm 1884.	Siemens's ohm.
International ohm.	1	1·0136	1·0028	1·0630
B.A. ohm	0·9866	1	0·9894	1·0488
Legal ohm.....	0·9972	1·0107	1	1·0600
Siemens's ohm	0·9407	0·9535	0·9434	1

Thus to reduce British Association ohms to international ohms we divide by 1·0136, or multiply by 0·9866; and to reduce legal ohms to international ohms we divide by 1·0028, or multiply by 0·9972, etc.

§ 85. *Electromotive Force.*—Electromotive forces can be measured indirectly when resistances and currents are measured by any of the methods mentioned; for, by Ohm's law, the difference of potential between any two points of a circuit is equal to the product of the current passing into the resistance between the points. Electromotive forces can be measured directly as the ratio of the work done by the transfer of a given quantity of electricity to the quantity transferred. Lord Kelvin has determined, from data supplied by Dr. Joule, the E.M.F. of a single cell of Daniell's battery by this method.

(See "Applications of the Principle of Mechanical Effect to the Measurement of Electromotive Forces, and of Galvanic Resistances," by Lord Kelvin, *Phil. Mag.*, December, 1851. Reprinted in "Mathematical and Physical Papers," vol. i., p. 490.)

As a practical standard of E.M.F., the Board of Trade has taken the electrical pressure at a temperature of 15deg. C. between the poles or electrodes of the voltaic cell known as Clark's cell (specially prepared) as 1·434 volts. Corrections, similar to those mentioned regarding the ohm, must be applied to B.A. volts, legal volts, etc., to reduce them to Board of Trade volts or international volts.

§ 86. *Capacity.*—The capacity of a conductor is the ratio of the quantity of electricity in the charge to the E.M.F. producing it, and hence an indirect measurement of capacity is easily performed. It can be measured by a ballistic galvanometer when the resistance of the circuit in electromagnetic measure is known (§ 80).

MEASUREMENT OF ELECTRIC UNITS BY THEIR ELECTROSTATIC EFFECTS.

§ 87. *Quantity.*—The practical method of measuring a quantity of electricity is to measure the capacity of the conductor containing the charge (§ 90), and to multiply this by the E.M.F. producing the charge (§ 89).

§ 88. *Current.*—The practical method of measuring current is to find the difference of potential (§ 89), and the resistance (§ 91), and to divide the one by the other.

§ 89. *Electromotive Force.*—The practical method of measuring E.M.F. is to measure the force between two electrified bodies, for the difference of potential between them is proportional to the force exerted between them. Absolute electrometers are constructed on this principle.

§ 90. *Capacity.*—The capacity of a conductor is measured by comparing its capacity with that of a spherical conductor insulated at a distance from other conductors. The capacity of the latter is equal to its radius.

§ 91. *Resistance.*—Electrostatic resistance can be measured by allowing a body of known capacity (§ 90), and charged to a potential measured as in (§ 89), to discharge itself through the conductor whose electrostatic resistance we want to measure. This method is applicable only to conductors of large resistance.

§ 92. Now that we know how to measure the electric units electrostatically and electromagnetically, we can find the ratio of the one to the other—that is, we can experimentally find what was denoted by v in § 65. This velocity, v, has been determined experimentally by measuring in electrostatic units and in electromagnetic units:

	Ratio.
I. Quantity, §§ 87 and 76	v
II. Current, §§ 88 and 77, 78, 79	v
III. Resistance, §§ 91 and 80-83	$1/v^2$
IV. E.M.F., §§ 89 and 85	$1/v$
V. Capacity, §§ 98 and 86	v^2

Date.	Experimenter.	Reference.	Method employed Comparison of	v in centimetres per sec.	
1856	Weber and Kohlrausch	*Pogg. Ann.*, 1856	Quantity	$3·107 \times 10^{10}$	mean $= 2·9633 \times 10^{10} = 3 \times 10^{10}$cms. per sec.
1868	Maxwell	*Phil. Trans.*, 1868	Potential	$2·842 \times 10^{10}$	
1869	W. Thomson and King	B. A. report, 1869	Potential	$2·800 \times 10^{10}$	
1872	McKichan	*Phil. Trans.*, 1872	Potential	$2·896 \times 10^{10}$	
1879	Ayrton and Perry	*Jour.* Soc. Tel. Eng., 1879.	Capacity	$2·960 \times 10^{10}$	
1880	Shida	*Phil. Mag.*, 10, 1880	Potential	$2·955 \times 10^{10}$	
1881	Stoletow	Soc. France de Phys., 1881.	Capacity	$2·990 \times 10^{10}$	
1882	F. Exner	Wein. Ber., 1882	Potential	$2·920 \times 10^{10}$	
1881	Klemencic	Wein. Ber., 1884	Capacity	$3·019 \times 10^{10}$	
1883	J. J. Thomson	*Phil. Trans.*, 1883	Capacity	$2·963 \times 10^{10}$	
1888	Himstedt	*Weid. Ann.*, 1888	Capacity	$3·009 \times 10^{10}$	
1889	Rowland	*Phil. Mag.*, 1889	Quantity	$2·9815 \times 10^{10}$	
1889	E. B. Rosa	*Phil. Mag.*, 1889	Capacity	$3·0004 \times 10^{10}$	
1889	W. Thomson	Inst. E.E.	Potential	$3·004 \times 10^{10}$	
1890	Thomson and Searle	*Phil. Trans.*, 1890	Capacity	$2·9955 \times 10^{10}$	

PRACTICAL NOTES ON DYNAMO CALCULATION.*

BY ALFRED E. WIENER.

(Continued from page 717.)

36. *Total Flux to be Generated in Machine.*—The total flux to be generated in any dynamo is the product obtained in multiplying its useful flux by the factor of its magnetic leakage:

$$\Phi' = \lambda \times \Phi = \lambda \times \frac{6 \times b \times E \times 10^9}{K \times N} \quad . \quad . \quad (109)$$

Φ' = total flux to be generated in machine, in lines of force;
Φ = useful flux necessary to produce the required E.M.F. under the given conditions, from formula (91);
λ = factor of magnetic leakage (see Chapters 37 to 40).

The value of the total magnetic flux in a dynamo directly determines the sectional areas of the various portions of the magnetic circuit in the frame (see Part III.), and since the magnetomotive force required depends upon the total

* From the *Electrical World* (New York).

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magnetic flux to be effected, has a direct influence also upon the magnetic winding. In calculating a dynamo-electric machine, therefore, it is of great importance to compute the actual value of the total flux, and, consequently, to predetermine with sufficient accuracy the amount of the magnetic leakage.

But since the dimensions of the magnetic circuit depend upon the total flux to be generated, the accurate value of the total flux, however, is given by the coefficient of magnetic leakage, which, in turn, for a newly-designed machine is to be calculated from the dimensions of the magnet frame, it is necessary to proceed as follows:

An approximate value of λ for the type and size of dynamo in question is taken from Table LII., Chapter 40, and the corresponding approximate total flux calculated from formula (109). With the value of Φ' thus obtained, the principal dimensions of the magnet frame are determined according to the rules given in Part III. The dimensions now being known, the probable leakage factor, λ, can be figured from formula (110) or (111) respectively, Chapter 37, the single terms of which are found by applying the formulæ and rules given in Chapters 38 and 39 to the particular type under consideration. From formula (109), finally, the accurate value of the total flux is obtained. Should the latter prove so much different from the assumed approximate value of Φ', as to necessitate a change in the dimensions of the frame, then the calculation of λ will have to be partly or wholly repeated.

That such a calculation of the probable leakage factor is necessary in every single case, is evident from the fact that not only the leakage in two machines of same general design, and even of approximately the same size, which are merely differently proportioned in their essential parts, may widely differ from each other, but that in one and the same dynamo the amount of the leakage can be considerably varied by using armatures of different core diameters in its magnetic field.

From the same reason it can also be concluded that the method of assuming a valve of λ from previous experience with a certain type, or even with an individual machine, is an entirely unreliable one, and that the calculation of the magnetomotive force based upon such an assumption cannot be depended upon.

The author's method of predetermination of the magnetic leakage from the dimensions of a machine to the process of calculation, to within but a few per cent. of the actual value, is given in the following Chapters 37, 38, and 39 (Prof. Forbes*).

Logarithmic formulæ (2), heretofore employed for the computation of the magnetic leakage, being too cumbersome for the practical electrical engineer, the writer believes that by his set of simple geometrical formulæ contained in Chapter 38 he has removed some of the difficulty in leakage calculations.

37. *Formula for Probable Leakage Factor.*—Since air is a conductor of magnetism, the conditions of the magnetic circuit of a dynamo-electric machine resemble those of a closed metallic electric circuit immersed in a fluid. In the latter case the main current will flow through the metallic conductors, but a portion will pass through the fluid. Similarly for the magnetic circuit, the main path for the magnetic flux being the magnetic circuit of the dynamo, consisting of the iron field frame, the air-gaps, and the armature body. The amount of electric current passing through the surrounding medium, the fluid, depends upon the ratio between the conductances of the main to the shunt paths. In order to calculate the amount of magnetic leakage in a dynamo, therefore, it is, analogically, only necessary to determine the ratio between the permeances of the useful and the stray paths.

The leakage factor in any dynamo having a smooth armature can accordingly be expressed as the quotient of the total joint permeance of the systems by the permeance of the useful path. But since the reluctance of the iron portion of the main path is very small compared with that of the air-gaps, the sum of their reciprocals—that is, the total permeance of the useful path is practically equal to the permeance of the gaps; hence, the permeance of the gaps can be taken as a substitute of the permeance of the whole magnetic circuit within the machine, and we obtain the following formula for the probable leakage factor of any dynamo having a smooth armature:

$$\lambda = \frac{\text{Joint permeance of useful and stray paths}}{\text{Permeance of useful path}};$$

or,
$$\lambda = \frac{P_1+P_2+P_3+P_4}{P_1} \quad . \quad . \quad . \quad (110)$$

where P_1 = relative permeance of the air-gaps (useful path);
P_2 = relative average permeance across magnetic cores .....
P_3 = relative permeance across pole-pieces...
P_4 = relative permeance between pole-pieces and yoke .....
(stray paths).

The relative permeances—by which are understood the absolute permeances divided by the magnetic potential, and which, therefore, include a constant factor on account of the units chosen—are taken for convenience; for in each individual case the maximum magnetic potential is the same for all permeances, and a constant numerical factor, if absolute permeances were used, would be common to all terms in (110), and consequently would cancel.

In order to obtain the probable leakage factor for toothed and perforated armatures, the "factor of armature leakage" (Chapter 8) is to be introduced, and we have for this case:

$$\lambda' = \lambda_1 \times \lambda = \lambda_1 \times \frac{P_1+P_2+P_3+P_4}{P_1} \quad . \quad (111)$$

Numerical values of λ for various kinds of armatures are given in Table XI., Chapter 8.

38. *General Formulæ for Relative Permeances.*—In order to obtain the values of the permeances of the various paths we start from the general law of conductance:

$$\text{Conductance} = \left\{\begin{matrix}\text{conductivity}\\ \text{of medium}\end{matrix}\right\} \times \frac{\text{Area of medium}}{\text{Distance in medium}},$$

so, in our case of magnetic conductance:

$$\text{Permeance} = \text{permeability} \times \frac{\text{Area}}{\text{Length}}.$$

Since the permeability of air = 1, the relative permeance between two surfaces can be expressed by the general formula:

$$P = \frac{\text{Mean area of surface exposed}}{\text{Mean length of path between them}} \quad (112)$$

From this, formulæ for the various cases occurring in practice can be derived.

(*a*) *Two Plane Surfaces, Inclined to Each Other.*—In order to express, algebraically, the relative permeance of the space between two inclined plane surfaces, Fig. 49, the mean path is assumed to consist of two circular arcs joined by a straight line tangent to both circles, said arcs to be described from the edges of the planes nearest to each other, as centres with radii equal to the distances of the respective centres of gravity from these edges.

Hence

$$P = \frac{\frac{1}{2}(A_1+A_2)}{\frac{c+a_1+a_2}{2} \times \frac{\pi}{2} \times \frac{\alpha}{180}} \quad . \quad . \quad . \quad (113)$$

where A_1, A_2 = areas of magnetic surfaces;
c = least distance between them;
a_1, a_2 = widths of surfaces A_1 and A_2 respectively;
α = angle between surfaces A_1 and A_2.

(*b*) *Two Parallel Plane Surfaces Facing Each Other.*—If the two surfaces A_1 and A_2 are parallel to one another, Fig. 50, the angle closed is $\alpha = 0$deg., and the formula for the relative permeance, as a special case of (113), becomes:

$$P = \frac{\frac{1}{2}(A_1+A_2)}{c} \quad . \quad . \quad . \quad . \quad (114)$$

(*c*) *Two Equal Rectangular Surfaces Lying in One Plane.*—In case the two surfaces lie in the same plane, Fig. 51, they enclose an angle of $\alpha = 180$, and the permeance of the air between them, by formula (113), is

$$P = \frac{a \times b}{c + a \times \frac{\pi}{2}} \quad . \quad . \quad . \quad . \quad (115)$$

* Geo. Forbes, *Journal* Soc. Telegraph Engineers, XV., p. 531, 1886.

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a = width of rectangular surface;
b = length „ „ „ ;
c = least distance between surfaces.

(*d*) *Two Equal Rectangles at Right Angles to Each Other.*—If the two surfaces are rectangular to each other, Fig. 52, the angle $\alpha = 90$deg., formula (113), consequently, reduces to

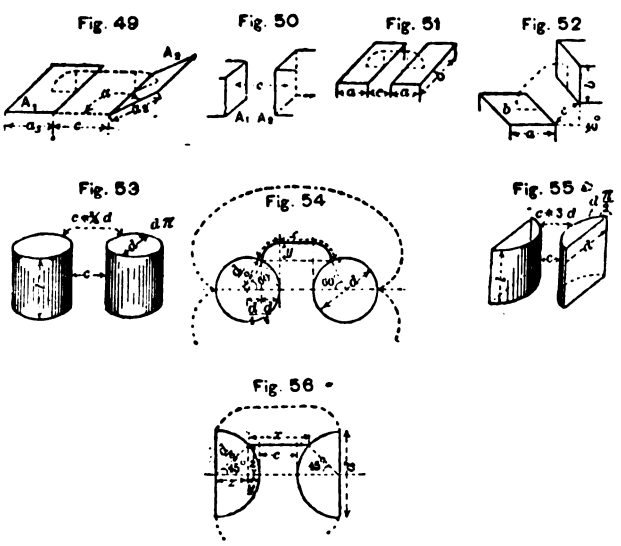
$$P = \frac{a \times b}{c + a \times \frac{\pi}{4}} \quad . \quad . \quad . \quad . \quad . \quad (116)$$

(*e*) *Two Parallel Cylinders.*—In case the two surfaces are cylinders of diameter d and length l, Fig. 53, the areas of their surfaces are $d\pi \times l$; and if they are placed parallel to each other at a distance c apart, the main length of the magnetic path is $c + \frac{3}{4} d$; hence the permeance of the air between them:

$$P = \frac{d \times \pi \times l}{c + \frac{3}{4} d} \quad . \quad . \quad . \quad . \quad . \quad (117)$$

In this formula the expressions for the mean length of the path is deduced from Fig. 54, in which it is assumed that the mean path consists of two quadrants joined by a straight line of length c, and extends between two points of the cylinder peripheries situated at angles of 60deg. from the centre line.

Since in an equilateral triangle the perpendicular,



dropped from any one corner upon the opposite side, halves that side, the perpendicular, from either of the end points of the mean path upon the centre line, bisects the radius of the corresponding cylinder circle, and the radius of the leakage-path quadrant is $y = \frac{a}{4}$, hence the length of the mean path:

$$\chi = c + y \times \pi = c + d \times \frac{\pi}{4},$$

or, approximately:

$$\chi = c + \tfrac{3}{4} d.$$

This approximation even better meets the practical truth, as most of the leakage takes place directly across the cylinders, and the mean path, therefore, in reality is situated at an angle of somewhat less than 60deg., which was taken for convenience in the geometrical consideration.

(*f*) *Two Parallel Cylinder Halves.*—If two cylinder halves face each other with their curved surfaces, Fig. 55, the mean length of the magnetic path is $C + \cdot 3\, d$, where c is the least distance apart of the curved surfaces, and d the diameter of the cylinders, and we have for the permeance:

$$P = \frac{d \times \frac{\pi}{2} \times l}{c + \cdot 3\, d} = \frac{d \times \pi \times l}{2\, c + \cdot 6\, d} \quad . \quad . \quad . \quad (118)$$

The mean length of the path is geometrically found from Fig. 56, as follows:

$$2 z^2 = \left(\frac{d}{2}\right)^2; \quad z = \frac{d}{2}\sqrt{\frac{1}{2}};$$

$$\therefore y = \frac{d}{2} - z = \frac{d}{2}\left(1 - \sqrt{\frac{1}{2}}\right) = \cdot 15\, d;$$

$$\chi = c + 2\, y = c + \cdot 3\, d.$$

For in this case the extent of the leakage field is much smaller than in that of full cylinders, and the mean path can be assumed a straight line meeting the two semi-circles at an angle of 45deg. from the centre line.

(To be continued.)

ON THE EFFECT OF MAGNETISATION UPON THE DIMENSIONS OF IRON RINGS IN DIRECTIONS PERPENDICULAR TO THE MAGNETISATION, AND UPON THE VOLUME OF THE RINGS.*

BY SHELFORD BIDWELL, M.A., LL.B., F.R.S.

A recent communication† to the society contained an account of some experiments relating to the effects of magnetisation upon the dimensions of two iron rings, one of which was annealed and the other hardened. The rings had the form of short cylinders about 6cm. in diameter, 3cm. in height, and 0·4 cm. in thickness. The experiments in question were concerned with the circumferential variations which took place along the lines of magnetisation. Those to be here described deal with the concomitant variations in the height of the cylinders (width of the rings) transversely to the magnetisation. On the assumption that variations similar to the latter occur at the same time in the thickness of the metal, it is possible to deduce the changes in the volume of the ring which attend magnetisation.

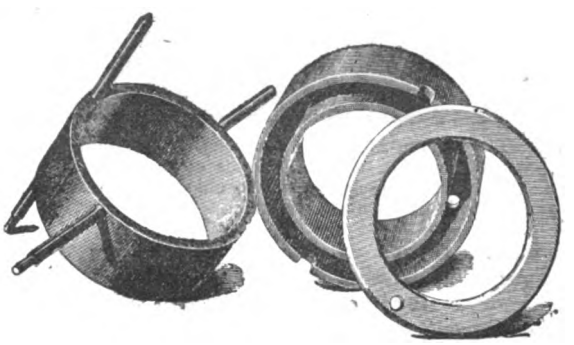


FIG. 1.

Fig. 1, from a photograph, shows how the rings were prepared for the experiments. Four brass rods were hard-soldered to the iron, two of them being in a line with a diameter, while the other two were attached to the edges opposite to one another, and parallel to the axis of the ring. The ring was inserted in a wooden case, also shown, through holes in which the four brass rods projected. Insulated wire for carrying the magnetising current was wound over the wooden jacket.

For the new experiments the ring was placed in a horizontal position, one of the edge rods resting upon a brass socket on the adjustable base of the instrument, and the other, which had a chisel-shaped end, actuating the lever.‡ To counterbalance the weight of the ring a horizontal arm, carrying a sliding weight, was fixed to the lower rod.

It need hardly be said that the experimental difficulties in the way of determining to a ten-millionth part the changes which took place in a length of less than 1¼in. were very considerable.

The annealed ring will, as before, be distinguished as Ring I., and the hardened one as Ring II.

The changes observed in the widths of the two rings (transversely to the magnetisation) are indicated in Table I. and in the curves of Fig. 2. It will be seen that they are quite similar in the two cases, little or no effect being produced by annealing. Under gradually ascending forces both rings first become narrower, and then recover their

* From the *Proceedings* of the Royal Society.
† Royal Society's *Proceedings*, vol. 55, p. 228.
‡ The chisel-shaped terminal piece was removable, and is not shown in Fig. 1.

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original width, and ultimately become wider than when unmagnetised.

TABLE I.

Ring I. (annealed)		Ring II. (hardened)	
Magnetising force, C.G.S. units.	Elongations in ten-millionths.	Magnetising force.	Elongations.
6	− 9	7	− 5
17	−18	18	−13·5
41	−23	47	−21
59	−21	69	−18
75	−17	82	−17
116	−13	117	−11
151	− 9	155	− 7
220	− 4	242	2·5
306	8	342	14
405	17	451	23
509	23	570	27

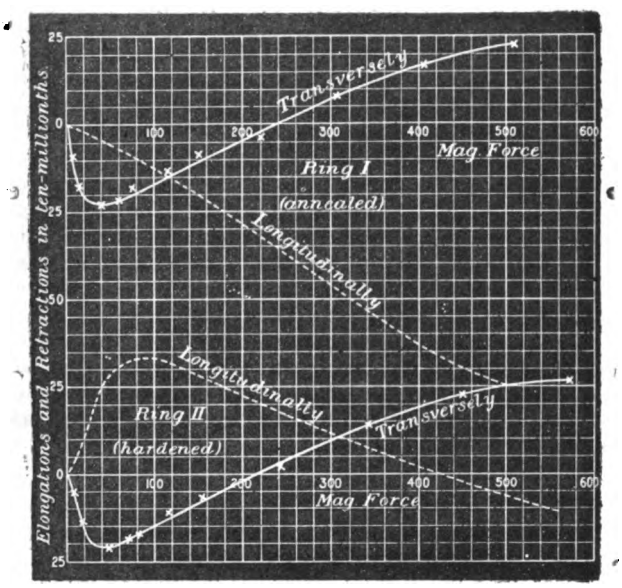

FIG. 2.—The curves marked "longitudinally" relate to circumferential changes, *along* the lines of magnetisation. Those marked "transversely" relate to changes in the width, *perpendicularly* to the magnetisation.

The only previous experiments that I know of relating to magnetic changes of dimensions in directions perpendicular to the magnetisation are those of Joule,* who used a piece of iron gas-piping one yard long, and ⅜in. in mean diameter, having an insulated wire inserted into it and bent over the sides, so as to form a magnetising coil of one and a half convolutions. The greatest current he used seems to have been about 12 amperes, and the magnetising force therefore about eight C.G.S. units. With this he found a contraction in the length of the pipe of seven ten-millionths, a result which agrees very well with that obtained by myself for the same small magnetising force.

As was shown in my last paper, the effects along the lines of magnetisation are very different in the two rings. The annealed ring (Ring I.) begins to contract circumferentially with the smallest forces, and continues to contract with the large ones; while the hardened ring expands with small forces and contracts with large ones. These effects are indicated in the figure by the dotted curves.

By combining the results of the old and of the new experiments we can ascertain the nature of the changes produced by magnetisation in the volumes of the rings.

If k = elongation (+ or −) along the lines of magnetisation;

l = elongation (+ or −) transversely to the lines of magnetisation;

then the increment or decrement of volume when the ring is magnetised is approximately† $k + 2l$

From the two sets of curves in Fig. 1 corresponding values of k and l can be found, and thence the changes of volume may be deduced. These are given in Table II. and Fig. 3, which show that the volume of the annealed ring is rather suddenly diminished by a small magnetising force, passes a minimum under a force of about 50 units, and then slowly increases, until, with a force of 500 units, it is about 30 ten-millionths less than at starting. The unannealed ring also at first suffers diminution, but its original volume is recovered with a force of about 90, and with higher values is increased.

TABLE II.

Magnetising force, in C.G.S. units.	Increments and decrements of volume in ten-millionths.	
	Ring I. (annealed).	Ring II. (hardened).
10	−27	−11
20	−42	−20
30	−47	−20
40	−51	−17
60	−51	− 9
80	−48	− 2
100	−46	3
140	−42	11
180	−39	17
220	−37	22
260	−35	26
300	−32·5	30
400	−30	40
500	−29	44

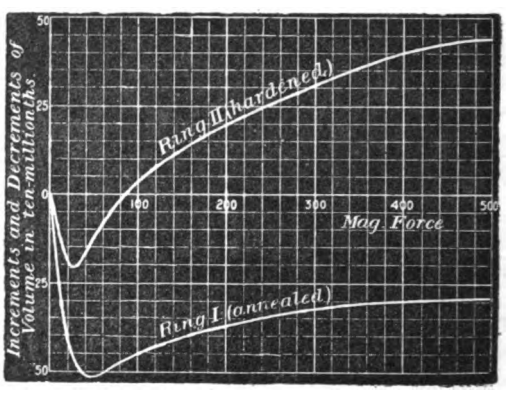

FIG. 3.

The behaviour of this latter ring may be regarded as probably similar to that of the great majority of rods and rings, the annealed ring used in these experiments being the only specimen of iron that has yet been found to contract along the lines of magnetisation with the smallest forces that produced any effect at all.

Experiments upon the volume changes produced by magnetisation have been previously made by Joule, Barrett, and Knott.

Joule* concluded that the volume of an iron bar was altogether unaffected by magnetisation, even though the magnetising current which he employed "was quite equal to saturate the iron." It was at that time believed that "saturation" was produced by a force of from 80 to 100 units, and, assuming that Joule's force was of about that value, an inspection of the curve for unannealed iron in Fig. 3 will show the probable reason of his having failed to detect any change of volume. There is, in fact, none at all with a force of about 90 units.

Barrett,† experimenting in the same manner as Joule, "enclosing the bars in a vessel of water terminating in a capillary tube, and surrounding the vessel by a powerful magnetising helix," also obtained a negative result, perhaps for the same reason.

Knott's‡ experiments were made with hollow iron tubes 45·7cm. in length, 3·84cm. in external diameter, and of different bores, ranging from 0·7cm. to 3·19cm. "Each tube was closed below, and into the upper end a nut screwed tightly, through a perforation in which issued a fine capillary glass tube. The nut was adjusted under water, so that the whole of the interior space of the metal tube was filled with liquid, and also part of the glass tube. When the tube was set vertically in the heart of the magnetising coil, the changes of volume were measured by the motions of the liquid meniscus in the capillary tube." "A few experiments were made on the external change of volume of a few of the tubes, which were enclosed in a thin-walled brass tube. The brass tube yielded because of its thinness, so that the results were not certain. But

* Joule's Scientific Papers, p. 263.

† Neglecting l^2 and products of k and l.

* Joule's Scientific Papers, p. 236. † *Nature*, vol. 26, p. 485.

‡ Edinburgh Royal Society's *Proceedings*, 1891, p. 315; 1892, pp. 85, 249; British Association Report, 1892, p. 659. The quotations are from the latter.

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there was no doubt that with the specimens of iron tried there were large changes of volume."

The changes observed by Knott in the interior volume appear in the case of a tube of large bore to have been of the same nature as those in my unannealed ring; while with a tube of smaller bore they rather resembled the changes exhibited by the annealed ring. His published investigations are, however, only of a preliminary character, and it is not at present possible to make a satisfactory comparison between his results and my own. But he was undoubtedly the first to show that magnetisation is generally attended by considerable changes of volume.

ELECTRIC LOCOMOTIVES FOR SERVICE IN TUNNELS.

Some time ago a contract was entered into with the General Electric Company to furnish motors to propel the trains of the Baltimore and Ohio Railway through the Howard-street tunnel. Conductors to furnish the power are now being placed in the roof of the tunnel. From the masonry lining is suspended an iron trough, supported by Z-bars, containing the conducting wires. The engine will be propelled by combination trolleys, four poles being used. The locomotive consists of a double set of trucks, each having two axles and four driving wheels. On each axle is mounted a 300-h.p. gearless motor supported on spiral springs resting on the frame of the truck. The motor fields are of the iron-clad type, each with separate windings embedded in a mica-lined slot, cut into the curved body of a laminated iron armature.

The axles of the locomotive pass through the hollow shaft on which the armatures are mounted, these shafts resting on the bearings of the motor frame and being connected to the axles by universal couplings, this arrangement of parts allowing freedom of motion in all directions. Each commutator is provided with four sets of brushes, the motors being manipulated by parallel controllers in the cab. The motor can be used for pushing or pulling, and will work in either direction, it being simply a double engine. Each locomotive will have a capacity of 1,200 h.p., and will weigh nearly 100 tons; it will also be equipped with air brakes, and a whistle worked by a small auxiliary motor within the cab. It is expected that these electric locomotives, of which there will be three in use, will develop a speed of 30 miles an hour, and will propel trains over the Belt Line Railroad between Camden Station and Huntington-avenue as quickly as could be done by steam.

If a freight train is to pass through the tunnel, the motor will be coupled on behind, and will push the train and its locomotive through to Bolton Station, whence the two machines will run the train up grade to Huntington-avenue, where the electric motor will be detached without stopping the train. With passenger trains, the electric locomotive will couple on ahead, pull the train through to Bolton Station, and there leave it, while passengers are getting on and off.

The power-house is in process of erection at the south end of the Belt line below Camden Station. The excavations and embankments of the Belt Line Railroad are all completed, a small part of the masonry on the retaining walls of the Bolton Lot cut remaining unfinished. Tracks are laid over the entire course, but not yet ballasted. The electrical engineers are at work in the tunnel, and workmen are crowding up the walls of the power-house as rapidly as possible. Finishing touches are being put upon the bridges and masonry, and the greater part of the work will be completed by January 1. Trains can be run over the line soon afterwards, while the depôts are building and final repairs to the cuts and embankments are being attended to.

THE OLD GAS-MAIN HAS A TALK WITH THE NEW ELECTRIC LIGHT MAIN.

SCENE.—MOUNT EPHRAIM PROMENADE, TUNBRIDGE WELLS.

Gas-Main.—Hello! What's this a shakin' and a worrin' of me just lately? Here have I bin a restin' for years and doing my duty quietly, and no notice a taken of me, and now—why, what a queer little main it is they are puttin' in a top of me. It ain't for water and it ain't for gas as I know of.

Electric Light Main.—No, certainly not. I am the new electric light main, and am going to put you out of use after a time, so they tell me. At present I am what they call "dead," so there is no great harm in me yet. That is an odd state to be in before one is alive, isn't it, old man? However, I don't want to be bad friends with you; we must try and get on as well as we can together, so I am glad to hear you laugh at my little joke.

G.—Larfin'—can't help it—but it warn't because you said you was dead; you'll be lively enough presently, and have to take care you don't make dead 'uns of some of them 'ere chaps as handle you about so easily. I was a smiling 'cause you said you was going to put me out of use. That won't do—but as to being friends I hopes we shaull be—I've been or hearin' a good deal about you lately, because sometimes I have to work round to the Council-chamber, and light them up—but my word, what hard names they do use when they are talkin' about you—you'd think they was all a swearin' at one another if you didn't know their karacters was above it. The only wonder is as the town as taken you up so strong, instead of letting one of these 'ere limited companies try their luck fust, 'specially just now as money is so flush; they say you can get as much as you like for nothing.

E.—Well, anyway, the town *is* going to try first, old comrade. They can get money *almost* for nothing, and they are quite certain it will pay; and if it don't exactly do that, they have no shareholders to look upon the dividends, and so they are making a start and bowling me along Mount Ephraim. It's a pretty place, and I shall light it up in fine style.

G.—Humph! very likely; but I shall go on about the same, I reckon. I remembers when they first put me down what a hubbub there used to be. I went for oil, taller candles, and rushlights, and such things as they called lights in them days; and I fancy we warn't long after we gave them notice a-putting them out. But then they warn't much to go agin, was they—not like gas? specially when the article putty good, and nothing to complain as to price, and they always gets as much as they want. They did abuse us at first, I can tell you. Thought we should blow them all into the next world afore some on them as warn't quite certain as to their state of mind wanted to go, but, howsomever, here I am, and, not as I know of, haven't done no harm to no one since I bin here. They have guv you a little turn that way, haven't they?

E.—Oh, yes! They have said some very hard and false things about me, and want to make out I am dangerous, and go out just when I am wanted, and other things like that—all prompted by jealousy and fear that my superior light will be so manifest to all that they will soon welcome me into their homes, as well as want me to light the streets. You see, as time goes on, I know how to manage better, and don't go skipping about like a skyrocket, as I used to. At times I get a little jerky even now, as very small things upset me, and they have an awful trouble to keep me right sometimes, but from what I hear they know what they are about down here. They say they are a very clever lot.

G.—Well, at fust they was some time a finding out that it must be a wery small hole as I can't get out of, so we are both about alike that way, but I suppose they never maligned you as much as to say you would come cheaper than me. Now, you was a saying that this here is a beautiful promenade, and so it is. There ain't a better in England—fine air, fine views, and all that sort of thing; but all I hopes is that they will give you a better chance than they guv me—I've never had the same chance here as I've heard they guvs 'em in some towns. I'd guv them plenty of light if they'd use me properly, and show them what could be done, but, howsomever, I'm glad you won't be under the old committee, as liked to keep the place in darkness for fear of spending a penny. Let's see, I ain't good at new names, what do they call themselves now?

E.—The Lighting Committee.

G.—The Lightening Committee—then I suppose it 'ill be all electricity?

E.—No, the Lighting Committee.

G.—Oh, I sees, some of one and some of t'other, just as it takes them; give me the best and take the worst themselves, I reckon, but, as I said afore, I hopes they will guv you a better chance than t'other one did me. Why, look at some places in the town, what a disgrace it is. They do say, as people as come here to the Brighton station at night, when they come out of the well-lit station into the road can't hardly see which way to turn. They might put a few hextra lamps down that road, but perhaps they have been waiting for you to come along. Anyhow, the more light one gets at night, the more cheerfuller it will be all round. Well, good-bye, young spark, glad to make your acquaintance, hope you will enjoy your Christmas, and that we shall lay alongside one another for many a day; but mind, none of your skylarks, and if you do get a singeing anybody when they make you alive, don't be mean enough to lay it off on me—that's all.—*Tunbridge Wells Advertiser.*

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THE PROGRESS OF ELECTRICITY.

Even to-day one hears the mild objection sometimes raised by well-meaning but very ignorant individuals—ignorant on this point at least—against the use of electric light or power in any of the well-accepted forms, on the score that the entire science "is in its infancy"! Nothing could well prove the fallaciousness of this idea more than the tendency which has been manifested, especially during the past year, in the direction of effecting economies in methods and appliances for generating and distributing electric energy for all purposes. So far from electrical engineers being yet engaged in experimenting upon broad principles and fundamental devices, they have for some time past been occupied in making the detailed improvements that become necessary to satisfy human desire for perfection of work and economy, after the general foundation of a science has been thoroughly and soundly erected.

The electrical industry does not now concern itself so much with devising new dynamos, new motors, or new lamps that embody principles of a different nature to those at present in use, but endeavours rather to improve the mechanical and electrical details of these appliances, and to find out, if possible, more economical combinations of methods now available rather than absolutely novel modes of obtaining, distributing, and using electric energy. Of course, the efforts of abstract research are not relaxed; they can never be so, altogether—thanks to human ambition that continually aims at still greater perfection—and it would be a sad day for science in general, and electricity in particular, when further investigations in pure science were ceased. These are now, however, left more to the teachers and investigators—to men like Hertz and Tesla, whilst the commercial improvements of latter days tend more to concrete perfection of details.

In regard to the latter, it is, of course, impossible to deal with or even take note of the numerous developments that the past year has brought out; probably there is not a single firm engaged in the manufacture, erection, or use of electrical appliances that would be unable to show some new or improved device effecting small economies, and due to the ingenuity of themselves or their employés. Some brief mention may, however, be made of the principal improvements in adapting more economical methods to the generation of electric energy. Thus the present year has seen a very notable increase in the use of what would otherwise be wasted sources of power, for developing energy in central stations that supply light and power circuits. Take, for instance, the refuse destructor plants not only specified for erection here and there in different localities where conditions favour their use, but actually at work with a considerable amount of success and economy. Water power has also come to the front, and to the limited extent which the physical character of this country will allow, it must undoubtedly occupy a still more prominent place in the future.

Both these methods have been introduced or used for the sole purpose of effecting an economy in the

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cost of electric energy, the electrical apparatus remaining in essence pretty much the same as before; and instances of their use will serve to show very clearly in what directions commercial improvements are now being attempted.

Still another is yet to be spoken of. We refer to the use of gas and gas motors in the electricity supply station, instead of steam boilers and engines. The economical ratio between light or amount of illumination from a given quantity of gas when burnt in gas jets and when passed through a gas-engine which operates a dynamo and arc lights, is too well known and threadbare to require mention in these pages; but the great economy obtained by converting raw fuel into gas for use directly in gas motors as compared with its combustion in steam-boilers which supply steam-engines as prime movers in an electricity station, has not hitherto been made so clear, largely because the available appliances were suited to special conditions, and did not possess characteristics which could be modified to satisfy any demands.

No little credit is due in this respect to the efforts of Mr. Thwaite and his co-workers for developing a practical method and apparatus which may serve under almost any conditions to give the economy thus claimed for gas instead of steam power. It is to all intents and purposes clearly proved that at any rate in the gas-generating plant there are no further difficulties to be faced, on whatever scale the supply of power be based. What now remains to be effected is for the makers of gas-engines to show that they are capable of turning out prime motors of a size and type as large and economical as has long been done by the firms whose speciality is the construction of steam-engines. There seems every promise of satisfaction in this respect. Hardly a week passes by without the engineering papers chronicling, perhaps in illustrated detail, the construction of large and powerful gas-engines, of a capacity equal to 100 h.p. and upwards to perhaps 600 h.p. These are, moreover, in some cases intended for service in electric energy development, and not only for lighting, but for power purposes also: one engine of 100 h.p. or more has been put down lately for operating an electric tramway, though, it is hardly necessary to say, not in this country, unfortunately.

There is no little promise for improved methods of this kind, and their use is much to be favoured on every hand, not merely with the idea of change or of doing away with what we now depend upon (each method will probably have its own most suitable field of service, and room will exist for all, according to local conditions), but to promote true economy, and show the elastic nature of electrical working as a full and complete answer to any statement respecting its presumed elementary state.

Telegraphy in Morocco.—The question of facilities being afforded for extending the British cable system from Tangiers to several places on the western coasts as far as Mogodor is being pressed upon the Moorish Government by Mr. Salow, the British Minister.

THE ELECTRIC-PHŒBUS ACCUMULATOR.

Our French contemporary the *Revue Industrielle* states that the Compagnie Générale d'Electricité in Paris is producing, under the title of the "Electric-Phœbus," an accumulator in which the grid very firmly holds the active material and prevents it from falling, a matter which is favourable to mechanical resistance and the duration of the battery. It is submitted that the composition and special treatment of the active material allow of one obtaining a degree of porosity sufficient to ensure the penetration of the electrolyte to the core of the plates, and also prevent expansion. Experiments made with this type of accumulator at the Laboratoire Central d'Electricité under a normal rate of discharge (one ampere per kilogramme in average types) have given a capacity of 14 ampere-hours per kilogramme of electrode mounted, this including the weight of the connecting bars and the insulation of the plates. This capacity is said to be obtained by arresting the discharge when the difference of potential at the terminals of the accumulator falls to 1·85 volts. It is possible in case of necessity to discharge the accumulators without inconvenience at double the normal rate, the only disadvantage being a reduction in their efficiency in watts.

The commercial accumulator cells measure 220mm. in length by 100mm. in width and 8mm. in thickness; they are mounted in lead supports, surrounded by pitch pine, and assembled without metallic pieces; porcelain separators are used to keep the plates apart, and all the connecting parts of the electrodes are of inoxidisable metal. The company also construct for laboratory work and domestic lighting a type of accumulator having ebonite or glass supports and indiarubber separators. These cells are 95mm. by 110mm. and 6mm. Portable accumulators are also made on this method.

WIRE LOSSES, OVER-COMPOUNDING OF DYNAMOS, AND REGULATION OF P.D. IN MULTIPLE ARC CIRCUITS.*

BY E. P. ROBERTS.

Preliminary Note.—Since writing that which follows this paragraph, Prof. Crocker's criticism has appeared. That which Prof. Crocker states is certainly correct, although the writer is inclined to think that he puts somewhat too much stress on the omission, in the article of October 13, to state that the equaliser bar method was successful in practice after having made the statement that it is correct in theory. From the standpoint of the criticism the point is well taken. The article was intended to deal with errors in a practice which is daily followed by engineers in good standing, and the degree to which the error is injurious, and it was not intended to deal with other methods, though, in the light of Prof. Crocker's criticism, the facts which he states could wisely have been incorporated, and the writer advises that such be done by the reader.

It was an unexpected pleasure to the writer to find that his note entitled "Relation between Line Wire Losses and the Over-Compounding of Dynamos," published in the *Electrical World*, October 13, was considered worthy of an editorial notice, and also to find it considered by the *Engineering Magazine*; and, in addition, to receive a number of personal enquiries relative to the subject. The *raison d'etre* of this article is that both personal and editorial criticisms and comments have led the writer to believe that the following notes may be of assistance to those who have not studied the maintenance of constant P.D. at the translating devices of a multiple arc circuit.

An article by the writer of this paper was printed in the *Electrical World* of March 3, showing various systems of wiring for M. A. circuits, and their comparative advantages as far as even distribution is concerned. The usual system for a plant for general distribution is, as shown in Fig. 1 of this article, and for isolated plants, either as in Figs. 1 or 2.

* *Electrical World* (New York).

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First.—Let us consider the inherent weakness of the system shown in Fig. 2, taking only one branch circuit, and, for convenience sake, considering that we can obtain a wire to give just the line drop indicated at full load. If it be decided to lose four volts from A to D and return, and one volt between C and D, and also between D and E, and not over 100 volts is to be allowed at when D at full load and 20 amperes flow across at C and at D and E, we will have at C and E 99 V. and the R of D to C and of D to E ·05 and of A D B—·06⅔ and the V. A. at A B 104 V. If the P.D. at A B be constant, the condition of greatest rise of P.D. at the translating devices is when the load is lightest, and if ·5 ampere only be used and be taken off at D, and then at P.D. at D rises to 103·97. This is the one extreme case, and how nearly it will be reached depends upon the conditions of the case and the care and skill of the designer. If, then, the P.D. is to remain constant at D, that at B must have a range of from 100 to 104. It is evidently impossible to have C, D, and E at the same P.D., and the practice is to have the loss between them small and put the loss in the feeder. If such is done, evidently the P.D. at A B must be capable of regulation.

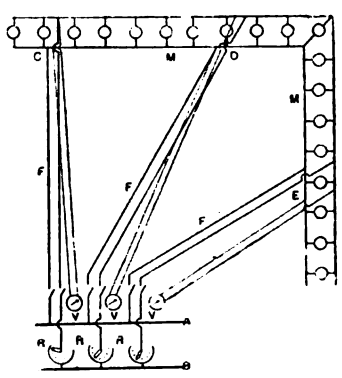

FIG. 1.

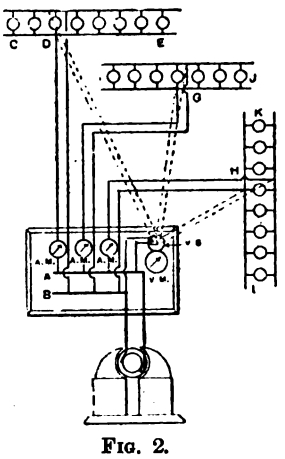

FIG. 2.

Second.—Let us consider the case of several such circuits from a constant source (see Fig. 2). Evidently, if any one branch is fully loaded, another one at half load, and another one at very light load, the P.D. at the source can only be regulated to be that which is correct for some one circuit. In order to make the average P.D. correct, probably the circuit half loaded would be chosen, if any choice be made, and if there exists means for determining the conditions and the adjustment thereto.

Third.—From the condition of Section 2 arose the design of the feeder and main system shown in Fig. 1, consisting of a number of feeders, serving one system of mains, of voltmeters to indicate the P.D. at the junction of feeders and mains, and of resistance to cut into the feeders to maintain either constant P.D. at the junction, or to have the same lowered when the C in the feeder lessens. Constant, or almost constant, P.D. is maintained at the 'bus bars A and B. The amount of R was found to be large and bulky, and the manipulation, in large plants, a source of considerable difficulty.

The next step was to employ a large number of feeders and a supplementary source of P.D. greater than that generally needed. When the P.D. at any feeder end becomes high the feeder is cut out; when low, it is thrown into the high P.D. 'bus bars.

The next improvement was to increase the P.D. by a "booster," and is the method employed on many alternating as well as direct current circuits.

Fourth.—The system described in Section 3 necessitates apparatus and attention not usually obtainable for isolated plants, but the general principle remains the same, and an isolated plant has before it a choice of evils as has a larger plant, and, in fact, almost every plant of any character. The isolated plant wiring must either be arranged as a number of circuits of the character indicated in Fig. 2, or on the feeder and main system shown in Fig. 1. If Fig. 2 be chosen, there should be indicators of current, A M, for each circuit, and voltmeter, at V M, connected at A B, and the voltage cut down either to that necessary for the least loaded circuit or slightly above, or means for determining the voltage of one or more distant points—preferably, one of each circuit—and the voltage adjusted thereto. In either case means must be furnished for regulating the P.D. at the source, and it is very seldom that it is wise to have such P.D. rise in proportion to the current output. Generally something less is preferable, and any automatic means should so deliver it, leaving hand regulation for the finer adjustment.

Fifth.—If only one dynamo is employed, then its P.D. should rise somewhat, but not exactly, in proportion to the current output and the line loss. If a number be employed, it is best not to have them over-compounded at all, or at most to only a very small amount, depending upon the ratio of size to total load (this was explained in the article of October 13). Also, as the E.M.F. varies according to the temperature of the dynamo, the hand control should have sufficient additional range to compensate for same.

Sixth.—Plants having only small wire losses, say, 4 per cent. or less, can be operated with a close approximation to accuracy by having the circuits carefully laid out and having quite a number, though not necessarily a "multiplicity," and when it becomes necessary to throw in additional dynamos dividing the circuits, giving some to each dynamo, and, as far as practicable, putting all the light loads on one and keeping its voltage down. When there are not many dynamos there is no trouble or complication in doing this. If, however, it be considered preferable to operate the dynamos in multiple arc, have hand control and means to determine the P.D. at the lamps, or the C in each circuit and the P.D. at the dynamo.

Whether the system of Fig. 1 or Fig. 2 is best to use for an isolated plant, depends upon the conditions of the case. The greatest load, the variation of load as a whole and in the various sub-circuits, must be considered, and also as to whether the control of each circuit from the main switchboard is desirable. Whatever the wiring system, the degree of over-compounding of the dynamos and the amount of wire losses have no fixed relation, and hand control is always advisable. If there be only one dynamo, and the load increases and decreases in all parts of the circuit in the same ratio, then, and then only, should the dynamo be over-compounded in the ratio of the line loss to total load. Even in the last case a hand regulation is advisable to compensate for temperature of the dynamo.

If more than one dynamo be used and the circuit be divided so that each dynamo operates independently, the conditions are similar to the preceding paragraph. If the dynamos be used either individually or collectively, and the series winding be not connected by an "equaliser," the over-compounding of each should be the same as that of the smallest dynamo used, which should be such that when it is operated alone and at full load the P.D. at the lamp is that desired. If the total line loss be 10 per cent. and the smallest dynamo have a capacity of one-quarter the total load, it should over-compound 2½ per cent.

Therefore, dynamos, when used as stated, should be shunt wound, or only slightly over-compounded, or connected by an equalising bar, and should always have a hand rheostat.

All other features being equally good, the man who can and does pay attention to the above considerations, produces a better plant than the man who slights them. Possibly the clients will never know the difference, but the designer will, provided he be competent, and that should count for something. If the plant be for incandescent electric lights, special care, instead of general plans, along some broad path intended to be an average and really not suitable to anything, will save the client from 1 to 5 per cent. yearly on his investment. The investor is not likely to consider the advisability of purchasing such advice when professional men relegate wiring plants to the "wireman" or the average installing "expert," admirable artisans as such men may be. Even the recently-graduated collegian with his magnificent training for the future, and his lack of knowledge of the conditions of practice, is not the man best fitted to design wiring plans, or to consider the mutual relation of the various elements of the electric light plant.

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PROPOSED REGULATIONS FOR ELECTRIC LIGHT INSTALLATIONS IN GERMANY.

The Technical Committee of the Berlin Electrotechnical Society have drafted regulations proposed to be adopted in Germany in regard to the precautions to be taken in carrying out installations where powerful currents are used, so as to prevent danger from fire. The proposals are as follow:

I. Inspection Rules.

Section 1.—(*a*) On completion, and before being set in operation, all "strong current installations," or any extension of same, are to be tested by an expert. An inspection is subsequently to be made at least every two years.

(*b*) The tests are to be permitted by the owner of the installation. The latter, on the first examination, is to provide a plan of the installation, the correctness of which is to be determined by the expert, who is to certify so on the plan. A certificate of the condition is, moreover, to be made. This certificate is to contain the expert's results of the measurements of consumption, and it must state whether the installation fulfils the following safety regulations, or what alterations and improvements are necessary. The plan and certificate of the tests are to be retained by the owner.

(*c*) In the case of those installations in operation before the issue of these safety regulations, it is to be left to the expert to decide whether or how far any deviations from these rules are to be regarded as allowable.

II. Precautions for Safety.

Section 2.—*Division of the Rooms.*—The requirements to be fulfilled in strong current installations in regard to safety from fire refer to the kind and use of the rooms in which the installations are arranged. These are differentiated as follow:

(A) Engine or working rooms for electric light installations.
(B) Ordinary living, business, and work rooms.
(C) Damp rooms.
(D) Rooms where operations are carried on which are dangerous with regard to fire risks, or containing inflammable material.

A.—Engine or Work Rooms.

Section 3.—(*a*) Workrooms of electric light installations are those in which are arranged the motors, electrical machines, transformers, accumulators, main switching apparatus, or electrical measuring instruments.

(*b*) These rooms must not contain a large quantity of articles of an inflammable nature.

(*c*) The rooms are to be protected against the possible admission of explosive gases, fumes, or dust.

(*d*) Care is to be taken to provide ample ventilation where gas-pipes or batteries exist, so that an accumulation of explosive gases cannot occur.

(*e*) Bare conductors, fuses, or other apparatus carrying current, and having parts which are not insulated, are not to be fitted in places where water can accumulate.

(*f*) Regulating and switching appliances and lightning conductors which have no incombustible bases are to be separated from wooden walls by means of an intermediate fireproof medium.

(*g*) If persons other than those engaged in attending to the plant are employed in the room the following (*B*) safety regulations are to be adopted.

B.—Ordinary Business, Living, and Work Rooms.

Section 4.—*Covering of the Conductors.*—(*a*) Bare conductors are only permitted in fireproof rooms not containing inflammable materials.

(*b*) In all other cases the conductors must be covered and be protected against the access or entry of moisture either by the method of putting up (on porcelain insulators, rollers, etc.) or by waterproof coverings. Thus only waterproof insulated wires are admissible in wooden casing.

Section 5.—*Insulation Resistance.*—At the normal working pressure the current which may pass the insulating appliances to earth or to another conductor must not exceed $\frac{2}{10000}$ of the normal working current.

Section 6.—*Distance of Conductors.*—(*a*) The conductors laid on insulators must be placed at least 2cm. distant from one another and from uncovered metal parts, and at least 1cm. from the walls, or they must be securely protected by an intermediate medium of good insulating material from contact with the surroundings. These regulations apply, for instance, also to places where the conductors are carried through the walls and to movable double conductors.

(*b*) Where the conductors are particularly exposed to slight damage, they must be provided with a suitable protective covering.

Section 7.—*Size of the Conductors.*—The size of the conductors is to be calculated so that the heating effect of the current at the normal strength does not cause the temperature of the surroundings to exceed 30deg. C.

This condition is regarded as fulfilled with round wires of good copper when the current strength remains within the limits given in the following table:

Diameter in millimetres.	Section in square millimetres.	Greatest current in amperes.
1·0	·79	6
1·2	1·13	8
1·4	1·54	10
1·6	2·00	13
1·8	2·5	15
2·0	3·1	18
2·4	4·5	24
2·8	6·2	30
3·2	8·0	36
3·6	10·0	43
4·0	13·0	50
4·5	16·0	60
5·0	20·0	70
6·0	28·0	90
7·0	38·0	120
8·0	50·0	150
9·0	64·0	170
10·0	79·0	200

Conductors of less than 1mm. diameter are not admissible.

Section 8.—*Joints.*—(*a*) Joints between conductors are to be made by twisting them together and using solder, or by a method of jointing of equal value which affords satisfactory mechanical strength and a good contact.

(*b*) Branches are to be free from strain.

(*c*) The joints between conductors and apparatus are to be made by being securely screwed. The contact surfaces must afford a contact at least five times as great as the cross-section of the conductor, and where possible be tinned. Pointed terminals are not allowed.

Section 9.—*Automatic Cut outs.*—All conductors which would heat on the occasion of a short or earth circuit are to be protected by means of automatic current breakers (fuse wires, automatic cut-outs, etc.). At each place where the cross-section of the conductor is reduced, a safety appliance is to be inserted. The latter, as far as practicable, must be arranged near the branch. Twin and movable conductors must be so made safe that the normal current strength which operates on the safety appliance does not exceed five amperes.

(*b*) The current must be interrupted if it has reached twice the amount of the admissible strength, as stated in Section 7.

(*c*) The current strength at which the cut-out acts must be indicated on the fuse-wire socket.

(*d*) A fuse for a higher current strength must not be fitted in a socket intended for a smaller current.

Section 10.—*Protective Boxes.*—Fuse wires, cut-outs, resistances, and all apparatus at which sparks and great heating may occur are to be enclosed in boxes of incombustible material.

Section 11.—*Switches.*—(*a*) The switches must be so constructed that an arc cannot occur.

(*b*) The contact surfaces where the break takes place must in operation make sufficient contact to the extent of

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at least two square millimetres effective contact surface for each ampere of the current to be carried.

(*c*) The heating of the metal parts by the current must not be greater than with the conductors.

Section 12.—*Resistances.*—With resistances, heating of the wires or plates must not exceed 100deg. C.

Section 13.—*Lamps.*—(*a*) Arc lamps are to be so arranged that no incandescent particles of carbon can fall.

(*b*) Arc lamp cases and the holders for incandescent lamps must be insulated from the conductors and from earth.

C.—Damp Rooms.

Section 14.—In damp rooms, where the insulation resistance prescribed in Section 5 cannot be obtained, all conductors shall be arranged on double porcelain insulators at distances of 10cm. from each other and from other objects, and the apparatus must similarly be insulated. When possible, the latter should be erected outside rooms.

D.—Rooms when Fire Risk is Great.

Section 15.—(*a*) Fuses and arc lamps are not to be placed in those rooms in which operations are carried on which involve the risk of fire, or which contain inflammable articles. Switches, electric motors, transformers, and resistances are at all events to be enclosed in a thick fireproof box.

(*b*) If explosions are to be apprehended through gases, fumes, or dust, such boxes must be rendered completely airtight.

(*c*) Incandescent lamps are to be provided with airtight outer covers.

SOME POSSIBILITIES OF THE STORAGE BATTERY.*

BY PEDRO G. SALOM.

There are few subjects that have excited more general interest and widespread speculation than that of the storage battery. From the wildest vagaries of the enthusiasts, who predict that in the future storage batteries will be so improved in capacity and efficiency that it will be necessary only to occasionally have a few cells of battery at one's house in order to supply an unlimited amount of light or power, that locomotives will be able to run hundreds of miles with a few hundred cells, and that ships will cross the Atlantic, we turn to the gloomiest forebodings of the pessimist, who can reason only from the failures and difficulties of the past to further trials and tribulations in the future. Inasmuch as storage batteries are likely to play a not unimportant part in the future development of electrical science, a proper understanding of the general principles underlying the subject may perhaps remove many popular errors and misconceptions.

A storage battery, or electric accumulator, is an apparatus for the transformation of energy. There is no such thing as storing electricity, and the current of electricity obtained from a storage battery after charging is derived solely from the chemical reactions taking place within the battery. This being the case, therefore, there is nothing mysterious about the operations of a battery, and it is self-evident that the limitations of its power must be directly proportional to the amount of material entering into its composition which is subject to chemical changes within the battery itself, although from the extravagant claims that are sometimes made for different forms of battery it might be supposed that the designer had discovered some method for creating energy out of nothing. Fortunately, we are able to measure to a nicety the exact amount of energy to be derived from a given combination of substances, and such claims, therefore, deceive only the credulous and unwary speculator. There are an infinite variety of forms of storage battery, all of which resolve themselves into two general types, in the first of which, known as the Planté type, the active material is produced by the disintegrating action of the current on a portion of the plates themselves, and in the second the active material is applied directly to or combined with the conducting supports.

A number of different materials have been used in the composition of the plates, but the modern storage battery—the one which is in most general use—consists almost entirely of lead and lead oxides, and the plates composing it are grids, in and upon which the oxides of lead have been mechanically applied.

The modern storage battery is the joint but independent invention of Charles F. Brush and Camille A. Faure, although Brush has been awarded the priority of invention in the United States by the highest court of appeal. Prior to their inventions in 1859, Gaston Planté made a very interesting and exhaustive study in what might be called the parent form of storage battery, although the real germ of the invention must be awarded to a French chemist, named Gautherot, who as far back as 1804 discovered the reversed currents obtained from plates which had been previously electrically acted upon. It was not, however, until the time of Planté that any attempt was made to store the electrical energy from an outside source by means of a battery or accumulator.

The original Planté battery consisted of plates of lead which were repeatedly and alternately acted upon by a current of electricity, first in one direction and then in the opposite one, until a certain proportion of the lead had been converted into oxide of lead and spongy lead. When two lead plates are placed in dilute sulphuric acid and their terminals are connected with the opposite poles of a dynamo, or some other source of electricity, and an electric circuit is made, oxygen is generated, through electrolysis, on the plate connected with the positive pole, and hydrogen on the plate connected with the negative pole. The oxygen attacks the plate of lead and combines with it, forming a thin coating of peroxide of lead, the hydrogen on the first charge escaping as hydrogen gas.

The plate connected with the positive pole is called the positive plate, and that with the negative pole the negative plate. If now the current is reversed and the positive pole is attached to the former negative plate, this, in turn, becomes coated with a thin coating of peroxide of lead, but the hydrogen which is liberated now at what was the former positive pole, instead of merely passing off into the air, acts upon the thin coating of peroxide formed by the original charge, and reduces it to spongy lead. The current is again reversed, the spongy lead produced by the second charge is peroxidised, and a further oxidation of the lead plate takes place. This operation is continued for a great number of times until the coatings thus formed are sufficiently large to do a useful amount of work, and the battery is then said to be "fully formed." In order to overcome this tedious operation of formation, it occurred to both Brush and Faure that inasmuch as the peroxide of lead and spongy lead were the useful parts of a battery, that if they could be applied directly to the lead plate, the plate acting in this case merely as a conductor, all the useful effect of a storage battery could be obtained at once without the necessity of the tedious process of formation, and this was the real invention in the Brush-Faure type of battery.

Brush took the oxides of lead and rammed them into grooves which had previously been made in the lead plate, while Faure took the same oxides, and, mixing them with a little dilute sulphuric acid, plastered them first on the surface of a plain sheet of lead, and afterwards into various forms of lead supports in the shape of grids or plates provided with other receptacles which would retain the active material. The oxides were then in some cases reduced to spongy lead by chemical means, or the plates put directly into circuit with the dynamo, and the oxides converted into peroxide of lead and spongy lead, after which they were ready to generate a current of electricity on having their terminals connected.

As has been said above, the current derived from a storage battery is produced by purely chemical means. If a piece of zinc be placed into dilute sulphuric or hydrochloric acid a violent action immediately takes place with the evolution of hydrogen gas, and the generation of a definite amount of heat. If, however, we connect this piece of zinc with a copper wire, the end of which is also placed into the acid, the wire becomes endowed with the extraordinary properties which are produced by what we call an electric current, and as this phenomenon appears, the generation of heat in the acid disappears. It has been found, after the most careful investigations and research

* From *Cassier's Magazine* for December, 1894.

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that the electrical energy, measured in foot-pounds, derived from the consumption of a pound of zinc in a battery is exactly the same as the amount of energy in the form of heat, measured in foot-pounds—that is, produced by the burning or combustion of a pound of zinc—showing conclusively the correlation of these two physical forces.

The electrical energy derived from a storage battery is, therefore due to the electrical burning or combustion of the lead, of which its active part is composed. In the case of a lead storage battery the product of combustion, sulphate of lead, is not soluble in the acid, or what is technically termed the electrolyte. One pound of lead has a theoretical potential energy of about 0·15 h.p. But in order to utilise in a battery a pound of lead, which must be in a spongy condition, 5lb. of solid lead and oxide of lead are necessary, and even then only one-half of its potential energy can be taken out as useful work before it becomes necessary to recharge the battery. Of course, the remaining 50 per cent. is not lost, but it is retained as a surplus, like the water in a tank which is allowed to discharge one-half its contents and is then filled up again.

If, then, we know the amount by weight of spongy lead and peroxide of lead, or that of any other equivalent active material, we have an absolute means of measuring the maximum capacity of any given cell for furnishing electric energy for a given time, and thereby determining the limitations of its usefulness. The source of the E.M.F. of a battery, whether primary or secondary, is primarily dependent on the relative positions that any two elements or substances occupy in the electrical scale. By the electrical scale is meant the systematic arrangement of all elements and compounds beginning with the most electro-positive substance, and passing to the most electro-negative substance in the order of their degree of intensity with which they possess one or the other of these properties. Each substance in the scale is electro-positive to the substance immediately below it and electro-negative to the substance immediately above it; the substances at the beginning and end of the scale exhibiting, of course, electro-positive and electro-negative qualities in the highest degree.

The metals, as a rule, make electro-positive elements, and the non-metals—oxides and chlorides, etc.—make electro-negative elements; or in other words, the various chemical affinities which these substances have for each other determine the E.M.F. of the couple. This varies from the smallest fraction of a volt to about three volts, and in ordinary secondary batteries averages about two volts. In order to get any desired E.M.F. above two volts from a battery it is necessary to couple the elements in what is commonly termed "series"—that is, to have a number of them whose poles are connected to each other alternately negative and positive, which makes the E.M.F. cumulative similar to the winding of an armature, whereby the E.M.F. is increased in proportion to the number of turns of wire passing through a given field of force.

One of the most important applications for storage batteries is found in connection with electric lighting. Electric lighting with such batteries may be divided into isolated lighting and central-station lighting. All isolated installations that are now being run night and day can advantageously and economically be improved by the addition of a storage battery, and the continuous operation of a dynamo thus be dispensed with, as well as the services of an extra engineer. When plants are not run night and day, owing to the great expense which it is impossible to avoid in operating a few lamps before and after the hours of maximum load, it is necessary to use gas or other source of illumination. This is a ridiculous and unnecessary humiliation to the owners of a costly installation, when a few storage batteries only are required in addition to the plant which they already possess to make it available day or night.

When lamps are supplied direct, the machinery must have a power capacity equal to the maximum number of lamps, and since the lamps are usually needed only a few hours a day, the plant will remain idle the rest of the time. Moreover, the engine and dynamo must be of the best construction and design, steady and quick regulating, to prevent flickering or variation in candle-power. But with storage batteries the generator is not limited as to the time or manner of working, and can prepare its supply slowly, ahead of time, during the day, in the many hours at its disposal; and in addition to its requiring only a dynamo of very much smaller size, the machinery may be of much simpler and cheaper construction, for with the battery, irregularities in movement can exist without in any way affecting the quality of the light. The current from the accumulators is always uniform and regular, even while the charging current is subject to marked fluctuations. The storage battery is, in fact, an equaliser and regulator to the dynamo, beside acting as a reservoir in case of accident, liable to happen with the best machinery.

In all cases a direct lighting plant can be made complete and perfectly reliable by the addition of storage batteries, as the surplus energy, which can be stored while the dynamo is running under light load, can be utilised during the remaining hours of the day or night. With water or gas we cannot expect a reliable supply without providing facilities for storage. In the profitable and practical application of electricity we must also have a means of storing to ensure an absolutely steady and uniform current, so necessary with incandescent lighting, and also to provide against any possibility of the extinguishing of the lights by failure of the generating plant.

The problem of domestic lighting has been solved by the introduction of storage batteries. Heretofore, electric light was only obtainable in localities adjacent to a central station, but by the application of accumulators almost any power can be made available. In places where an arc circuit is already installed, the introduction of the incandescent light becomes a comparatively simple and inexpensive matter. The arc dynamos can be used in the daytime to charge the batteries, and at night to supply the arc lamps, while the stored electrical energy is used to supply the incandescent lamps.

As an accessory to direct lighting in mills or other manufacturing establishments, hotels, office buildings, schools, institutions, and public buildings, the advantages of the use of storage batteries are too apparent to admit of argument. They furnish light when the power is shut down (which is usually at six o'clock) for office work, watchmen, storerooms, and warehouses, for repairing and rearranging machinery, boilers, engines, shafting, etc., which in many cases has to be done at night. They will also furnish power for running electric motors when other sources of power are stopped, as at night, or on Sundays or holidays.

The advantages to be derived from the use of storage batteries in an isolated electric light installation when once fully recognised and appreciated by electrical engineers will render their introduction well-nigh universal. They may be summed up as follows: Light and power on tap at all hours of the day or night; the ability to add incandescent lighting to an arc system already installed; increase in life of lamps due to perfect regulation of the current, thus effecting a great saving in lamp renewals; as an auxiliary to direct incandescent lighting, where it is not possible or practical to keep the generating machinery in continuous operation; ease of manipulation and freedom from annoying breakdowns and other mechanical irregularities; the battery may be charged from either arc or incandescent circuits by the introduction of proper automatic safety switches and rheostats; the utilisation of the current for many household conveniences, such as the running of fans, sewing machines, clocks, electric bells, pumps, etc.; economy obtained by dispensing with an extra engineer for nightwork, and by obviating the necessity of running a large engine and dynamo for lighting a few lamps during the day or night, or before and after the time of maximum load.

The ideal electric lighting for country homes is to be able at all hours, night or day, to turn on one or the full quota of lamps, with a never-failing supply of electricity, without the annoyance and expense of running the generating plant all night. This can be obtained only by the use of storage batteries, in which sufficient energy is stored during the day, according to the amount required for the 24 hours. Where steam power is not available, or is otherwise objectionable for charging batteries, a reliable, safe, and economical power is a good oil-engine, which is so simple to

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manipulate that an ordinary workman or gardener may be educated in a few days to safely operate and attend it.

One important point to be remembered is that with a storage battery the generating machinery need be only a fraction of the size required for direct lighting. Inasmuch as the work done in an isolated plant does not average more than three hours per lamp per day, or, say, for a 100-light plant, 300 lamp-hours, it is manifest that a 50-light dynamo running six hours will accomplish the same work through a storage battery as a 100-light dynamo running direct.

The advantages of using storage batteries in central-station lighting may be briefly summed up as follows: they effect a substantial saving in operating expenses, they increase the factor of safety, they permit of a material extension of distribution without increasing the size of the power plant. Since the question of economy is largely the determining factor in considering the advisability of introducing a battery, let us examine more at length the means by which economy may be effected: (1) by taking care of sudden and excessive load when all the generating machinery is taxed to its utmost extent; (2) by dispensing with one shift of labour in taking care of the entire minimum load; (3) by permitting the operation of large units exclusively; (4) by operating all the units at their maximum load, and hence their maximum efficiency.

Owing to the peculiar nature of electric lighting it frequently happens that the number of units generated at the maximum load is not more than a few per cent. of that of the total average load, and the total load is only a few per cent. in summer, and rarely above 40 per cent. in winter of the total possible output of the plant.

The first requisite in determining whether a battery can be advantageously introduced in any given central station, and, if so, what its size or capacity shall be, is to have diagrams of the load curves. The next important factor is the number and size of the units employed at the station. From these data can be determined what has very appropriately been called the load-factor, and then it is simple to calculate the size of the battery required to give the most economical operating results. Once the size of the battery determined we can calculate the saving effected (*a*) by dispensing with a night shift; (*b*) by diminishing the consumption of coal for a given output; (*c*) by the saving effected by operating a few large units of one size, instead of a number of small units of various sizes; (*d*) by the saving effected in operating each unit at its maximum efficiency; (*e*) by the additional revenues from increase of total output taken from battery at time of maximum load.

As the item of labour in small stations is frequently as high as 25 per cent. of the operating expenses, the saving effected by dispensing with a night shift is not inconsiderable. By operating exclusively large units there is also a material saving both in labour and the much higher efficiencies of large over small units. Again, as the coal bill is the largest item of expense, amounting in some cases to 50 per cent. and over of the total operating expenses, any saving effected in this item is of paramount importance, and is reflected at once in the decrease in operating expenses.

The question of mechanical efficiency with varying loads has not been as carefully studied with each type of engine as its importance deserves, but Prof. W. Cawthorne Unwin has shown that the decrease of mechanical efficiency for light loads has a serious effect on the economy of working with a variable load, and that with a load varying from 100 to 25 per cent., the efficiency decreases from 85 to 40 per cent. While it is impossible to say in a general way what the exact saving would be from the introduction of a battery of sufficient size to permit of the operation of all the units at maximum load (since the load is not the same in any two central stations), the results prove that in central stations equipped with storage batteries the operating expenses are diminished as much as 30 per cent.

As to the factor of safety, in case there is a derangement or breakdown of the generating machinery, or where the steam pressure cannot be kept up to a sufficiently high point to operate all the units at maximum load, the elasticity of a storage battery permits of an immediate discharge rate enormously in excess of its normal rate. In other words, a battery designed for a given output could in emergencies be safely called upon for one half-hour or more to deliver a current three times as great as that for which it was designed.

This is a question of vital importance, as in any direct system of transmission there is always the liability of a derangement or breakdown of one of the links in the chain, whereas in a station equipped with a storage battery the manager can depend on the battery to take the load of an individual unit until such time as the derangement or breakdown can be remedied or repaired. Moreover, it frequently happens where the business of a station has increased since the original introduction of its generating machinery, that the boiler capacity at maximum load is so taxed that it is difficult to maintain steam pressure sufficient to operate all the units at once. In such a case, if a battery is employed, recourse may be had to the battery until such time as the engineer shall be able to keep steam up to the required pressure.

As regards distribution, it is evident that when a central station, for example, has supplied the demand within a given radius of economical distribution, and a demand arises for electric light or power immediately adjacent to and outside of this given radius of distribution, it is possible to supply this demand by having sub-stations of storage batteries which may be charged by a special wire at comparatively high pressure during the day, thus increasing the average load of the central station. At night the current may be distributed from the sub-stations at the regular pressure, thus enabling the central station to materially increase its revenues without increasing its original power plant. There is an economy also effected in this method of distribution by decreasing the size of the feeders to the outlying districts. This is accomplished by being able to charge the batteries used at a comparatively small rate for 10 or 12 hours, whereas by lighting direct the feeders would have to be large enough to carry the entire load of the sub-station at its maximum output, which might last only for two or three hours.

Besides the saving effected in operating expenses, the use of a battery may be made to yield additional revenues in proportion to the amount of current supplied to the circuit over and above what could be supplied by the direct system, at the time of maximum load, without increasing the size of the power plant.

From what has been said above, it is evident that central-station lighting is one of the most important fields of usefulness of the storage battery, and one which has hardly yet been touched upon.

HINTS TO BEGINNERS IN THE DRAWING OFFICE.

BY ERNEST SCOTT.

As more and more importance is being attached to mechanical drawing in engineering establishments, it behoves the apprentice or pupil to be well acquainted with drawing-office work and routine, otherwise his chances as an engineer may be retarded.

To have a good set of instruments is a very important matter, as those of inferior workmanship never wear satisfactorily. On the other hand, a good set of instruments improve by use, working more smoothly as they get older. The best test for compasses and dividers is to see that when the legs are drawn apart with an even tension there is no fluctuation in speed. It may be mentioned that beeswax rubbed into the joints of compasses will greatly improve their working. Instruments with needle points are best, but the needle should have a shoulder to prevent its making too large a hole in the paper.

The box of instruments should contain a pair of large compasses, with needle points and lengthening bar, pen and pencil legs, small compasses having needle points, with pen and pencil legs, a pair of dividers, a drawing pen, and a scale of chords. The framed set squares are much better than the plain wood or vulcanite ones. The pencils that will be found most useful are those marked H or HH, or No. 4, and should have their points sharpened, chisel fashion, the flat face being placed against the edge of the T or set square. The compass pencils should be sharpened in a similar manner. These may be kept in good order for some time by sharpening them on a strip of fine glass-paper or a smooth file. The edges of the set squares should not be less than 1-16in. thick, as the ink is liable to run out of the pen on to the set square if they are any thinner.

Those who are not inclined to give a good price for a complete set of instruments by a good maker will do well to procure

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their instruments separately, and have a case made for them when they have obtained the full number; until then they may be kept in washleather, pockets being provided to prevent the instruments coming in contact with one another when folded up. Second-hand instruments are often very disappointing, as large numbers of instruments are manufactured to be sold as second-hand.

Bow pen and pencils are the most useful instruments, and the writer has seen splendid work done with them alone, the bow pens being opened out flat and used as a ruling pen when necessary. The ruling pen should be ground fine, and the inside faces of the nibs close to the extremity should be as nearly parallel as possible. The instrument is held between the thumb and first or second fingers as nearly as possible at right angles to the drawing. In using the dividers, place the forefinger on the head, and move the legs with the thumb and second finger; and in dividing distances into equal parts, it is better to hold the compasses by the head as much as possible after they are once set to the required dimensions. In taking off distances by the dividers, first open them a little too wide, and then bring them back to the point required by adjusting with the little screw and loose leg. The cheapest and one of the cleanest scales to use is that made of paper; it should, however, be varnished on each side with two coats of the best white shellac made with alcohol. They should have from 10 to 14 hours to dry before using. When the scale gets worn with the points of the dividers and compasses, revarnish. These paper scales are always sold unvarnished; why, the writer cannot understand.

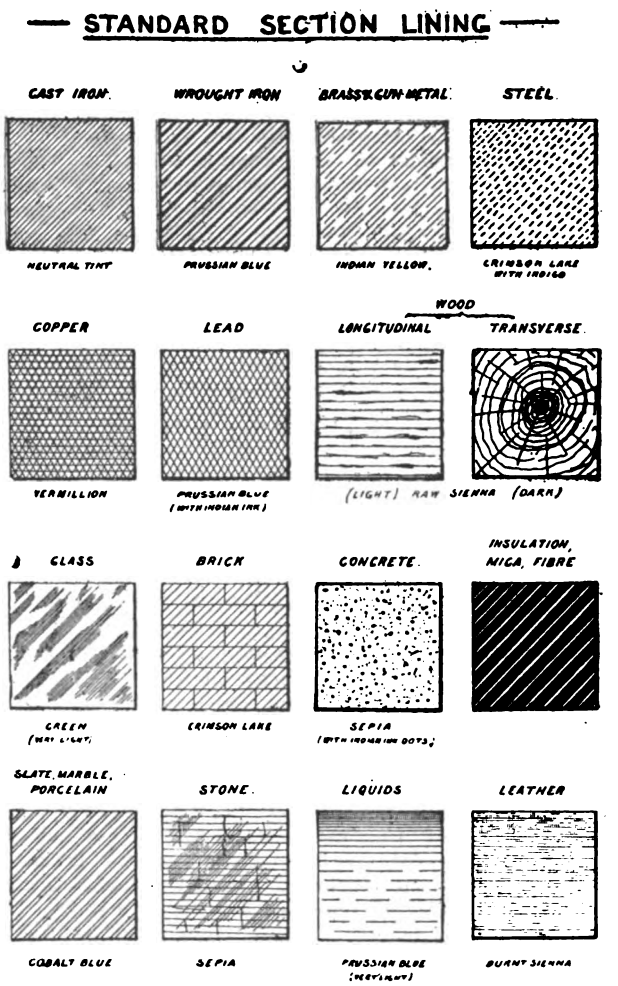
The so-called "universal" scales are a delusion and a snare, and sure, sooner or later, to cause an error. One scale on each edge is quite sufficient. An ordinary steel foot rule, or double-up boxwood rule, is best for full size, and a boxwood scale rule fish-back section, 18in. long and marked with half size, 3in., 1½in., and 1in. to 1ft., is very useful. The remaining scales—¾in., ⅜in., ¼in. and ⅛in. to 1ft.—requiring very fine dividing, should be cut on an ivory rule 1ft. long. Other scales—such as 2in., 3-16in., etc.—can be drawn on paper as required or along with chain scale, and millimetre scales can be bought very cheaply. Not being often used, a coating of varnish will preserve them for a long time.

The reservoir drawing pen is a very useful instrument where a good deal of section lining has to be done, or where, as with diagrams, the lines are very thick. The pen can be charged with ink for half an hour's continuous work. Transparent set squares have been introduced recently, and being thin, well glazed, and slightly flexible, they have all the advantages of the best vulcanite set squares without the disadvantage of readily collecting the dirt. As a result of their transparency, they do not obstruct from view the lines, etc., on that part of the drawing over which they are being used. The polish on the underside (the side next to the paper) of T-squares should be sandpapered off before being used; if this is not done, it will only wear off on to the paper and spoil the drawings.

The kind of work a beginner will have to do on commencing depends on his previous training. As a general rule he is always given tracing to do first, and it has the advantage over drawing in that blunders will be much more apparent. Moving the T-square or set squares over newly-inked lines is one of the first points to avoid. A slight pressure of the hand on the head of the T-square, so as to raise it about 1-16in. off the paper as it is moved, is the way to overcome this. One of the most effectual means of keeping white paper clean, and preventing the dust that collects on it from being ground in by the T-square, is to rest the hand firmly on the head of the T-square; it will be found that the square can be balanced so as to touch on the paper at the opposite end only.

In inking in and tracing, the circles and curves are put in first, as it is much easier to join up straight lines to curves than *vice versâ*. A tracing may be finished off in various ways. If it is for sending away it should be coloured, but if it is to be used as a negative for taking blue or white prints, the sections should be cross hatched. Cross hatching or sectioning requires a considerable amount of practice to make it appear effective and neat, and it also consumes a large amount of time. Patent drawings and illustrations for books, catalogues, etc., always require doing this way.

It is usual to represent the parts in section by lining them in various ways, and an endeavour has been made (at the Sibley College of Mechanical Engineers, Cornell University, U.S.A.), by Prof. R. H. Thurston (*vide American Machinist*, April 9, 1887) to standardise a system of section lining. The following will, however, be found to be almost universal. It is fairly comprehensive, and possesses the merit of being simple and easily remembered. Chilled and hardened surfaces might be indicated by stopping the section lines short of the edge. A striking appearance may be quickly given to a drawing or tracing by shade lining, or making light and heavy lines. The lines having first been drawn of uniform thickness, the direction of the light is assumed to fall on the object from the upper left-hand corner—that is to say, the shadows, if any, fall on the right hand and lower edge of all the parts being drawn. The heaviest lines on objects should therefore be those on the lower and right-hand edge of each part. It is not necessary that the contrasts between the lines should be very marked. Beginners generally make the heavy lines too thick, and where the corners join into the circles the effect is not good unless there is considerable experience beforehand. An excellent little instrument for this work is the duplex ruling pen. By simply setting two small screws, all the fine and shade lines can be done together, and always of the same thickness.



After a few tracings have been inked in, an attempt should be made to design a suitable border. They are easily and quickly made, and for illustrative tracings sent out on tender work have much to do in giving them a finish. Too much elaboration should, however, be avoided, for fear the border lines show more care than the drawing. The writing or printing often makes all the difference between a good and badly finished drawing, and a few hints may not be out of place. Artistic lettering may be learnt by purchasing a book giving examples of the different classes of letters, or by obtaining handbills which have the larger form of letter on them, and tracing these for a few days. The student will be surprised to see how easy it is to acquire the correct shape of the letters. Plain block letters are very useful, and they can be modified by shading. Of the various forms, the italic letters are easiest to acquire, and at the same time present a very striking appearance, the letters a and g being the most difficult. If the drawing is symmetrical, the title should have as nearly as possible the same symmetry, and should be printed in the centre underneath—the drawing or tracing number being at the two bottom corners, and the drawer number at the top corners. The lettering of a drawing should have a close resemblance to both the drawing and border; therefore, if the two latter are plain the lettering should also be plain. The size of the title should be in proportion to that of the drawing, the largest letters not being more than 1-30 of the height of the drawing. The name of the object and the customer should be the largest, that of the engineering firm doing the work being much smaller.

Stencil plates are much used in printing letters and words that are constantly required, such as plan, elevation, section, north, full size, half size, etc., numbers 1 to 9, and the letters of the alphabet in two or more sizes. The stencil brush should be moderately stiff, and the ink rubbed into it on a piece of old leather belting 4in. square, set in a recess in a convenient-shaped piece of wood, the brush being gently dabbed, not rubbed, on the stencil. Stencil plates are best made of copper, this metal being far superior to brass, as it lies closer to the paper. This close contact is important, as it prevents the hairs

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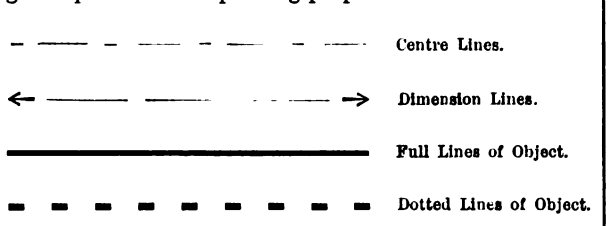
of the brush getting under the plate and producing uneven edges. When the plates have been in use for some time, the corners are apt to get clogged up with ink; this can be removed by leaving them for a few minutes in hot water and then carefully wiping. If the plates become cockled, they may be flattened by pressing between two hard metal surfaces. When being used the stencil plates should be held firmly to the paper by the fingers of the left hand, the right being used for the brush.

To prevent tearing the edges, the plates should be turned up $\frac{1}{8}$in. all round. Where separate rubber stamps are used for the numbers or letters, instead of stencils it is a good plan to put the stamps through holes in a small wooden box so that the rubber rests on an inked pad of felt at the bottom. In this way they are always ready for use, and there is no inking-pad to get lost, the whole being self-contained. Rubber stamps are a little more expensive than stencils, but they have the advantage of never getting clogged with ink, and are much handier to use. Lithographic ink with the addition of a dryer may be used for stencilling on tracing cloth, as it gives a deep black impression which prints well, and it will not rub off.

Indian or Chinese ink is always used because it gives a dense black line, and being free from acid it is not injurious to the instruments. The genuine ink as imported from China varies considerably in quality. The best quality may be fairly ascertained by breaking off a small portion; if the quality be good it will show a prismatic-coloured fracture and not a dull, black appearance. The mixing of Indian ink is not a thing to be despised, and the beginner should rub ink until he can make it in a clean manner. The ink must be made moderately thick, so that the pen on being shaken will retain it about 3-16in. up the nib, and should be used directly after mixing, for if redissolved it becomes cloudy.

It is found in practice that on a brush being passed over the ink lines in colouring a drawing that the lines wash up, but this may be avoided as follows. It is generally known in photography that animal glue, with potassium bichromate, after being exposed to the action of sunlight, becomes impermeable to water. If, therefore, in rubbing the Indian ink (which has been found to contain, according to the latest investigations, not vegetable, but animal glue, as binding material) one uses a diluted solution of potassium bichromate, containing about 2 per cent. of this substance, the lines, after exposure to sunlight for one or two hours, will not become blurred if gone over with water-colours. The water used for mixing colours (lithographic ink, Indian ink, etc.) should really have been previously boiled to get out the chalky matters, but this is not generally done. If ink is required for sun printing purposes, it should be mixed as thick as is consistent with free running, and should have a small quantity of chrome yellow or burnt sienna mixed in with it, as these colours stop the actinic rays to a large extent. For this reason the above colours should be used very sparingly, or not at all on tracings which are intended to be sun-printed at any time. Of course, no colour will show on the sun print, but a wash of neutral tint is useful for showing up certain parts, sections, etc.

One of the great advantages of prints with blue or black lines on white ground is that the print can be coloured afterwards. All the lines should be in black, and made as follows, if the tracing is required for sun printing purposes:



For inked-in drawings and for tracings which are not required for sun printing purposes the lines are drawn in their respective colours, thus:

Red for centre lines.
Blue for dimension lines.
Black for full and dotted lines of object.

Written figures and letters should all be in black, and machining lines shown in red. A blue or red line can be drawn over a black one by mixing the blue or red colour with a small quantity of Chinese white. The white gives a dense dead colour which prevents the black showing through.

The glaze on tracing cloth is difficult to work on. It can however, be removed by rubbing over the surface with chalk. Precipitated chalk at 2d. a pound is cheaper than buying blocks of French chalk and scraping off what is wanted each time a tracing has to be made. A special duster or brush should be set aside for this work. Ox-gall mixed with the ink or colour will make it run and adhere better; it should, however, be used sparingly. Fractions of an inch should not be written in grocer's fashion—thus, 1/16, but like this, $\frac{1}{16}$—and the ticks feet (′) and inches (″) should never be omitted. All working drawings should be fully dimensioned, and the dimensions as far as possible be in that position required for reading the title. Any exceptions to this rule to be placed so as to be read when looking from right to left of the drawing.

It is as well to have one standard size for all drawings—double elephant or imperial—and also a standard size for all sketches, say 8½in. by 1ft. 1in. These sizes should never be deviated from, for although some drawings may be rather crowded and others just the reverse, they are much easier to find in the drawers when all one size and the titles and numbers lying just above one another.

The best plan of supplying the drawing pen with ink is by means of an ordinary pen nib, this method keeping the outsides of the drawing pen clean. If, after laying the pen down for a moment or two, the ink at the point dries and won't run—it may be started by touching it on the skin; this plan seldom fails so long as there is ink between the nibs. There are several liquid inks on the market put up in bottles, Wolff's and Higgins's being about the best. Their great advantage is that the ink is just as good at the last drop as when first opened, and also always of the same intensity of blackness—a very good feature on an "inking-in" job taking several days or a week to complete. The cork should be fitted with a pointer which dips down nearly to the bottom of the ink, and with this the pen or compass may be supplied without wetting the outsides of the nib, as mentioned above. Before putting the pen away it should be carefully wiped, and if the ink has been allowed to dry between the nibs it may be removed by softening in a little water and wiping directly afterwards.

The following are the colours generally used for representing the different kinds of metal, etc. They are not so much intended to represent the material used as to distinguish one material from another on the same drawing:

Initials in general use.	Material.	Colour.
C.I.	Cast iron	Neutral tint.
W.I.	Wrought iron	Prussian blue.
M.C.I. ...	Malleable cast iron ...	Purple.
S.	Steel	Crimson lake with indigo.
C.	Copper	Vermillion.
B.	Brass	Indian yellow.
G.M.	Gunmetal	Indian yellow.

Material.	Colour.
Phosphor and aluminium bronze	Gamboge with crimson lake.
Lead and white metal linings for bearings	Prussian blue with Indian ink (very light).
Soft wood, as deal, pine, etc.	Gamboge with small amount of raw sienna.
Hard wood	Raw sienna with small quantity of gamboge.
Oak and teak	Vandyke brown.
Brickwork	Venetian red or crimson lake with sienna.
Ebony, ebonite, and vulcanite	Indian ink (dead black).
Indiarubber	Burnt umber and neutral tint.
Granite, freestone, stone	Sepia.
Concrete	Sepia, with Indian ink dotted on with a bit of cloth.
Earth and clay	Burnt umber.
Water	Prussian blue, with lining (very light).
Oil	Indian yellow and Prussian blue, with lining.
Porcelain, slate	Cobalt blue.
Glass	Very light green.
Leather	Burnt sienna.

The grain of wood may be shown by streaks of burnt umber. In electrical engineering drawing offices it is usual to represent all insulation by a dead black, notifying in writing whether it is mica fibre, longcloth, ebonite, indiarubber tape, etc. A steel colour (crimson lake and indigo) is sold by Halden and Co., Manchester. For tinting large areas a large brush is used, and the colour should be light. If wanted darker two or three coats are put on, each after the other is dry. In proceeding to lay on the colour, tilt the drawing slightly and start at the top, so that the colour will run down. After taking the first stroke with the brush, the second stroke should immediately follow into the moist edge of the first line. This is important, because wet colour may be easily united to a moist edge, but not to a dry edge. It is well to have a dry brush handy to take off superfluous colour if necessary.

All sections are given twice the depth of colour that the elevations, etc, receive—that is, they should have two washes where the elevation gets one—care being taken to allow the first wash to dry before the second is put on. If this is not done it is apt to be blotchy. Cloth and paper tracings are coloured on the back: there is then no fear of the lines washing up.

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All material such as charcoal iron, stick or rod brass, etc., should be gone over with the same colours that are used for wrought iron, brass, etc.; but a special note should be made in writing on the drawing that such and such a detail is made of "well annealed charcoal iron," or "three-quarter drawn rod brass," as the case may be. For shading drawings, Indian ink mixed very thin is best. Sable hair brushes are generally used, and there should be a brush at each end of the handle, one being larger than the other. The small brush is supplied with colour, and the large one thoroughly moistened with clean water. The colour which represents the dark portion is then laid upon the drawing with the small brush. Before it is dry, however, the moistened brush is drawn down the line to be shaded off, and then another nearly dry brush is drawn along the outer edge to take up any surplus water. If darker shades are required, the first coat should be allowed to dry (this is very important), and the above operation gone over again. After shading, go over each part with its characteristic colour. If the drawing has to be varnished afterwards, it is necessary that a small quantity of alum should be added to the water-colours before using. The varnish should be made of 2oz. of Canadian balsam and 4oz. of oil of turpentine dissolved together whilst warm. Gamboge should not be used alone on tracing cloth, as it smudges badly. Chrome or Indian yellow or vermillion is much better. Indian ink and colour may be removed from tracing paper by the application of a little soap and water, carefully removed with a clean brush and blotting paper. Indiarubber may now be bought very cheaply, but a piece taken from an old air-pump valve gives very good results. To clean a drawing after colouring, it should be gone over with bread, because indiarubber disturbs the colour. For very highly-finished shaded drawings it is customary before starting drawing to take off the surface of the paper with fine glass-paper. If this precaution be taken, any erasure that may be made before the colour is put on will not be noticeable, whereas if this is not done the colour comes out blotchy, and several days' work may be spoilt in a few minutes.

If duplicate drawings are wanted on Bristol board or drawing paper, considerable time and labour may be saved by using a printing frame as follows: the drawing to be duplicated is laid next to the glass with the drawing facing the operator, and on this is placed the blank sheet, the frame being so arranged that a strong light falls on the underside of the glass from a window or lamp. It will then be found that the lines of the drawing show through the blank sheet, and they can be inked in straight away. Jobs can be done in this way in an hour, including time spent in fixing up, that would otherwise take the greater part of a day. This method is also useful for making a very neat coloured drawing, as there are no pencil lines to be rubbed out, and very smooth hot-pressed paper may therefore be used.

For mounting drawings, paper tracings, sun prints, etc., get a board with a good surface. Stretch the linen or calico (which should be cut to leave 2in. margin) flat on the board, tacking it down all round, the tacks being close together and care taken not to pull the edges of the cloth; it should then be well coated with strong size and left until it is almost dry. The drawing to be mounted and the cloth should now be well covered with paste, to which a little gum arabic has been added, the paste being worked well into the cloth. This will be done best if done at two operations, leaving the first coat about five minutes to soak. Directly after applying the second coat, place the paper on the linen and work from the centre outwards with a sponge, squeezing out all the superfluous paste. It will take at least eight hours to dry thoroughly, even in warm weather.

To mount drawings, take a sheet of Whatman's paper and turn up 1in. all round, slightly damp the paper with a soft sponge, then glue the edges and turn them down on to the board, putting weights at the corners and the middle of each side, the edges being well rubbed down and allowed to dry for at least three hours. The paper in drying contracts slightly, so that it lies as tight as a drum on the board and is very pleasant to work on. Of course for ordinary jobs it is not usual to go to the trouble of mounting. Pencil lines may be fixed by going over them with size, skim milk, or water starch of such strength as to form a jelly when cold.

It is necessary that the beginner should as early as possible make himself acquainted with the system of the particular drawing office he happens to be in. The mode of procedure in preparing drawings, entering them, and filing away varies with each office, and although some of it may seem to him rather tedious, he should remember that system is necessary in order to define the duties of each individual and to fix the responsibility should anything go wrong. It is also most necessary to preserve uniformity of practice with changing draughtsmen.

Before commencing a drawing, the conditions which *must* be complied with and the conditions which may be varied if necessary should first be set down mentally or in writing, all problems being also solved before commencing by calculation and hand sketches. These two simple rules if adhered to will save much valuable time in unnecessary drawing and rubbing out. The principal fundamental formulæ and constants should be committed to memory, and in the very near future a man who is not perfectly at home in the use of the slide rule will be at a discount. After one or two sizes of a new series of machines have been made and tested, dimensions of the other sizes to complete the series may be quickly arrived at by curves on squared paper. It will generally be found that the nearest whole number to what the curve gives will not be far wrong.

In making illustrative drawings for tender, a good deal of time may be saved by as far as possible keeping to standard with regard to the scales employed, so that combinations may be made by tracing. There is no advantage in laying down a small engine dynamo or pump to a large scale merely to fill up the paper. The following are suitable scales for the different classes of work:

¼in.	to 1ft.	for buildings.
½in.	,,	for foundations and pipe arrangements.
1in.	,,	for general drawings of machines.
3in.	,,	and full size for details.

With regard to the scale for general arrangements, it may be mentioned that Messrs. Willans and Robinson's drawings and lithos, which are more widely distributed in the electrical engineering trade than those of any other firm, are all drawn 1in. to 1ft. These particular engines have had such a run that dynamo makers had in many cases to follow suit, although 1½in. to 1ft. is generally considered to be a better scale for arrangements.

Although neatness and accuracy of drawing and projecting is desirable, it only represents a small part of a draughtsman's work, and if it is obtained with the expenditure of an undue amount of time, and does not carry with it, practical knowledge of shop needs and processes, it ceases to be a virtue. The writer has come across men calling themselves draughtsmen having an exceedingly limited knowledge of shop processes. Such men cannot be left to their own resources for a moment, although at the same time they are able to make a very pretty drawing. They therefore rarely get beyond tracing and tender work. The drawing office is undoubtedly one of the best schools for the young mechanical engineer, provided he goes at his work well trained in the principles and fundamental laws of mechanics, and works with a combined purpose of making a good machine as well as a good drawing.

In making shop drawings the draughtsman has to be continually asking himself, "Now, if I had to do this work in the shop, what information should I want?" and he should then proceed to put down just that amount of information. He should send out the drawings so that he has not to be asked by either foreman or leading hand how this or that part has to be fitted together. I would impress on those just beginning the importance of drawing everything correctly, properly projected and to scale. I have come across men who systematically draw incorrect projections and sections, and who, when remonstrated with, said "they did so in order that the workmen would understand the better how to mark it out." There never was a greater mistake; much better take it for granted the workman knows as much as yourself (he probably knows considerably more), and give him the best work you can do. A part section here and there and not too many dotted lines will tell him all that is needful. Thanks to our technical schools and evening classes, a considerable change has come over our artisans since James Nasmyth described mechanical drawing as the "alphabet of the engineer—without a knowledge of it the workman is a 'hand,' with it he indicates the possession of a 'head.'"

In connection with this I should like to mention that Cryer and Jordan's "Mechanical Construction," Tomkin's "Machine Construction," and Angel's large book and plates on "Geometry," are the best books I know of for a beginner; and he also cannot do better than attend the nearest evening technical school and get the "first advanced" science and art certificate in machine construction and drawing. For although science and art certificates are at a discount at present, I feel quite sure that that particular examination is a very fair test, and the holder of such a certificate will stand a better chance with the next generation (if I may use the word) of leading draughtsmen and managers.

PHYSICAL SOCIETY.

At an ordinary meeting on the 14th inst. **Prof. W. E. Ayrton** and **Mr. H. C. Haycraft** communicated a paper on a "**Students' Simple Apparatus for Determining the Mechanical Equivalent of Heat.**" Mr. Haycraft, who read the paper, explained that the object at which the authors had aimed was the construction of an apparatus which could be placed in the hands of junior students, and by means of which a result correct within 1 per cent. could be obtained without the introduction of troublesome corrections. The method employed is the electrical one, and the measurements to be made are (*a*) the value of the constant current passed through the resistance, as given by a direct-reading ammeter; (*b*) the average value of the P.D. between the terminals of the resistance, as

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given by a direct-reading voltmeter; (*c*) the mass of water heated plus the water equivalent of the containing vessel, resistance coil, and stirrer; (*d*) the rise of temperature of the water; (*e*) the time during which the current is passed. Of these the measurements (*a*), (*b*), (*c*) can be effected without the introduction of an error anything like so great as 1 per cent. The case of (*d*) and (*e*) is different. The rise of temperature to be measured with accuracy should be fairly considerable, and the same remark applies to the time of heating as measured by an ordinary stop-watch. At the same time, if these two quantities are made unduly great, there will be too great a ratio of heat lost to heat generated during the experiment. The authors consider that with a given amount of electrical power available the best conditions will be obtained by making the percentage accuracy of the temperature measurement the percentage accuracy of the time measurement, and the percentage of generated heat lost by surface cooling equal. Hence, they determine the mass of water to be used, and the time of heating which may be expected to give the best results. The immersed conductor is a strip of manganin about 0 25in. wide, 0 03in. thick, and 5ft. long, which is bent into a series of zigzags, so as to form a kind of circular gridiron; the successive portions of strip lying all in one plane and the whole being held rigid by a strip of vulcanised fibre, to which each portion of the strip is screwed. Another precisely similar grid is placed 3in. below the first, and the two are joined in series, and are mechanically connected together by thin vulcanite pillars. The water is contained in a glass beaker of just sufficient diameter to take the framework of manganin strip. This latter exposes a considerable surface (about 400 square centimetres) to the water, and is moved bodily up and down during the experiment, thus constituting an efficient stirrer. To allow sufficient freedom of movement, electrical connection is made by means of very flexible leads, each made up of about 210 thin copper wires. The results obtained by students for the heat equivalent of the watt-second have an average deviation from the mean, if several experiments are made, of less than one-half per cent.; and they agree with the best standard determinations within 1 per cent.

Mr. Griffiths thought it inadvisable to provide junior students with apparatus from which every source of error had been eliminated; they were thus led to underrate the difficulty of an experiment and the care required to obtain reasonable accuracy.

Prof. Carey Foster agreed generally with Mr. Griffiths, and deprecated the use of direct-reading ammeters and voltmeters in experiments of this kind. He thought it preferable that a student should learn to reduce instrumental readings to absolute measure for himself.

Prof. S P. Thompson dissented from the opinions expressed by the two previous speakers, and thought it was an advantage to students to have the use of direct-reading instruments.

Dr. Sumpner described a simple method which he had employed for measuring the mechanical equivalent of heat, and which depended on the heating of a stream of water as it flowed through a pipe containing the current-conductor.

Prof. Ayrton replied, and explained that the calibration of ammeters and voltmeters would be part of the work of a student at another part of his course.

A paper by **Prof. Ayrton** and **Mr. E. A. Medley**, entitled "**Tests of Glow Lamps and Description of the Measuring Instruments Employed,**" was commenced by Mr. Medley, the latter part of the paper being held over till next meeting. The object of the investigation was to find at what E.M.F glow lamps could be most economically run. Too low an E.M.F. gives a low efficiency, and too high an E M F. renders the lamps short-lived, so that there must be (for a given lamp) a certain E.M.F. which is more economical to work at than any other. It was also pointed out that, as glow lamps deteriorate and become less efficient with use, it may be an economy to discard a lamp before the filament actually breaks. The lamp is then said to have reached the "smashing point." Accumulators were used to drive the lamps, automatic apparatus being used to keep the E.M.F. constant, and when a lamp filament broke, the fact was automatically recorded on a tell-tale.

LEGAL INTELLIGENCE.

REDDAWAY AND OTHERS v. BANHAM AND OTHERS.

This case was heard last week before the Master of the Rolls, Lord Justice Lopes, and Lord Justice Rigby. It was an application by the defendants for judgment or a new trial in an action tried before Mr. Justice Collins and a special jury at Manchester. The action was for an injunction to restrain the defendants from continuing to use the word "camel" in such a manner as to deceive purchasers into the belief that they were purchasing goods (camel-hair belting) of the plaintiffs' manufacture, and from passing off their goods as and for goods of the plaintiffs' manufacture It appeared that several years ago the Lancashire Belt Company made a camel-hair belting for machinery, and called it Reddaway's camel-hair belting, and largely advertised and sold it as such, and stamped a camel upon the belting. The defendant Banham had been a workman in the plaintiffs' employment, and after he left that employment the defendants made a belting of similar material, and advertised and sold it as Banham's camel-hair belting, and on the belting itself they stamped the words "Camel-hair Belting." At the trial the plaintiffs called evidence with the view of showing that in India a person buying camel-hair belting would expect to get Reddaway's camel-hair belting. The learned judge granted the injunction claimed, and the defendants moved for judgment or a new trial.

Mr. Bigham, Q.C, and **Mr. M'Call, Q.C.** (instructed by Messrs. W. C. Chew and Sons and Hilditch, of Manchester), for the defendants, contended that the defendants had a right to manufacture belting of camel-hair and to call it by its true name, and sell it as such, so long as they added nothing to the description likely to deceive purchasers.

Mr. Gully, Q.C., and **Mr. J. C. Graham** (instructed by Mr. A. Macdonald Blair, of Manchester), for the plaintiffs, relied on the fact which had been found by the jury—that the words "camel-hair belting" had come to be understood by the public as indicating goods manufactured by the plaintiffs, and had ceased to be merely words of description.

The **Master of the Rolls** said that the action was for an injunction, and an injunction alone. The defendants, he held, had a right to imitate the plaintiff's belting, and if they were trying to beat them out of the market they had done nothing wrong. In calling the goods camel-hair belting they only told the truth. It was said that the defendants had a wrong intention—to pass off their goods as the plaintiff's. Even assuming that to be so, the law took no notice of intention in a man's mind unless it was carried into effect by a wrongful act. Therefore, as the only default suggested was the using the name, intent was immaterial. In these circumstances the learned judge ought to have entered judgment for the defendants, and the appeal must therefore be allowed.

Lord Justice Lopes said the appeal must be allowed, and **Lord Justice Rigby** delivered judgment to the same effect.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Great Yarmouth.—Tenders are invited for installing the electric light at the Town Hall, free library, and Great Yarmouth police station, for the Town Council. Particulars were given in our last issue. Tenders must be sent in by January 2.

Great Yarmouth.—Tenders are invited for the supply of 200 tons of good hand-picked steam coal, from the Clifton or Hucknall pits, delivered into the coal bunkers at the electric light station, in lots of about 30 tons per week, commencing January 15, for the Town Council. Tenders to be at per ton of 21cwt., to be endorsed "Tender for Coal," and delivered at the office of Mr. T. M. Baker, town clerk, Town Hall, Great Yarmouth, before noon on January 1.

Stockport—Tenders are invited for providing and fixing complete a fuel economiser, for the Corporation. Plans of the boiler-house, now in course of construction, together with the specification of the work required, can be seen and form of tender obtained at the office of Mr. A. M. Fowler, 1, St. Peter's square, Manchester. Tenders to be delivered at the office of Mr. Walter Hyde, town clerk, 2, Lord-street, Stockport. by January 16, endorsed "Tender for Economiser." The standard rate of wages in the distriot will have to be paid by the contractor in the construction of the work.

Birmingham.—The committee of the Birmingham Municipal Technical School invite tenders for the installation of the generating plant, fittings and appliances for both the electric lighting and transmission of power by electricity in the new school. Plans of the building may be seen, and specifications and forms of tender obtained, at the offices of Messrs. Hy. Lea and Thornbury, consulting engineers, 38, Bennett's-hill, Birmingham, on a deposit being made with them of £2 2s., which will be returned on receipt of a *bonâ fide* tender. The committee do not bind themselves to accept the lowest or any tender, and no tender will be considered except upon the prescribed form and accompanied by an undertaking that not less than the minimum standard rate of wages current in the district is paid by the contractor and sub-contractors (if any). All tenders must be sent in to Mr. Geo. Mellor, secretary, endorsed "Tender for Lighting," on or before January 12.

Hanley.—The Corporation of Hanley are prepared to receive tenders for the supply and erection of the following plant: Contract No. 10—extension of engine-house plant, including 200-kilowatt alternator, 25-kilowatt alternator, and 20-kilowatt exciter, each separately driven by a compound steam-engine, with all necessary steam and exhaust pipes, valves, switchboard, and appurtenances; Contract No. 11—extension of condensing plant, consisting of circulating pump, air-pump, boiler pump, surface condenser, with all necessary pipes and appurtenances. The drawings can be inspected, and specifications. prepared by Mr. G. H. Cottam, Corporation electrical engineer, together with general conditions and forms of tender, can be obtained at the offices of Mr. Joseph Lobley, Town Hall, Hanley, on payment of 5s. Tenders are to be delivered to Mr. Arthur Challinor, town clerk, on or before January 5, 1895. The Corporation do not bind themselves to accept the lowest or any tender.

RESULTS OF TENDERS.

Blackburn.—For the supply of electricity meters to the Town Council, the tender of Messrs. S. Z. de Ferranti has been accepted.

Sunderland.—The School Board have accepted the tender of Mr. Davison Taylor to supply and fit apparatus necessary for lighting the Board offices by electricity according to specification for the sum of £39. 15s.

Enniscorthy.—The tender of Messrs. Curtis and Sons, Middle Abbey-street, Dublin, has been accepted by the Governing Com-

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mittee of the Enniscorthy District Lunatic Asylum for the supply and fitting up of telephonic apparatus throughout the asylum buildings.

Cardiff.—The Corporation have accepted the following tenders for the supply of steam coal for the electric lighting works at Canton for the six months ending June 10, 1895: W. T. Beavan, 120, The Exchange, Cardiff, 500 tons large coal £318. 15s; British Coal Company, 40, Miskin-street, Cardiff, nut and small coal as required to June 10, 1895, nut coal 9s. 9d. per ton, small coal 7s. 3d.

BUSINESS NOTES.

Portsmouth.—The baths have been lighted electrically.

Bristol.—The Clifton Down Hotel is to be lighted electrically.

Douglas (Isle of Man).—It is proposed to extend the electric tramway to Snaefell.

Longton.—The Queen's Theatre, which was burned, is being rebuilt. It will be lighted throughout electrically.

Brechin.—An agreement has been signed between the Police Commissioners and the Scottish House-to-House Electric Lighting Company.

Parndon.—Messrs. Crampton and Co., Cambridge and Yarmouth, have installed the electric light in large mills at Parndon, Hertfordshire. Water power is used.

Elmore's Patent Copper Depositing Company, Limited.—The accounts for the year ended June 30 show a loss of £10,435, thus increasing the debit balance to £31,953.

City of London Electric Lighting Company.—The allotment letters and letters of regret in respect of the further issue of £200,000 debenture stock issue have been posted.

Leith.—Messrs. Wm. Jeffery and Son's drapery warehouses have been lighted electrically. Both arc and incandescent lamps are employed, the total candle-power being 20,000.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 23rd inst. amounted to £938, as compared with £604 in the corresponding week of last year.

Chiswick.—The surveyor to the Local Board has reported that the work at the electric lighting station is now rapidly progressing, nearly the whole of the foundations having been laid.

Altrincham.—The Altrincham Electric Supply Co. propose to at once commence the supply of electric light in the Altrincham and Bowdon districts. The price which will be charged is 8d. per unit.

Bilston.—After some consideration the Township Commissioners have resolved to increase the lighting plant in the market at an estimated cost of £65 odd. It is proposed to provide four additional arc lights, two of which will be placed in the open market.

Engineers' Advertising Protection Association, Limited.—This Company has been registered with a capital of £5,000 to supply at all times—to engineers in particular—by correspondence or otherwise, confidential and reliable information touching advertising matters generally.

Anglo-Portuguese Telephone Company, Limited.—The coupons No. 14 of the Anglo-Portuguese Telphone Company, Limited, first mortgage, and No. 9 of the second mortgage debentures will be paid (less income tax) by Parr's Banking Company and the Alliance Bank, Limited, on and after the 1st prox.

Leeds.—The Corporate Property Committee of the Leeds Corporation, under the presidency of Alderman Sir Edwin Gaunt, have received a form of agreement between the Yorkshire House-to-House Company and the City Council for the supply of the electric light by that company to the Town Hall and Municipal Offices. The agreement has not been approved.

Rogers's Arc Lamp Company, Limited.—This Company has been registered with a capital of £20,000 in £5 shares, to acquire and turn to account certain inventions of J. W. Rogers for improvements in arc lamps, and to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity, electrical apparatus manufacturers, and the business of an electric light company.

Acton.—At the last meeting of the Local Board the Chairman said that it was very desirable that the residents in the district, and particularly those in the High street, should make the Board or their successors acquainted with their feeling with regard to the proposals of the London United Tramways Company to use electric traction, and to carry their line through the High-street as far as Acton Hill.

Maidstone.—The Urban District Council have held a meeting, at which Mr. Morling said, as the Council evidently intended doing nothing with the electric lighting order, he desired to give notice that at the next meeting he should propose that the order should be put out for tender. He maintained that the town should have the benefit of the money which had been spent in obtaining the order.

Smoke and Fumes Annihilator, Limited.—This Company has been registered with a capital of £120,000 to carry on business as manufacturers of smoke annihilators and other apparatus for the treatment of smoke or fumes, to manufacture and deal in carbon, ammoniacal or other liquor, and all other residual products obtained in the treatment of smoke or fumes, and to carry on business as general engineers, ironfounders, machinists, builders, painters, chemists, etc.

City and South London Railway.—The receipts of the Company for the week ended December 23 were £968, against £952 for the corresponding week of 1893, or an increase of £16. The total receipts for the current period of the present half-year amount to £22,447, as against £21,049 in the corresponding period of 1893, an increase of £1,398.

Sunderland.—A meeting of the Town Council was held on Wednesday, when some discussion was provoked by a proposition to appoint an assistant electrical engineer at a salary of £120 per annum, and this was ultimately carried, despite an amendment by Councillor Summerbell that the subject be brought up again six months hence. It was agreed that the electric light be placed in parts of the free library, at a cost of £69 for fittings, lamps, etc.

H.M.S. "Magnificent."—This new vessel, which has been launched at Chatham, will have three dynamos, each of 400 amperes and 80 volts, from which, by means of insulated cables, the current will be distributed to the search and incandescent lights. About 700 electric lamps will be fitted for the lighting of the ship, and this will be carried out in a very efficient manner, even the coal bunkers having enough lamps to brilliantly illuminate them when coal is being trimmed or being worked down to the stokeholds.

British Electro-Chemical Agency.—A petition for confirming a resolution reducing the capital of this Company from £75,000, divided in 7,500 shares of £10 each, to £50,000 divided into 2,500 vendors' shares of £10 each, and 5,000 ordinary shares of £5 each, such reduction to be effected by reducing the nominal amount of each of the 5,000 ordinary shares from £10 to £5, was on November 1 presented to her Majesty's High Court of Justice, and is now pending. The list of creditors of the Company is to be made out as for February 1, 1895.

Smoking Concert.—Mr. T. Harding Churton entertained his staff of employés at a smoking concert held at the Grand Restaurant, Leeds, on Friday last. During the course of a very enjoyable evening, Mr. Churton thanked his staff for the loyal manner in which by good honest work they had enabled him to so largely increase the scope of his operations during the past few years. Mr. W. S. Parkinson, in moving a vote of thanks to Mr. Churton for his hospitality, expressed a hope that they might have such gatherings annually. Mr. H. M. Tempest seconded the motion, which was carried with acclamation.

Leicester.—The Corporation scheme for supplying the electric light in the centre of the borough was completed at Leicester on Thursday last week, when the new illuminant was turned on in several shops with which the connection has been made. It is not at present intended to light the streets with electricity, but considerable improvement of the public lamps is contemplated, the new incandescent light being adopted near the clock tower. Some of the mains for the electric light are not yet laid, but the installation is sufficiently advanced to enable the Corporation to keep up the supply where the fittings are completed.

Leeds Tramways.—The Bill deposited at the Private Bill Office, which bears the endorsement of Mr. John Harrison, town clerk, for the construction of further tramways by the Leeds Corporation provides that the motive power may be either animal, steam, or other mechanical power, including electricity. The eight sections proposed to be constructed are described in the Bill. All the tramways will be double lines, and the period for their completion is five years from the passing of the Act. The Corporation ask for power to borrow for these works, and for relaying the existing tramways, the sum of £213,000.

Eastbourne.—The parish church is now illuminated by the electric light, the installation having been provided by the Eastbourne Electric Light Company. The church has 75 lights in all. The nave is lighted by five 5lb. wrought-iron coronæ of handsome design, and the chancel has 25 lights, chiefly distributed in wrought-iron brackets. The remainder are distributed in the side aisles and vestries. The switching arrangement is perfect, as ensuring economy in using the light, it enabling as few or many lights to be used as required. The whole installation has been carried out in accordance with the Phœnix Office fire rules.

Chelmsford.—A document, addressed to the Chelmsford Electric Lighting Company, has been signed by a large number of consumers of electricity in the town, expressing the feeling that it would be a decided advantage to have the current supplied as many hours a day as possible, especially during the dark days before and after Christmas. At present the current is on from two o'clock in the afternoon until ten o'clock the next forenoon. The consumers stated that they require a light all day on such days as are now being experienced, especially in dark shops and warehouses. Some are asking also how they could cook their dinner, if they had the electric cooking apparatus, when the current is off just at dinner time?

Harrow.—In consequence of the decision of the public meeting, to which we have previously referred, held to consider whether or not the Board should go forward with the electric light scheme, the Harrow Local Board have resolved to sell the right of the provisional order granted a few months ago to Messrs. Crompton and Hawtayne on the condition that these gentlemen pay the full cost the Board have been put to to secure the order. Messrs. Crompton and Hawtayne offered £300 for the provisional order, and agreed to sell the plant, etc., to the Local Board in seven years if the Board then desired to light the town themselves, subject, of course, to certain conditions. The expenses of the Board have been somewhere about £340, so that it is probable the new Council will accept the offer.

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Worcester.—Alderman Walter Holland mentioned at a meeting of the Watch Committee of the Town Council last week the question of the lighting of Stanley-road, Vincent-road, and Cecil-road. An estimate prepared by the city engineer showed that the cost of lighting the streets by electricity would be £460 for 11 street lamps, and that the amount payable to the gas company for lighting the streets would be £24. 4s. per annum. As the mains would pass near the workhouse, Mr. Caink suggested that the new Board of Guardians might decide to light the workhouse with electricity. It was decided to defer the matter for the present.

Appointments Vacant.—A junior demonstrator and lecturer in physics is required by the committee of University College, Nottingham. The salary is £120 a year. Applications must be sent to the secretary by January 11.—The Blackburn Corporation want an electrical engineer to take charge of their station when completed. The salary is £200 a year.—The St. Pancras Vestry require an assistant engineer at the Regent's Park central station; salary £3 per week. Also a youth as improver; salary 10s. per week. Particulars appear in our advertisement columns.—The Corporation of Bristol are prepared to receive applications for the appointment of clerk of works to superintend the electrical installation at the Guildhall; salary £2 per week. Particulars are given in our advertisement columns.

Cardiff.—The series of experiments which has been carried on during the past few weeks in connection with the installation of electric light at Cardiff, has resulted so satisfactorily that the light was turned on permanently on Saturday evening. The members of the Lighting Committee of the Corporation, as well as the engineers, have been congratulated by many persons in a position to speak on the matter on the present result of the scheme, and the excellence of the light. The reason the light was not used permanently until Saturday was that the officials were waiting until reserve rectifiers and transformers were at Cardiff, ready to be used in case of a breakdown. The whole of the machinery is now in working order. After the holidays it has been decided by the Corporation to give the gas company the required week's notice to cease supplying gas to street lamps over the area covered by the electric light.

Glasgow.—Fourteen of the Corporation cars have been fitted with electric lamps, and the necessary fittings will be provided in all the vehicles as quickly as the contractors are able to overtake the work. The plan now adopted has the advantage of having been tested with satisfactory results. The lighting of each car is effected by means of four lamps—two inside and two outside. The electric current is provided by four batteries, two being placed at either end of the car. Each lamp is of 8 c.p. The inside lamps or domes are attached to the roof in such a manner as not only to light the interior of the car, but also to illuminate the platforms and steps. The outside domes are supported on hollow standards rising from each end of the vehicle, the electric wires being inside the standards. The outside domes contain the coloured signal lights indicating the route on which the cars are plying, and at the same time light the tops of the vehicles.

Bath.—The Town Council have considered an application from the electric lighting company for the consent of the authority to an application to the Board of Trade for a provisional order extending the license to 42 years, and also the area of lighting. Mr. E. B. Titley, solicitor to the company, was heard in support of the application. He said that about £45,000 had been spent by the company, and only a dividend of 4 per cent. had been paid. If the authority would not consent to the provisional order, the company were prepared to hand over the undertaking at the amount of their capital expenditure. After a brief discussion, it was agreed not to consent to the application, on the ground that it was desirable that, at the expiration of the seven years' license, the Council should take steps to get the electric lighting into their own hands. It was also agreed to obtain the services of a consulting electrical engineer to advise them generally upon the subject.

Hampstead.—An extension of electric lighting in Hampstead has recently taken place, the premises of several tradesmen in the High-street being lighted under the supervision of the Vestry's Electric Lighting Committee. The current was first switched on to the premises of Mr. E. Elliott—himself a member of that committee—which have been provided by Mr. W. Thompson, of Heath-street, with two Crompton-Pochin 1,000-c.p. arc lamps for external illumination, together with a number of 16-c.p. incandescent lights inside Mr. Elliott's two shops. Other shops were also illuminated by means of incandescent lamps. Amongst those who were present at this introduction of the electric light into the High-street were Mr. James Thwaites, chairman of the Electric Lighting Committee, with Messrs. Padbury, Bence, C. H. Reed, and Underwood, members of the committee, Mr. Chattock, the electrical engineer, and Mr. Roscoe, representing Messrs. Siemens Bros. and Co., the contractors for the laying of the mains, which have now been brought as far as Gayton-road. There is now every prospect of the electric light being generally adopted in the Town Ward.

Swansea.—Mr. E. R. Daniel, at a meeting of the Town Council, moved the adoption of the minutes of the Property and General Purposes Committee, which we gave last week. He remarked that the decision of the committee to proceed with the lighting of the town by electricity meant a large expenditure of capital, and if Swansea was to keep to the front the Council must do something finally in this matter. With regard to the establishment of a metallurgical school in the town, the committee considered there was no reason why the Government should not be approached for pecuniary assistance. The committee had considered the question put them by some other bodies as to the proposed new route from Swansea to Newport, and considered it was their duty to obtain as many lines as possible to the port. The purchase of the Swansea tramways was also a matter of great importance to the town, and it was now intended to appoint a committee to go into the subject. Mr. Mayne seconded. Mr. Viner Leeder asked what the estimate for carrying out the electric lighting and the erection of the refuse destructor to be used therewith had amounted to. The minute practically sanctioned the scheme, but mentioned no amount. The Town Clerk said Mr. Manville's report estimated the total capital expenditure on the electric lighting at £36,735, and on the destructor at £11,287. Mr. D. Davies proposed an amendment that the question of site and other matters should be further considered in committee before the scheme was proceeded with, but this received no seconder, and fell to the ground.

Brighton.—Last week, at a meeting of the Town Council, Councillor Stafford moved the adoption of the special report from the Lighting Committee recommending the public lighting of certain streets of the borough by electricity, to which we referred in our last issue. The committee thought the time had come when the ratepayers should receive some benefit, and that the streets should be better lighted. He believed it would be the commencement of a scheme that would be continued, and he believed the price of electricity would be so low as to be obtainable for every alley, square, and street in Brighton, and for every householder. The report was seconded, and Councillor Weston advocated the claims of North-road for the electric light, and suggested that that thoroughfare should be added to the list. Councillor Wishart hoped the "horrible light" would not be adopted for their narrow streets, and stated the light was totally unfit for business purposes. Councillor Halliwell thought the Council should wait if they were to go to the expense of providing standards for the electric light; and Councillor White hoped if the light was to be put on the Marine-parade, the Council would light the road instead of the heavens. Alderman Reeves thought the committee were a little hurrying the matter, and that the town would benefit by waiting. He moved that the question be discussed that day six months. Councillor Armes seconded. Councillor Turton thought the proposal a superfluous one, and Councillor Broadbridge considered the committee could easily wait another 12 months. The amendment deferring report was eventually defeated by 18 to 10, and the report was afterwards adopted.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅜-6
Bournemouth Electric Company	—	—
Brush Company, Ordinary	2	2½-2⅝
—— Nom. Cum., 6 per cent. Pref.	2	2⅝-2¾
—— 4½ Debenture Stock	100	111-114
Charing Cross and Strand	5	4½-5½
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	14-15
—— 6 per cent. Cumulative Pref.	10	15-15½
—— 5 per cent. Debenture Stock	115	132-135
City and South London Railway, Consolidated Ordinary	100	42-44
—— 4 per cent. Debenture Stock	100	124-126
—— 5 per cent. Pref. Shares	10	13⅜-14½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	8-8½
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	97-102
Electric Construction, Limited	2	¼-½
—— 6 per cent. Debentures	—	93-97
—— 7 per cent. Cumulative Pref.	2	1½-2
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1⅛-1⅜
Elmore's French Company	2	1/16-3/16
Elmore's Wire Company	2	¾-1⅛
Fowler-Waring Cables	5	¼-1¼
W. T. Henley's Telegraph Works, Ordinary	10	8¼-9¼
House-to-House Company, Ordinary	5	2⅛-2½
—— 7 per cent. Preference	5	6¼-6⅝
India Rubber and Gutta Percha Works	10	25½-26½
—— 4½ per cent. Debentures	100	102-104
International Okonite, Ordinary	—	—
Kensington and Knightsbridge	5	4½-4⅝
—— 6 per cent. Pref.	—	6¼-6⅜
Liverpool Electric Supply, Ordinary	5	7⅛-7¼
—— Pref.	—	—
Liverpool Overhead Railway	10	8⅜-8⅝
—— Pref.	10	13-13½
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric	5	¾-1⅛
Metropolitan Electric Supply	10	9¼-10½
—— 5 per cent. Reg. Debentures, 1-10,000 in Bonds of £10, £20, and £40	—	—
National Telephone, Ordinary	5	5⅛-5⅜
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-16
—— 5 per cent. Nom. Cum. Third Pref.	5	5⅛ 6
—— 4½ per cent. Deb. Stock	—	110-113
Notting Hill Company	10	7½-7⅞
Oriental and Electric Company, £1 shares	1	1-1⅛
—— £5 Shares	—	7-7½
—— £4½ shares	—	5⅜-6¼
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7⅜-8⅛
—— 7 per cent. Pref.	5	8½-9
Swan United	—	—
Telegraph Construction and Maintenance	12	41-43
—— 5 per cent. Bonds	100	106-109
Westminster Electric Supply, Ordinary	5	7½-7⅞
Yorkshire House-to-House	4½	4⅜-4⅝

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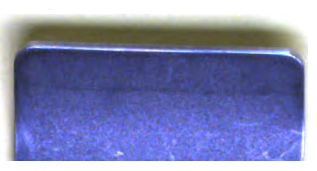

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